AMERICAN JOURNAL OF
Preventive Medicine

VOLUME 47(3S2) www.ajpmonline.org SEPTEMBER 2014

A Journal of the

ACPM American College of Preventive Medicine & APTR Association for Prevention Teaching and Research

ELSEVIER

AMERICAN JOURNAL OF
Preventive Medicine

A forum for the communication of information, knowledge, and wisdom in prevention science, education, practice, and policy.

A Journal of the ACPM American College of Preventive Medicine & APTR Association for Prevention Teaching and Research

Published by **Elsevier Inc**

www.ajpmonline.org

Acknowledgments

The opinions or views expressed in this professional education supplement are those of the authors and do not necessarily reflect the opinions or recommendations of the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, the National Institutes of Health Office of Disease Prevention, the National Institute of Mental Health, or the National Action Alliance for Suicide Prevention.

Dosages, indications, and methods of use for products that are referred to in the supplement by the authors may reflect their clinical experience or may be derived from the professional literature or other clinical sources. Because of the differences between in vitro and in vivo systems and between laboratory animal models and clinical data in humans, in vitro and animal data may not necessarily correlate with clinical results.

Editorial correspondence should be directed to:
American Journal of Preventive Medicine
University of Michigan School of Public Health
1415 Washington Heights
Ann Arbor MI 48109-2029

Tel (734) 936-1591
Fax (734) 936-1615

E-mail for AJPM business:
ajpm@umich.edu

E-mail for blog site:
ajpm-blog@umich.edu

E-mail for manuscript queries:
ajpm@umich.edu

E-mail for press queries:
ajpm@umich.edu

AJPM Online:
www.ajpmonline.org
AJPM blog site:
ajpmonline.wordpress.com

Fed Ex Address:
American Journal of Preventive Medicine
University of Michigan School of Public Health
1415 Washington Heights
Ann Arbor MI 48109-2029

Sponsoring Organizations' Offices:

American College of Preventive Medicine
Michael A. Barry, CAE
Executive Director
455 Massachusetts Avenue NW,
Suite 200
Washington DC 20001

Tel (202) 466-2044
Fax (202) 466-2662
www.acpm.org

Association for Prevention Teaching and Research

Allison L. Lewis
Executive Director
1001 Connecticut Avenue NW,
Suite 610
Washington DC 20036

Tel (202) 463-0550
Fax (202) 463-0555
www.aptrweb.org

Author's Instructions on AJPM's Website

Complete author's instructions and guidelines for submitting manuscripts to the **American Journal of Preventive Medicine** can be found on the **AJPM Online Website:** www.ajpmonline.org. The Journal welcomes brief reports (max. 1200 words); research articles (3000 words); RCTs/community-based trials (4000 words); and review articles (4000 words) on all aspects of practice, education, policy, and research in preventive medicine and public health. A list of common abbreviations, initialisms, and acronyms can be found in the Author Instructions on the website.

For Advertising Orders & Inquires: North & South America: Lorrie Young, Elsevier Inc., 360 Park Avenue South, New York NY 10010-1710; Tel (212) 633-3855; Email: lorrie.young@elsevier.com **International:** Advertising Department, Elsevier Inc., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom; Tel (+44) (0) 1865 843565; Fax (44) (0) 1865 843976; E-mail: media@elsevier.co.uk **Japan:** Advertising Department, Elsevier Science Japan; Tel (81) (3) 5561 5033; Fax (81) (3) 5561 5047.

Personal rates apply only when issues of the journal are sent to a private address and payment is made by personal check or credit card. Any enquiry relating to subscriptions should be sent to: **The Americas:** Elsevier Health Sciences Division, Subscription Customer Service, 3251 Riverport Lane, Maryland Heights MO 63043, USA; phone: (+1) (800) 6542452 [toll free number for US customers], or (+1) (314) 4478871 [customers outside US]; fax: (+1) (314) 4478029; E-mail: JournalsCustomerServiceusa@elsevier.com **Japan:** Elsevier, Customer Service Department, 4F Higashi-Azabu, 1-Chome Bldg, 1-9-15 Higashi-Azabu, Minato-ku, Tokyo 106-0044, Japan; phone: (+81) (3) 5561 5037; fax: (+81) (3) 5561 5047; E-mail: jp.info@elsevier.com **Asia Pacific *(excluding Japan)*:** Elsevier, Customer Service Department, 3 Killiney Road, #08-01 Winsland House I, Singapore 239519; phone: (+65) 63490222; fax: (+65) 67331510; E-mail: asiainfo@elsevier.com **Brazil:** Elsevier Inc., Rua Sete de Setembro 111/16 Andar, 20050-002 Centro, Rio de Janeiro-RJ, Brazil (Tel: (+55) (21) 509 5340. Fax: (+55) (21) 507 1991. E-mail: elsevier@campus.com.br). **Rest of the World: Amsterdam:** Elsevier, Customer Service Department, PO Box 211, 1001 AE Amsterdam, The Netherlands; phone: (+31) (20) 4853757; fax: (+31) (20) 4853432; E-mail: nlinfo-f@elsevier.com

The American Journal of Preventive Medicine is indexed and abstracted in Index Medicus/MEDLINE, EMBASE/Excerpta Medica, MEDLARS, Psychological Abstracts, PsycINFO, Sociological Abstracts, the Health Promotion and Education and the Cancer Prevention and Control Databases of CHID on BRS, the Smoking and Health Database on DIALOG, and Science Citation Index, Research Alert, and Current Contents.

The journal is printed on acid-free paper that meets the minimum requirements of ANSI Standard Z39.48-1984 (Permanence of Paper), beginning with volume 1, number 1.

AMERICAN JOURNAL OF
Preventive Medicine

Acknowledgments

The opinions or views expressed in this professional education supplement are those of the authors and do not necessarily reflect the opinions or recommendations of the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, the National Institutes of Health Office of Disease Prevention, the National Institute of Mental Health, or the National Action Alliance for Suicide Prevention.

Dosages, indications, and methods of use for products that are referred to in the supplement by the authors may reflect their clinical experience or may be derived from the professional literature or other clinical sources. Because of the differences between in vitro and in vivo systems and between laboratory animal models and clinical data in humans, in vitro and animal data may not necessarily correlate with clinical results.

Reflections on Expert Recommendations for U.S. Research Priorities in Suicide Prevention

Morton M. Silverman, MD, Jane E. Pirkis, PhD, Jane L. Pearson, PhD, Joel T. Sherrill, PhD

Introduction

The articles in this special supplement represent the collective thinking of suicide prevention experts from across the U.S. and several other countries about where research efforts might best be invested to address the vexing public health problem of suicide. The authors of these articles—and other suicide prevention experts—came together under the aegis of the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF), an initiative that was resourced by the National Institute of Mental Health (NIMH) and the Substance Abuse and Mental Health Services Administration (SAMHSA).[1]

As editors, we have had the pleasure of seeing this supplement come to fruition and the early manuscripts develop into articles that we are confident will have a major influence not only on the suicide prevention research agenda but also on reducing suicide. We brought different perspectives to our editorial roles. Two of us (Morton Silverman and Jane Pirkis) are career researchers with specialist expertise in various aspects of suicide prevention and were not directly involved in the RPTF process but were brought on board as independent editors. Two of us (Jane Pearson and Joel Sherrill) are members of the NIMH staff who oversee relevant portfolios of science and were involved in the RPTF initiative from the outset.

The articles in this supplement represent a subset of the presentations made by suicide prevention experts to inform the RPTF agenda. As editors, we served as "curators" and collated a representative set of articles that address the RPTF's Aspirational Goals (AGs) for suicide prevention.[2] The articles explicitly consider how these AGs might be achieved by reviewing existing research evidence, examining challenges to progress, and proposing future directions.

From the Suicide Prevention Resource Center (Silverman), Waltham, Massachusetts; the National Institute of Mental Health (Pearson, Sherrill), Rockville, Maryland; and the University of Melbourne, Melbourne School of Population and Global Health (Pirkis), Melbourne, Australia

Address correspondence to: Joel T. Sherrill, PhD, National Institute of Mental Health, 6001 Executive Blvd, Rockville MD 20892. E-mail: jsherril@mail.nih.gov.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.025

Scope of the RPTF Process and the Articles in This Supplement

Suicide prevention researchers are beset with methodological and ethical problems when they design studies. For example, universal or community-wide interventions are not always easily amenable to evaluation by RCTs; it can be difficult to select appropriate control conditions for trials testing interventions for at-risk or actively suicidal individuals, and sample sizes required to power studies become prohibitively large given the low base rate of suicide events. Such challenges have historically limited our understanding of what works and what doesn't work in suicide prevention.

The articles in this supplement grapple with these issues and make intelligent suggestions about how to overcome them. It should be noted that the articles represent abridged summaries of the research overviews that topic experts prepared to inform the research prioritization process. By design, the articles provide a snapshot of where the field is with regard to each AG, and the directions necessary to progress knowledge in the area. In each article, the authors cite relevant references that provide additional detail and serve as supplementary resources for readers.

The articles in this supplement summarize a unique undertaking in terms of the scope of the research prioritization activities and the RPTF process. The scope is remarkable, given the range of science that is considered (from basic science regarding the neurobiological underpinnings of suicide through science related to the dissemination/implementation of prevention strategies).

The RPTF approach was to simultaneously consider priorities and strategies within each AG, both short-term and longer-term. In this manner, researchers or funders might use the information to help identify overall priorities as well as priorities and promising directions within a given area of science, depending on their particular interests. The process is also unprecedented in suicide research in terms of the multistage, multigroup approach to collecting input, and in terms of the up-front attention to systematically using available data (e.g., burden estimates and simulations regarding the potential

impact of intervening in particular contexts) to guide the prioritization of research.

Other countries have engaged in research prioritization exercises, but, to our knowledge, none of those have occurred on this scale. In Australia in the mid-2000s, for example, Federal Government funding was provided for a project that examined existing priorities (through reviews of published literature and funded grants) and considered future priorities (through a questionnaire of stakeholders' views and a series of focus groups).[3,4] Existing priorities were re-examined last year.[5] This work showed that the bulk of the emphasis under Australia's National Suicide Prevention Strategy had been, and continues to be, given to epidemiologic studies at the expense of intervention studies.

This work in Australia was useful for identifying priorities, but this effort did not have the same machinery behind it as the RPTF. The Australian process relied on a small project team conducting what was effectively a series of small substudies, and sought the views of other researchers (and other relevant stakeholders) in a systematic but somewhat limited way. The process of drawing together topic experts from across the spectrum of suicide prevention research, and asking them to consider and write about the way in which research could be improved, clearly identifies the work of the RPTF as groundbreaking.

Prioritizing Across Interrelated but Diverse Areas of Science

The individual papers reflect concise reviews of the science related to specific AGs; as such, the papers stand alone. Table 1 lists the RPTF AGs and the corresponding papers in this special supplement. Nevertheless, there is substantial interdependence among the AGs and the corresponding papers, and some goals are inexorably linked.

For example, the science of developing and testing interventions to address individuals who have attempted suicide will share much in common in terms of content and approach with that related to interventions targeting other at-risk groups (e.g., individuals at risk due to depression or other psychiatric/substance use disorders[13]). Likewise, although psychotherapeutic interventions[12] and pharmacologic interventions[14] are addressed in separate reviews, as Griffiths et al.[14] note, it seems likely that optimizing prevention and treatment will ultimately require deploying evidence-based approaches in combination or sequentially.

Many if not most of the goals are not only interdependent, but also serially dependent in terms of their role in achieving prevention aims. For example, the development of effective screening instruments and practices[8,9] and actionable risk stratification algorithms[11] depends on earlier stages of science that identify readily assessed risk factors that are highly correlated with the likelihood of attempting suicide.[10] Similarly, the development and testing of effective interventions depends on the identification of modifiable risk and etiologic or maintaining factors that represent potential intervention targets, including neurobiological targets.[6,7]

Furthermore, the ultimate utility of screening and intervention approaches will depend not only on the development of effective preventive and therapeutic strategies but also on the development of effective strategies for training providers to ensure research-informed approaches are disseminated and implemented with fidelity.[16] Finally, the degree to which screening, identification, and intervention ultimately lead to a reduction in the rate of suicide deaths and attempts will depend on effective systems-level approaches to ensure the availability of and access to affordable, effective services.[17,18]

The interdependence of these AGs poses challenges for prioritizing across the full range of science. Is it necessary to first achieve a firm understanding of the causes of suicidal behavior before undertaking research on potential prevention strategies, or is it more important to prioritize science that has the potential for the most immediate impact on reducing suicide attempts and deaths (e.g., development and testing of effective preventive interventions and strategies)? Should efforts focus on broad-based prevention[21–23] and efforts to increase help-seeking[19] or on more intensive, targeted preventive or therapeutic interventions with high-risk groups (e.g., attempters,[15] the elderly[20])? If multilevel, layered interventions of varying intensities afford the best protection, as suggested by Niederkrotenthaler and collegues,[19] what is the optimal combination of interventions?

The approach involved providing experts with several information inputs as they considered optimal research pathways.[1] These inputs included examples of stakeholders' ideas as to why a particular AG would help reduce suicide attempts and deaths (including summaries of stakeholder feedback and verbatim suggestions); data regarding what was known, or not known, about the scope (e.g., epidemiology or burden); and summaries of the current evidence and state of the science relevant to their AG topic.

This process often pushed experts to consider research gaps (and AGs) outside their "comfort zones," particularly in areas that would affect their estimates of the public health impact of their research focus. For example,

Table 1. Aspirational goals and corresponding supplement manuscripts

Aspirational goal	Aspirational goal topic	Corresponding supplement manuscripts
1	Know what leads to, or protects against, suicidal behavior, and learn how to change those things to prevent suicide.	• Epigenetics and suicidal behavior research pathways[6] • Neurobiological risk factors for suicide: insights from brain imaging[7]
2	Determine the degree of suicide risk (e.g., imminent, near-term, long-term) among individuals in diverse populations and in diverse settings through feasible and effective screening and assessment approaches.	• Suicide risk screening and assessment: designing instruments with dissemination in mind[8] • Screening youth for suicide risk in medical settings: time to ask questions[9]
3	Find ways to assess who is at risk for attempting suicide in the immediate future.	• Improving the short-term prediction of suicidal behavior[10] • Prognostic models to detect and monitor the near-term risk of suicide: state of the science[11]
4	Ensure that people who are thinking about suicide but have not yet attempted receive interventions to prevent suicidal behavior.	• Evidence-based psychotherapies for suicide prevention: future directions[12] • Alcohol and suicidal behavior: what is known and what can be done?[13]
5	Find new biological treatments and better ways to use existing treatments to prevent suicidal behavior.	• Existing and novel biologic therapeutics in suicide prevention[14]
6	Ensure that people who have attempted suicide can get effective interventions to prevent further attempts.	• Evidence-based follow-up care for suicide prevention: where do we go from here?[15] • Alcohol and suicidal behavior: What is known and what can be done?[13]
7	Ensure that healthcare providers and others in the community are well trained in how to find and treat those at risk.	• Advancing training to identify, intervene, and follow up with individuals at risk for suicide through research[16]
8	Ensure that people at risk for suicidal behavior can access affordable care that works, no matter where they are.	• National pathways for suicide prevention and health services research[17] • Prioritizing research to reduce youth suicide and suicidal behavior[18]
9	Ensure that people getting care for suicidal thoughts and behaviors are followed throughout their treatment so they do not fall through the cracks.	• National pathways for suicide prevention and health services research[17] • Prioritizing research to reduce youth suicide and suicidal behavior[18]
10	Increase help-seeking and referrals for at-risk individuals by decreasing stigma.	• Increasing help-seeking and referrals for individuals at risk for suicide by decreasing stigma: the role of mass media[19]
11	Prevent the emergence of suicidal behavior by developing and delivering the most effective prevention programs to build resilience and reduce risk in broad-based populations.	• Suicide in later life: challenges and priorities for prevention[20] • Developmental approach to prevent adolescent suicides: Research pathways to efficacious interventions[21] • Promising strategies for advancement in knowledge of suicide risk factors and suicide prevention[22]
12	Reduce access to lethal means that people use to attempt suicide.	• Reducing a suicidal persons' access to lethal means of suicide: a research agenda[23]

experts who were asked about the benefits of providing effective psychotherapy to prevent reattempts had to rely on estimates from longitudinal data of reattempt rates, which highlighted the need for better data regarding the rate of reattempts in the U.S. Therefore, experts in psychotherapy might identify information on the trajectories of suicide attempters over time as a priority, in addition to intervention research needs.

A science has developed that helps identify such research gaps: value of information (VOI) analysis is a

strategy to inform priorities that can improve the effectiveness of spending on health research.[24] VOI provides an analytic approach to establish the value of acquiring additional information to inform a decision about how to approach a clinical problem. In the context of the RPTF, an informal VOI-like approach helped the experts identify gaps in knowledge and focus on essential information needed in the U.S. to refine suicide research prioritization that would contribute to the ultimate goal of reducing the number of suicide attempts and deaths.

Future Directions to Advance Suicide Prevention Science

Suicide has been a challenging and perplexing behavior to study because suicidal behaviors are multidetermined and multifactorial, thus defying simple models of etiology and pathogenesis. As with the aforementioned Australian review and research prioritization, the RPTF process and literature reviews highlight the fact that much more is known about the general epidemiology of suicide and potential risk factors.

Although the literature is replete with studies that identify various correlates, much less is known about mutable risk factors that carry substantial variance and might represent actionable intervention targets, and far less is known about effective strategies for preventing attempts and deaths. Despite the fact that, from a distance, the epidemiologic data suggest that we have made very little headway in significantly reducing the national suicide rate over the last 50 years, the research findings have been accumulating. The building blocks have been put in place: The critical factors have been identified and methodologies to study the problems have been evolving.

As part of the RPTF process, the NIH issued a "request for information" (RFI) regarding key methodological roadblocks and potential new paradigms for suicide prevention science (Guide Notice: NOT-MH-12-017; see Action Alliance's RPTF agenda, pp. 66–70, for a description of the RFI process and responses). Across the papers, many authors explicitly or implicitly suggest similar themes regarding challenges and barriers that parallel the responses to the RFI.

The authors also noted various strategies that might help overcome barriers and facilitate progress, such as enhanced research infrastructure, including the development of a national cadre of well-trained researchers and clinicians with specialized expertise, to increase research capacity in the field; more timely, integrated regional and national surveillance data systems, to allow for more accurate burden estimates and to track progress at reducing attempts and deaths; a uniform classification system to describe suicidal phenomena paired with standardized data collection,[25] integration, and sharing (and application of emerging strategies for leveraging "big data") to promote data sharing and meta-analyses; and utilization of new methodologies and analytic approaches to facilitate study of low base rate events.

Within and across the AGs, it is also evident that translational science and interdisciplinary research collaboration ("team science") will be critical for advancing science and ultimately identifying effective prevention strategies. We believe that the time is now to stimulate and support creative, cross-cutting research on suicide. A careful reading of these research summaries will confirm that we are on the brink of breakthroughs in many areas and lines of research.

One goal in publishing this supplement is to highlight opportunities for researchers in the area of suicide and for other talented scientists who have not yet applied their skills and techniques to the study of suicidal behaviors. As noted above, the papers in this series highlight the fact that progress will require interdisciplinary, collaborative science; likewise, coordinated, collaborative approaches to supporting research, involving both public and private partners, can effectively advance the prevention of suicide through cross-cutting and interactive research. The papers in this supplement, like the RPTF agenda itself, are intended as inspirational resources that highlight the challenges and rewards of engaging in suicide prevention research, and suggest future research directions that have the potential to advance the overall goal of reducing attempts and deaths.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The editor authors would like to acknowledge and thank Maureen Iselin and Chelsea Booth, PhD for their thoughtful assistance in editing, and efficient efforts at coordinating the receipt and review of manuscripts for this supplement.

No financial disclosures were reported by the authors of this paper.

References

1. Pearson JL, Claassen C, Booth CL. Introduction to the suicide prevention Research Prioritization Task Force special supplement: the topic experts. Am J Prev Med 2014;47(3S2):S102–S105.
2. Claassen CA, Pearson JL, Khodyakov D, et al. Reducing the burden of suicide in the U.S.: the aspirational research goals of the National

Action Alliance for Suicide Prevention Research Prioritization Task Force. Am J Prev Med 2014;47(3S2):S309–S315.
3. Niner S, Pirkis J, Krysinska K, et al. Research priorities in suicide prevention: a qualitative study of stakeholders' views. Aust eJ Adv Mental Health 2009;8:1–9.
4. Robinson J, Pirkis J, Krysinska K, et al. Research priorities in suicide prevention: a comparison of current research efforts and stakeholder-identified priorities. Crisis 2008;29(4):180–90.
5. Robinson J, Pirkis J. Research priorities in suicide prevention: an examination of Australian-based research 2007–2011. Aust Health Rev 2014;38(1):18–24.
6. Turecki G. Epigenetics and suicidal behavior research pathways. Am J Prev Med 2014;47(3S2):S144–S151.
7. Cox Lippard E, Johnston J, Blumberg H. Neurobiological risk factors for suicide: insights from brain imaging. Am J Prev Med 2014;47(3S2): S152–S162.
8. Boudreaux E, Horowitz L. Suicide risk screening and assessment: designing instruments with dissemination in mind. Am J Prev Med 2014;47(3S2):S163–S169.
9. Horowitz L, Bridge J, Pao M, Boudreaux E. Screening youth for suicide risk in medical settings: time to ask questions. Am J Prev Med 2014; 47(3S2):S170–S175.
10. Glenn C, Nock M. Improving the short-term prediction of suicidal behavior. Am J Prev Med 2014;47(3S2):S176–S180.
11. Claassen C, Harvilchuck-Laurenson J, Fawcett J. Prognostic models to detect and monitor the near-term risk of suicide: state of the science. Am J Prev Med 2014;47(3S2):S181–S185.
12. Brown G, Jager-Hyman S. Evidence-based psychotherapies for suicide prevention: future directions. Am J Prev Med 2014;47(3S2): S186–S194.
13. Conner K, Bagge C, Goldston D, Ilgen M. Alcohol and suicidal behavior: what is known and what can be done. Am J Prev Med 2014;47(3S2):S204–S208.
14. Griffiths J, Zarate C, Rasimas JJ. Existing and novel biologic therapeutics in suicide prevention. Am J Prev Med 2014;47(3S2):S195–S203.
15. Brown G, Green C. Evidence-based follow-up care for suicide prevention: where do we go from here? Am J Prev Med 2014;47(3S2): S209–S215.
16. Osteen P, Frey J, Ko J. Advancing training to identify, intervene, and follow-up with individuals at risk for suicide through research. Am J Prev Med 2014;47(3S2):S216–S221.
17. Ahmedani B, Vannoy S. National pathways for suicide prevention and health services research. Am J Prev Med 2014;47(3S2):S222–S228.
18. Bridge J, Horowitz L, Fontanella C, Grupp-Phelan J, Campo J. Prioritizing research to reduce youth suicide and suicidal behavior. Am J Prev Med 2014;47(3S2):S229–S234.
19. Niederkrotenthaler T, Reidenberg D, Benedikt T, Gould M. Increasing help-seeking and referrals for individuals at risk for suicide by decreasing stigma: the role of mass media. Am J Prev Med 2014;47(3S2): S235–S243.
20. Conwell Y. Suicide in later life: challenges and priorities for prevention. Am J Prev Med 2014;47(3S2):S244–S250.
21. Wyman P. Developmental approach to prevent adolescent suicides: research pathways to efficacious interventions. Am J Prev Med 2014; 47(3S2):S251–S256.
22. Sareen J, Isaak C, Katz L, Bolton J, Enns M, Stein M. Promising strategies for advancement in knowledge of suicide risk factors and suicide prevention. Am J Prev Med 2014;47(3S2):S257–S263.
23. Barber C, Miller M. Reducing a suicidal person's access to lethal means of suicide: a research agenda. Am J Prev Med 2014;47(3S2):S264–S272.
24. Claxton KP, Sculpher MJ. Using value of information analysis to prioritise health research: some lessons from recent UK experience. Pharmacoeconomics 2006;24(11):1055–68.
25. Data and Surveillance Task Force of the National Action Alliance for Suicide Prevention. Improving national data systems for surveillance of suicide-related events. Am J Prev Med 2014;47(3S2):S122–S129.

Introduction to the Suicide Prevention Research Prioritization Task Force Special Supplement

The Topic Experts

Jane L. Pearson, PhD, Cynthia A. Claassen, PhD, Chelsea L. Booth, PhD, on behalf of the Research Prioritization Task Force of the National Action Alliance for Suicide Prevention

Despite continued public and private research investments in suicide prevention over the past several decades, there is no evidence of an overall decrease in suicide deaths or attempts. The Research Prioritization Task Force (RPTF) has developed the first U.S. research prioritization plan aimed at producing the knowledge necessary to substantially reduce the national suicide burden using multiple inputs and work products. A critical step in the process was engaging several types of expert research groups to consider how the diverse field of suicide prevention could accomplish this task. In 2012, two of these groups were asked to consider the state of the science associated with 12 potentially burden-reducing research goals selected by the RPTF from a national stakeholder survey. These groups identified research challenges and roadblocks and proposed research pathways for these 12 goals. This special supplement includes summaries of that work as well as specific background activities that prepared key information (e.g., surveillance resources, literature review quality, models of interventions) developed by RPTF staff and supplied to these expert groups. The NIH and CDC, as federal supporters of this supplement, are pleased to share these resources with the field.

Introduction

There is no real evidence that public and private research investments in suicide prevention over the past several decades have resulted in an overall decrease in suicide deaths or attempts. The National Action Alliance for Suicide Prevention was established in 2010 as a public–private partnership to explore barriers to progress and garner support for broad-based, multi-level strategic suicide prevention initiatives. One of the Action Alliance's first efforts was to assemble the RPTF in order to develop national priorities for U.S. suicide prevention science.[1]

The Expert Panels and Their Functions

The process and rationale the RPTF used in prioritizing suicide research has been described elsewhere.[2] Briefly, the RPTF process utilized input from a series of diverse suicide prevention expert groups working in tandem with the RPTF and its staff to delineate promising research pathways toward a set of 12 previously defined "Aspirational Goals" (AGs).[3] The RPTF AGs were derived from a national stakeholder survey via a modified Delphi process and are believed to be areas of focus necessary to the prevention of substantial numbers of suicide deaths and attempts.[4]

After the goals were set, diverse expert panels were recruited to help compile various types of information required during the decision-making processes associated with the final research agenda. A panel of highly cited researchers with diverse expertise and capabilities (called the "Overview Experts") was responsible for development of the agenda as a whole. A second panel (composed of "Topic Experts" and "Discussants") included researchers with specialized, well-recognized expertise relevant to one of the 12 AGs. This group volunteered time in 2012–2013 to present their views on research challenges and approaches to a particular AG (Table 1). Finally, a handful of individuals with highly specialized expertise within the aforementioned areas[5] were recruited by the RPTF and its support staff to address key information needs that were otherwise still unmet.

Forging Research Objectives and Pathways for Each AG

The process of forging detailed research objectives for each AG included several steps. RPTF staff first

From the Division of Services and Intervention Research, National Institute of Mental Health (Pearson); Suicide Prevention Branch; Division of Prevention, Traumatic Stress, and Special Programs, Substance Abuse and Mental Health Services Administration (Booth), Rockville, Maryland; and the University of North Texas Health Science Center (Claassen), Fort Worth, Texas

Address correspondence to: Jane L. Pearson, PhD, National Institute of Mental Health, 6001 Executive Blvd, Room 7133, Rockville MD 20892. E-mail: jpearson@mail.nih.gov.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.05.027

Table 1. Twelve aspirational goals of the research prioritization process of the National Action Alliance for Suicide Prevention

Aspirational Goal 1—Know what leads to, or protects against, suicidal behavior, and learn how to change those things to prevent suicide.
Aspirational Goal 2—Determine the degree of suicide risk (e.g., imminent, near-term, long-term) among individuals in diverse populations and in diverse settings through feasible and effective screening and assessment approaches.
Aspirational Goal 3—Find ways to assess[a] who is at risk for attempting suicide in the immediate future.
Aspirational Goal 4—Ensure that people who are thinking about suicide but have not yet attempted receive interventions to prevent suicidal behavior.
Aspirational Goal 5—Find new biological treatments and better ways to use existing treatments to prevent suicidal behavior.
Aspirational Goal 6—Ensure that people who have attempted suicide can get effective interventions to prevent further attempts.
Aspirational Goal 7—Ensure that health care providers and others in the community are well trained in how to find and treat those at risk.
Aspirational Goal 8—Ensure that people at risk for suicidal behavior can access affordable care that works, no matter where they are.
Aspirational Goal 9—Ensure that people getting care for suicidal thoughts and behaviors are followed throughout their treatment so they don't fall through the cracks.
Aspirational Goal 10—Increase help seeking and referrals for at-risk individuals by decreasing stigma.
Aspirational Goal 11—Prevent the emergence of suicidal behavior by developing and delivering the most effective prevention programs to build resilience and reduce risk in broad-based populations.
Aspirational Goal 12—Reduce access to lethal means that people use to attempt suicide.

[a]Although stakeholders indicated that predicting who is at imminent risk was an aspirational research goal, expert consultants recommended that assessments focused on finding treatable conditions or symptoms were more actionable than prediction per se. Therefore, this goal has been reworded.

developed and posted supporting background materials online along with Topic Experts' narrated PowerPoint presentations. The website containing this material permitted review and discussion by Topic Experts/Discussants, Overview Experts, and RPTF members. A structured, real-time conversation between Topic Experts/Discussants and Overview Experts on each AG took place a few weeks after materials were posted via telephone conference call. During these calls, Topic Experts provided a brief summary of their narrated presentations, Discussants provided a critique of Topic Expert presentations, and proposed research pathways were reviewed with Overview Experts.

Background Materials for the RPTF's Final Priorized Agenda

Four types of background material were required in the discussions that preceded assemblage of the final agenda. Specifically, these AG-specific information streams each included (1) a summary of the current status of research in the area encompassed by that AG; (2) a description of the research breakthroughs or barriers needed to facilitate progress toward realization of the AG; (3) conceptualization of one or more AG-specific research pathway (e.g., sequenced research activities needed to realize that goal); and (4) estimates of the degree of suicide burden (attempts or deaths) that will be eliminated when the goal is realized.

First, RPTF staff provided the expert working groups with a brief summary describing the state of the science in each AG research area. Efforts were made to identify existing theories (e.g., Joiner's interpersonal theory) or highlight the absence of relevant theory (e.g., how or why individuals select a suicide method). These summaries also reviewed important methodologic issues and relevant research strategies (e.g., reaction time to verbal stimuli in detecting near-term risk of suicidal behavior).

Topic Experts were offered the opportunity to enhance these staff-prepared reviews and were invited to provide key reviews or references they believed would be essential to expert deliberations. Abstracts of these references along with key points suggested by Topic Experts were included in background materials prior to posting on the shared website. A systematic review of the quality of suicide literature was ongoing at the time of the Topic Expert presentations and, where possible, conclusions from that review were also included in these background materials.[6]

Second, information derived from qualitative analysis of the stakeholder survey that led to the 12 AGs was provided as part of this process.[7] In some cases, verbatim suggestions from survey respondents were reported to experts to illustrate how stakeholders viewed particular areas of research or as a way to define parameters for the AG. Third, logic models developed by RPTF staff were provided. These models were intended to illustrate underlying constructs and moderators relevant to scientific work in the research area addressed by a given AG.

Finally, RPTF staff worked to identify suicide burden information relevant to each AG, such as national surveillance or large community estimates that can serve as the basis for credible estimates of the potential impact of particular lines of research on numbers of U.S. attempts or deaths). For instance, identifying data sources that can provide information on the number of suicide-attempting individuals who access health care prior to a suicidal act but then are not adequately identified or treated suggests the potential impact of a significant breakthrough in both risk detection and screening research (Table 1, AG 2 and 3).

Manuscripts describing the experience and results of preparing these four types of background information are found in Section One of this supplement. These papers include a review of literature quality,[6] a qualitative analysis of the stakeholder survey,[7] a description of efforts to evaluate the quality and ease of use of existing surveillance data systems,[8] a discussion of approaches to defining the burden of suicide attempts and deaths within particular contexts where high numbers of individuals at risk might be found,[9] and an approach to modeling potential various proposed interventions to prevent attempts and save lives.[10]

Section Two in this supplement is composed of work by Topic Expert panel members who share their goal-specific research ideas in brief papers. When Topic Experts were unable to develop a manuscript for this supplement, other experts on that topic were invited to submit succinct manuscripts and were provided with RPTF background materials. For these manuscripts, Topic Expert authors were asked to first summarize the state of the science for their particular AGs and identify any definitional issues for particular variables or constructs. Next, experts were asked to take a long view and propose scientific approaches that would accomplish that AG, noting that goals vary in the degree to which there is existing research to support links among constructs.

Experts were then asked to identify research barriers, challenges, or roadblocks, which might permit research progress, if addressed. Many of these barriers are methodologic or infrastructural in nature; some address the lack of U.S. surveillance data to inform the scope and trajectory of suicidal behaviors (e.g., changes in selection of attempt methods) or the absence of research on a particular technology required to study a problem (e.g., contagion of a suicide means through social media networking). After studying their assigned research challenge, some experts used an AG logic model prepared by RPTF staff[1]; others preferred to suggest alternative model(s). Finally—and most importantly—authors were asked to identify the most pressing research questions and objectives that would need to be addressed in order for scientific advancement to occur within their research area.

Although these papers do not fully reflect the extensive discussions and debates among the experts, the manuscripts in this special supplement provide a glimpse of both the scope and diversity of input that has characterized the development process for this first-ever U.S. prioritized research agenda for suicide prevention. The input of Topic Experts was particularly critical to final agenda development in that they provided the vision necessary to delineate the research activities with potential to substantially reduce the numbers of suicide deaths and attempts in the U.S. We are grateful for the contributions of the hundreds of individuals who volunteered to participate in the research prioritization process, and now its dissemination. The nature of scientific dialogue around suicide prevention activities has changed to a plan of action to save lives.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The Research Prioritization Task Force (RPTF) gratefully acknowledges the support for this supplement provided by the CDC, Office of Noncommunicable Diseases, Injury, and Environmental Health, and the following NIH Offices: The Office of Behavioral and Social Sciences Research, the Office of Disease Prevention, and the Office of Rare Diseases. The National Institute of Mental Health (NIMH) and the Substance Abuse and Mental Health Services Administration provided staffing support for the RPTF and this publication effort. The NIMH staff wish to thank *American Journal of Preventive Medicine* Editors Charlotte Seidman and Angela Beck for their helpful guidance through this publication effort.

The views presented herein are those of the authors and do not necessarily represent the views of the NIH, CDC, the Substance Abuse and Mental Health Services Administration, or USDHHS.

No financial disclosures were reported by the authors of this paper.

References

1. National Action Alliance for Suicide Prevention. actionallianceforsuicideprevention.org.
2. Claassen C. National Action Alliance for Suicide Prevention Research Prioritization Task Force. The agenda development process of the U.S.' National Action Alliance for Suicide Prevention Research Prioritization Task Force. Crisis 2013;34(3):147–55.

3. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
4. Claassen C, Pearson J, Khodyakov D, et al. Reducing the burden of suicide in the U.S.: the aspirational research goals of the National Action Alliance for Suicide Prevention Research Prioritization Task Force. Am J Prev Med 2014;47(3):309–14.
5. Cox Lippard ET, Johnston JAY, Blumberg HP. Neurobiological risk factors for suicide: insights from brain imaging. Am J Prev Med 2014;47(3S2):S152–S162.
6. Molock S, Heekin JM, Matlin SG, Barksdale CL, Gray E, Booth CL. The baby or the bathwater? Lessons learned from the National Action Alliance for Suicide Prevention Research Prioritization Task Force literature review. Am J Prev Med 2014;47(3S2):S115–S121.
7. Booth CL. Experiences and wisdom behind the numbers: qualitative analysis of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force stakeholder survey. Am J Prev Med 2014;47(3S2):S106–S114.
8. Data and Surveillance Task Force of the National Action Alliance for Suicide Prevention. Improving National Data Systems for Surveillance of Suicide-Related Events. Am J Prev Med 2014;47(3S2):S122–S129.
9. Colpe LJ, Pringle BA. Data for building a national strategy to reduce suicide in the U.S.: what we have and what we need. Am J Prev Med 2014;47(3S2):S130–S136.
10. Lynch F. Population health outcome models in suicide prevention policy. Am J Prev Med 2014;47(3S2):S137–S143.

Experiences and Wisdom Behind the Numbers

Qualitative Analysis of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force Stakeholder Survey

Chelsea L. Booth, PhD

Background: The Research Prioritization Task Force of the National Action Alliance for Suicide Prevention conducted a stakeholder survey including 716 respondents from 49 U.S. states and 18 foreign countries.

Purpose: To conduct a qualitative analysis on responses from individuals representing four main stakeholder groups: attempt and loss survivors, researchers, providers, and policy/administrators. This article focuses on a qualitative analysis of the early-round, open-ended responses collected in a modified online Delphi process, and, as an illustration of the research method, focuses on analysis of respondents' views of the role of life and emotional skills in suicide prevention.

Methods: Content analysis was performed using both inductive and deductive code and category development and systematic qualitative methods. After the inductive coding was completed, the same data set was re-coded using the 12 Aspirational Goals (AGs) identified by the Delphi process.

Results: Codes and thematic categories produced from the inductive coding process were, in some cases, very similar or identical to the 12 AGs (i.e., those dealing with risk and protective factors, provider training, preventing reattempts, and stigma). Other codes highlighted areas that were not identified as important in the Delphi process (e.g., cultural/social factors of suicide, substance use).

Conclusions: Qualitative and mixed-methods research are essential to the future of suicide prevention work. By design, qualitative research is explorative and appropriate for complex, culturally embedded social issues such as suicide. Such research can be used to generate hypotheses for testing and, as in this analysis, illuminate areas that would be missed in an approach that imposed predetermined categories on data.

(Am J Prev Med 2014;47(3S2):S106–S114) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

This paper presents results from a discourse analysis of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force (RPTF) stakeholder survey. The survey has been described in detail elsewhere[1]; briefly, multiple comments from 716 respondents representing 49 U.S. states and 18 countries[a] were gathered in the initial data-generating round of a modified Delphi process. In this initial round from August 8 to November 11, 2011, an opportunistic sample of individuals from a wide variety of suicide-related organizations and departments were asked to generate ideas ("goals") for a suicide prevention research agenda. These early-round, open-ended responses fed into the modified Delphi process—which involved a more structured and constrained response format as part of an iterative consensus process to identify the 12 Aspirational Goals (AGs) discussed throughout this supplement.

From the Suicide Prevention Branch; Division of Prevention, Traumatic Stress, and Special Programs; Substance Abuse and Mental Health Services Administration, Rockville, Maryland

Address correspondence to: Chelsea L. Booth, PhD, Public Health Advisor, Substance Abuse and Mental Health Services Administration, 1 Choke Cherry Road, Room 6-1114. Rockville MD 20857. E-mail: chelsea.booth@samhsa.hhs.gov.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.021

[a]Australia, Austria, Belgium, Canada, China, Denmark, France, Germany, Hong Kong, Israel, Italy, Mexico, New Zealand, Norway, Pakistan, Sweden, Switzerland, and the United Kingdom.

The goal of this qualitative analysis was to provide additional perspectives for use in the research prioritization process, specifically in-depth analysis of the complex way respondents thought about suicide prevention and suicide prevention research. As will become clear throughout this paper, distinctions are not always made between the two. Individuals would discuss a gap they saw in suicide prevention as an area that needed research, whereas others saw suicide prevention activities and suicide prevention research as completely interconnected. In order to understand such intricacies, the early-round, open-ended responses were qualitatively analyzed and results are presented below. To be clear, the kind of analysis described in this paper is not a substitute for more comprehensive, properly designed and executed qualitative research (e.g., ethnography, proper sampling, and semi-structured interviews). These survey responses do, however, provide a rich source of information about culturally constructed meanings of suicide (e.g., the event itself, what could precipitate it, what it means for the family/society at large).

This study was conducted as part of a Presidential Management Fellowship at the Substance Abuse and Mental Health Services Administration, USDHHS; survey analysis occurred at the National Institute of Mental Health. As a result of the author's participation in the RPTF, a collaborative research team based at the University of North Texas Health Sciences Center provided de-identified data from the RPTF online survey conducted between August and November 2011[1] and requested her qualitative perspective as a linguistic anthropologist.[2,3]

Results analyzed here include the 719 de-identified responses of varying lengths (from a few words to pages) from that online survey. The survey allowed respondents to self-identify as one of four categories: "survivors" (family survivors as well as attempt survivors, 228 respondents); "researchers" (220 respondents); "policy/administrators" (170 respondents); and "providers" (101 respondents).[b] Once the author received this data, each respondent was randomly assigned a number within their self-selected category.

The sections that follow provide background regarding the survey data that form the basis of the analysis; an overview of the qualitative methods employed; a summary of the resultant codes and metacategories extracted in the initial analysis; a more detailed description of a discourse summary for one subcode, "life and emotional skills," that illustrates how qualitative methods reveal things that did not otherwise come to light in the top–down impositional approach and can be used to develop an approach to create testable theories and investigate the nuances of a topic; and discussion of future research directions.

[b]Respondents' categorization came from their self-selection. Some respondents were unhappy that they had been forced to choose only one category because they identified as more than one category. Future efforts in this area should allow individuals to choose more than one category and include an "other" category to allow respondents to write freely. Such a design will allow for more nuanced analysis, if desired, by the researcher.

Methods

Responses were loaded into MAXQDA, version 10 (VERBI GmbH, Berlin), a qualitative and mixed-methods data analysis software package for textual and content analysis. The software allows coding of text, images, audio and video files, and other forms of data as well as transcription of audio and video files. The mixed-methods features allow for comparison of code segments, crosstabs, creation of frequency tables, comparison of themes through quote matrix, typology tables, and various visualizations of data (e.g., code relationship maps, matrix browsers, code relations, text comparison, and word frequencies).

After inputting the de-identified responses into MAXQDA 10, the coding process began (Figure 1) using what some researchers call "in vivo coding," labeling a section of text with a label taken from the text itself. The first round of coding was completed using categorizing strategies—coding and thematic analysis.[4,5] Using a grounded theory approach[6–9]—in which theories are developed from gathered data (allowing conclusions to be gathered from what participants actually do, not just what it is believed they should or may do) rather than of gathering data to test a theory or hypothesis—data were analyzed for potential analytical categories (codes) and then relationships between categories.[10] An inductive coding model allowed for meaningful categories to emerge from the data rather than being imposed by the researcher.[11] Some codes and thematic categories produced from the inductive coding process were very similar to the 12 AGs derived from the modified Delphi process such as those dealing with risk and protective factors,

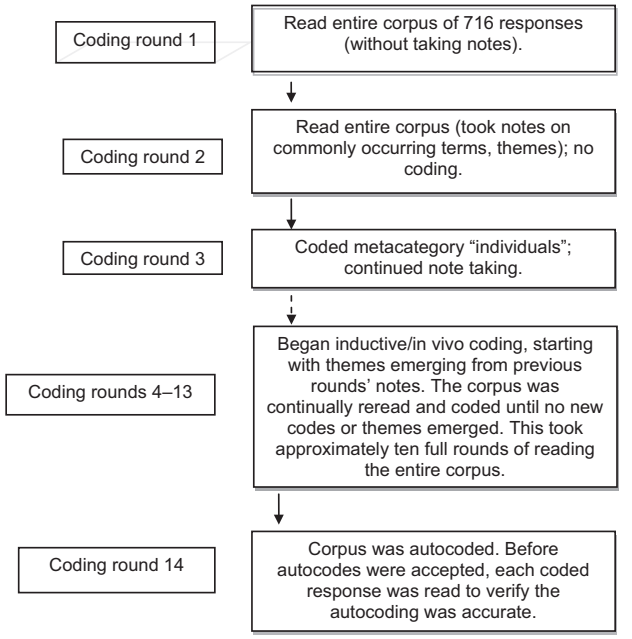

Figure 1. Coding process

Table 1. Research codes: "people" metacategory

Code	Subcode	Number of times referenced
Survivors/completers	Attempt survivors	46
	Loss survivors	31
	Reattempt survivors	13
	Completed suicide	9
Community members	Family	62
	Parents	20
	Friends	19
	Managers/employers	8
	Caregivers	7
	Coworkers	4
	Support system	3
	Peers	3
	Church members	2
	Classmates	2
	Society	2
	Spouse	2
	Bully/victim	1
	Boy scouts	1
	Community coalitions	1
	Famous people	1
	Girl scouts	1
	Natural helpers	1
	Neighbors	1
	Parent–teacher association	1
Demographic groups	Suicidal individuals	330
	Teenagers/young adults	130
	Children/youth	74
	Those with mental illnesses	32
	Men	29
	Seniors	25
	Military/veterans	21
	Native American	12
	Trauma survivors	11
	Those with substance use issues	9
	Adults	8
	Rural residents	8
	Those not in treatment	6
	LGBTQ2S	5
	Deaf community	3
	Homeless individuals	2
	Those with physical illness	2
	Urban residents	2
	Women	2
	Latinos/as	2
	African Americans	1
	Babies	1
	Economically distressed	1
	General public	1
	Immigrants	1
	Uninsured/ underinsured	1
	Non-native English speakers	1
Healthcare and service providers	Healthcare professionals	81
	Mental health providers	64
	Educators/school personnel	39
	Policy makers	7
	Researchers	7
	Law enforcement	5
	Gatekeepers	5
	Clergy	4
	Social workers	3
	Alcoholics Anonymous	1
	Bereavement counselors	1

(continued)

(continued on next page)

Table 1. Research codes: "people" metacategory *(continued)*

Code	Subcode	Number of times referenced
	Funeral directors	1
	Government or public worker	1
	Suicide prevention task force members	1
	Suicide hotline staff	1
	Telephone/reception staff at hospitals and primary care offices	1

LGBTQ2S, lesbian, gay, bisexual, transgender, queer, two spirit.

provider training, preventing reattempts, help-seeking, and stigma; other codes highlighted areas not identified as important in the later rounds of the Delphi process, including life and emotional skills, importance of a holistic approach to suicide, role of spirituality in recovery.

During the coding process, some sub-subcodes were identified (e.g., postvention, research on risk, and protective factors) that, as coding rounds continued, were clearly part of an overarching code of "research," meaning respondents were explicitly calling for research on these topics or what was being described was clearly a research pathway. At that point, the author would go back and nest those under overarching subcodes. Other times, a subcode was identified first (e.g., life and emotional skills). Subsequent coding rounds showed that a substantial number of these responses directly referenced help-seeking (a new sub-subcode) rather than general life and emotional skills.

Two metacategories emerged from the qualitative analysis; the first related to all individuals or groups named in the data. These codes included all individual groups mentioned in the text, including populations, subpopulations, community members, and all other groups of people (e.g., attempt survivors, demographic groups, and healthcare and service providers). Table 1 provides an example of how actual language and terms used by respondents can be nested within themes. Such attention to the way people actually talk about suicide is critical to help researchers, and the field more broadly, understand the complex relationships and webs of meaning that exist for individuals. It is also helpful to understand the different ways individuals and groups conceptualize these ideas. The second metacategory was the "strategy" codes, which included all suggestions for research pathways, suicide prevention practices, policies, and interventions (Table 2). Both metacategories represent areas that were clearly important to respondents and collectively presented a holistic and nuanced vision of suicide and suicide prevention. To illustrate a "strategy" code, this paper will report on the secondary analysis of one subcode: "life and emotional skills."

The survey responses were also deductively coded using the RPTF's 12 AGs.[12] Future papers will explore qualitative analysis of both deductively derived codes based on the 12 AGs as well as the many other inductively derived codes.

Results

Results reported in this paper illustrate the qualitative approach by focusing on a subcategory from the strategies/research pathways metacategory. They are from a discourse analysis performed on all responses coded as "life and emotional skills."[c] This type of contextualizing strategy[4,5] allowed for a holistic analysis of an individual response (as part of a larger analytical category or "code") and a closer exploration of their assumptions about the nature of suicide, argumentation, the role(s) of research in suicide prevention, and so on. Using both strategies provides richer results and enables attention to both macrolevel trends and microlevel responses.

Control, Communication, and Not Being Understood

An attempt survivor responded to the survey by describing the difficulty of being able to adequately express pain to others. This individual noted that "there is a [g]ap of understanding between the individual going through the pain"[d] and those around them:

> When you're at the end of your rope and others are looking at you like you are over exaggerating, complaining[,] or unrealistic, it's devastating….It is important for others to understand that suicide is [merely] one of the symptoms[,] like lack of [appetite] or interruption in sleep[,] [but] it is just the most serious one. Suicidal thoughts are not just crying [wolf]. It becomes a [physical] and medical problem[,] not [necessarily] the individual[']s psychological profile. Suicide becomes the last ditch effort to stop the pain…. Your mind formulates a cost-[benefit] analysis of [whether] or not you can withstand the pain or not…. They may in fact [exercise] their only weapon and that is to [relieve] the pain through [suicide] (Survivor).[e]

For this attempt survivor, suicide was considered a way to reclaim control—control over both their pain and

[c]Codes were not mutually exclusive and many passages were coded for more than one category/subcategory.

[d]All quotes are attributed to the self-identified group in which they belonged and are reproduced as written by respondents; an attempt to make responses more readable can be found in brackets [ ]. Those changes include spelling—when the original is difficult to understand—and grammatical additions to facilitate readability. No substantive changes were made.

[e]On the first page of the online survey (before the actual survey began), the following disclaimer was printed: "Your participation is completely voluntary. In order to protect your confidentiality, all responses and comments you submit will be deidentified before review. *Please note that by participating in this survey you will be giving the Task Force permission to use your ideas as it develops its suicide prevention agenda*" (emphasis in original). The quotes reproduced anonymously here were also used as input in the RPTF agenda development process, which is why they appear here as well.

Table 2. Research codes: "strategy" metacategory

Code	Subcode	Sub-subcode	Sub-sub-subcode	Number of times referenced
Individual	Emotional/life skills			109
		Help-seeking		106
Infrastructure/legal/policy				47
	Data/surveillance			23
Medical/research	Medication			7
		Pro-medication		75
		Anti-medication		5
	Research	Treatment/intervention/ prevention		189
		General/miscellaneous		106
		Cultural/social factors		105
		Protective/risk factors		95
		Dissemination/outreach		76
		Suicidality		75
		Genetic/structure/ biology		73
		Assessment/screening		61
		Mental health and mental illness		45
		Attempt/reattempt		30
		Definitions/models		25
		Substance use		8
		Postvention		4
			Distinguish between those who attempt and those who do not	84
			Protect from self/from acting on ideation	48
	Testing	Genetic/structure/ biology		35
		Mental illness/ suicidality		28
Social/collective	Education			184
	Messaging/dissemination/ outreach			184
	Stigma			99
	Community			63
	Communication			30
	Culture change			14

(continued on next page)

Table 2. Research codes: "strategy" metacategory *(continued)*

Code	Subcode	Sub-subcode	Sub-sub-subcode	Number of times referenced
Treatment/services/care	Accessibility and acceptability			98
	Services/interventions/ treatment			92
	Screening/assessment			78
	Means safety/restriction			65
	Prevention programs			52
	Systems and systems integration			49
	Follow-up			27

a situation on which they appear to have little control. Suicide is a "weapon," and one used by someone with no other ways of addressing a hopeless situation. Survey respondents believed suicide rates would drop if we could teach suicidal individuals and young people life and emotional skills to deal with the feelings described above. Respondents also noted that more research is needed to discover if such life and emotional skills trainings would, in fact, have an impact.

Communication was, in general, highlighted as being important for both communities and suicidal individuals. It is important to note that this category only emerged from the survivors (survivors of loss and survivors of attempts) group. It was clear that survivors of suicide loss and attempt believed that they could get the help they needed, if only they could find the right way to communicate with those around them. According to the same survivor quoted at the beginning of this section:

> The feeling of this misunderstanding is like being awake for an operation and under anesthesia, while the doctor operates on you. You are aware of what's going on, you can feel the pain, but you can't [get] through to anyone about it. No one hears your cry.

Some, but not all, respondents believe that reducing stigma would "allow depressed people or people with suicidal thoughts to be more open to discussing their depression or suicidal thoughts" (Survivor) and "decrease 'codes of silence'" (Survivor) among communities more generally.

Life Skills

Respondents highlighted six types of life skills that they believed would be crucial to reduce suicides: (1) dealing with stress and coping strategies for that stress; (2) emotional regulation, tolerance, and acceptance; (3) communication; (4) interpersonal skills and connectedness; (5) decision making; and (6) general life skills. Responses about these six categories of life skills fell into two overlapping, but distinct, groupings. In the first, respondents argued that we need to train suicidal individuals about life skills that we already know would reduce suicides. Respondents assumed that these areas would be effective; as the corpus only includes anonymous survey data, we have no way to know whether their assumption of efficacy was based on research, personal experience, or assumed to work because of some general cultural knowledge (assumptions and folk theories) about the way mental health, suicide, and the brain "work." This first group emerged primarily from the survivor group (with 27 of 40 total responses), although 9 of 40 responses in this category came from providers and 4 of 40 from policy/administrators.[f] No researchers advocated this position.

The second grouping focused on those same six categories of life skills, but explicitly advocated for research into whether teaching such life skills is effective. Unlike the first grouping, this group included respondents from all self-designated categories: providers (11 of 32 responses); researchers (10 of 32); survivors (6 of 32); and policy/administrators (5 of 32).

The next six sections of the paper will delve into the six categories of life skills, exploring how respondents connected them, what they thought about them, and how they may help us discover novel research pathways to reduce deaths by suicide.

[f]It is important to note that testing for statistical significance is not appropriate when analyzing code frequencies within qualitative research projects (Draper and Swift, 2010; Fade and Swift, 2010; Pope et al., 2000). These numbers are used here for illustrative purposes only.

Train Coping Strategies

Responses about teaching ways of dealing with stress and general coping strategies often connected this skill with school and youth. Training teens and young adults how to deal with stress in positive ways was the most common response. Some argued that programs could be based in schools to "develop the coping skills they will need to handle any adversity that they may face throughout their lifetime[,] and thus eliminate the option of suicide for everyone" (Provider). Respondents hoped these coping skills would teach youth more about emotional regulation, tolerance, and acceptance (described below) so that they "become comfortable with negative thoughts and emotions" and show them that such feelings are "temporary and workable instead of something that needs to be changed immediately" (Provider).

As far as research into dealing with stress and coping skills, respondents advocated for both the development of universal prevention interventions that teach coping skills to youth and research into the best way to implement such interventions. One researcher noted that research into postvention programs and their ability to "decrease the suicidal ideation and behavior of survivors and the ability of the postvention to facilitate adaptive coping with this loss" would be crucial. Others focused on promoting and developing coping skills among a diverse list of populations and focusing on identifying transitional periods in the lives of individuals or groups such as divorce, return from combat, or death of a family member. Most, however, promoted research to develop and analyze the effectiveness of universal prevention interventions to be deployed in schools.

Emotional Regulation, Tolerance, and Acceptance

Mindfulness programs and dialectical behavioral therapy (DBT) were advocated by respondents to teach emotional regulation and "interpersonal effectiveness" (Survivor). Such "emotional stability" and suicide prevention trainings, respondents argued, should be "free or inexpensive to all individuals, making it a mandatory training for people who work in public arena[s] such as educators and [politicians, and] to include training for increase in rank and position of authority in the military and corporate business" (Provider).

Another area of focus for respondents was tolerance and acceptance of oneself and of others. As one survivor argued, "[a]t pre-teen and teen years, their focus is what others think about them.… Children aren't raised with confidence in themselves and believe others if they say they are ugly, fat, whatever. Hormones and body changes are occurring and can lead to devastating comments from others." Such acceptance extends to mental illness and, some respondents argued, could be accomplished by teaching people about how bodies and minds work at different stages of development so they can "manage their thoughts" (Provider) and expectations. Teens, in particular, "don't want to feel that they are the only ones feeling this way" (Survivor), and teaching acceptance and compassion—respondents argued—would help solve many of these issues.

Those advocating for research pushed for "prevention research (universal and targeted) addressing evidence-based mechanisms to counter helplessness and hopelessness states contributing to suicidality (increase divergent thinking, identify advocates when powerless, reduce social isolation)" (Researcher). Others argued that universal preventive interventions should be developed to teach "emotional regulation skills, beginning in early childhood" (Researcher) and find "which therapy techniques work best with teens who have expressed suicidal ideation or which skill building activities have the biggest success with emotional regulation" (Provider).

Interpersonal Skills and Connectedness

This category was, in some ways, related to communication. Respondents argued that teaching interpersonal skills would increase the "connectedness of individuals to others and their community in order to cut through the pain and isolation" felt by suicidal individuals (Provider). These individuals "often feel no personal connection. Nobody cares about them. They have no reason to live and nothing to live for" (Provider). One respondent noted that this was particularly important for older white men; others argued that these skills would be most useful for young people, helping them interact with their peers and address issues of bullying and hopelessness.

Interpersonal skills were also an area of significant interest for those advocating research. Respondents wanted to know how to foster connectedness: from how to "induce in the high[-]risk person a sense of connectedness to the would-be therapist" (Researcher) to "identify[ing] effective strategies for helping isolated and lonely people feel more connected" to the communities in which they live (Provider). Such research, another argued, would help in understanding how to effectively create and strengthen support networks. Others focused on the importance of the connectedness of care and community as part of continuing support after a suicide attempt. As one survivor argued, this might be an online experience that would "allow the survivor to feel less alon[e] and stigmatized."

Problem-Solving and Decision-Making Skills

This category specifically relates to decision making about the act of suicide:

> I believe the best way to reach those individuals at risk of suicidal behavior is to be proactive by educating young people of the dangers and consequences of suicidal decisions by implementing better understood decision [making]. (Survivor)

Respondents argued that young people live "life in a very limited frame of reference" (Survivor) and may not understand the ramifications of this "irreversible" decision.

For those who advocated research in this area, determining if "problem solving, impulse control, and personal empowerment in children" (Survivor) would be effective deterrents to suicide could provide an important area of knowledge. However, most respondents argued that research in this area should focus on barriers to treatment and on the most "effective motivational techniques toward treatment" (Provider) to "increase the likelihood that a suicidal patient…will follow through with offered treatment" (Provider).

General Life Skills

Other skills for which respondents advocated were those emerging "from positive psychology and from various religious teaching[s]" (policy/administrators). Cultural knowledge also was mentioned, as were education in values and beliefs. Such education, one survivor argued, requires "agencies (healthcare providers, clinicians, clergy) to…form an alliance of care, including medical (med[icine]s if necessary, nutrition, exercise labs), clinical (behavioral modification, coping skills, necessary therapy), and to address spiritual concerns as well (core values, beliefs, heart issues)."

Respondents also believed that certain life skill areas need further research, including finding "effective methods to help suicidal individuals find purpose and meaning to their lives" (Provider) and focusing our prevention efforts on "increasing prevention and self-care, not simply screening and mental health treatment" (Provider).

Discussion

Future Directions

The first research pathway forward indicated by the stakeholder survey data is, as mentioned above, a holistic understanding of suicide. Much of the work on suicide has been macrolevel, epidemiologic analyses that separate biological, cultural/social, and environmental contexts. Aggregate data are critical but erase the rich, detailed information so vitally needed. More needs to be known about the qualitative experience(s) of suicide—how suicidal individuals and their families understand the experience of suicidality and the care received, holes in care, what "adequate" care actually means to suicidal individuals, what triggers crises, how resiliency helps them survive, what do they see as barriers, and what heterogeneity might exist within what we call "suicidal ideation" or "suicidality." More research is needed that tells us the why and how, not just the what. We not only need to know whether a risk factor exists or if X works, but also the nature of X. During a 2000 presentation at the Northeast Injury Prevention Network Invitational Conference for Suicide Prevention Planning, DeQuincy Lezine, PhD, said,

> I am your data and you are not talking to me, not working with me, not including me, not listening to me. Only when I am dead do you ask questions of me—"Why did you do it? What could I have done to help you?" You call me [as someone who has attempted suicide] a different population from "suicide completers" and then talk about me being the highest risk group for suicide. You said it is essential to include those I will leave [behind] once I am dead, but not talk to me before I die. Am I only worth something to you once I have altered my label one final time?
> I am your data but you wait until I am static and unchanging to ask questions of me, questions you should be asking while I am still a dynamic, changing, living individual. I am the attempts you can only estimate right now because only two out of five involved a hospitalization. I am your target. It is my death you are trying to prevent, and you are not talking to me. I am what you go to these conferences for, who you publish brochures for, and pass out cards for, and who you refer to in your presentations—I am your data—current and future…but you have not invited me to your table. (D Lezine, President and CEO, Prevention Communities, personal communication, 2013)

Dr. Lezine is absolutely correct; we researchers—as part of a broader research agenda that includes quantitative and qualitative research, social as well as biological research—must suspend our preconceived notions about suicide and work to understand it as having a web of meanings embedded within complex cultural systems. We must include the various voices of the community of suicidal individuals and value their contribution.

The second research pathway focuses on collaborative research. Not just collaborations among and between various disciplines, but the kind of collaborative research that brings communities in earlier in the process. Lab conditions rarely exist in the natural world and researchers must make the conditions, constraints,

and participants more explicit not just for research but to help communities and clinicians understand the elements that will affect the applicability and efficacy in their contexts. For example, if an intervention requires infrastructure, reliable transportation, access, and ability to pay for well-trained clinicians, child/elder care, or financial or time investment, this must be made clear. These are not just anecdotally important; such factors impact the validity and applicability of what is done to save lives.

All available tools should be used to save lives. Survivors, researchers, clinicians, and others are much closer than they appear on what they want (e.g., a reliable way to "diagnose" suicidality, a series of effective treatments—both biological and psychological/behavioral). Each have their own way of approaching and describing suicide, and more opportunities to collaborate between and among these groups will only succeed when they understand each other. There are ways of communicating that bridge the often difficult divide. Each group brings strengths and experience that are critical in moving our field forward.

Conclusions

Qualitative and mixed-methods research are essential to the future of suicide prevention work.[13] By design, qualitative research is explorative and appropriate for complex, culturally embedded social issues such as suicide.[2,3] It can be used to generate hypotheses for testing and, as in the case of this analysis, illuminate areas that would be missed in a top-down, impositional approach. Finally, qualitative research chooses as its site naturalistic environments—the same contexts in which suicidal people live. Only by combining qualitative and quantitative methods will we finally understand the complex phenomenon we call "suicide."

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

This work was conducted as part of a rotation at the National Institute of Mental Health while the author was a Presidential Management Fellow. The author has no commercial associations that may pose a conflict of interest; the author has no competing or conflicting interests.

No financial disclosures were reported by the author of this paper.

References

1. Claassen C, Pearson J, Khodyakov D, et al. Reducing the burden of suicide in the U.S.: the aspirational research goals of the National Action Alliance for Suicide Prevention Research Prioritization Task Force. Am J Prev Med 2014;47(3):309–14.
2. Ahearn LM. Living language: an introduction to linguistic anthropology. Malden MA: Wiley-Blackwell, 2012.
3. Duranti A. Linguistic anthropology. London: Cambridge University Press, 1997.
4. Maxwell J. Qualitative research design. London: Sage Publications, 1996.
5. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res 2005;15(9):1277–88.
6. Glaser BG. Basics of grounded theory analysis. Mill Valley CA: Sociology Press, 1992.
7. Strauss A. Qualitative analysis for social scientists. Cambridge: Cambridge University Press, 1987.
8. Morse JM, Stern PN, Corbin J, Bowers B, Clarke AE, Charmaz K. Developing grounded theory: the second generation. Walnut Creek CA: Left Coast Press, 2009.
9. Glaser BG, Strauss AL. The discovery of grounded theory: strategies for qualitative research. Chicago IL: Aldine Publishing, 1967.
10. Bernard HR. Research methods in anthropology: qualitative and quantitative approaches. 3rd ed. New York: AltaMira, 2002.
11. Thomas DR. A general inductive approach for analyzing qualitative evaluation data. Am J Eval 2006;27(2):237–46.
12. Pearson J, Claassen C, Booth C. Introduction to the Suicide Prevention Research Prioritization Task Force process special supplement: the topic experts. Am J Prev Med 2014;47(3S2):S102–S105.
13. Curry LA, Nembhard IM, Bradley EH. Qualitative and mixed methods provide unique contributions to outcomes research. Circulation 2009;119(10):1442–52.

The Baby or the Bath Water?

Lessons Learned from the National Action Alliance for Suicide Prevention Research Prioritization Task Force Literature Review

Sherry Davis Molock, PhD, Janet M. Heekin, MLS, Samantha G. Matlin, PhD, Crystal L. Barksdale, PhD, Ekwenzi Gray, PhD, Chelsea L. Booth, PhD

Context: The Research Prioritization Task Force of the National Action Alliance for Suicide Prevention conducted a comprehensive literature review of suicide prevention/intervention trials to assess the quality of the scientific evidence.

Evidence acquisition: A literature "review of reviews" was conducted by searching the most widely used databases for mental health and public health research. The quality of the reviews was evaluated using the Revised Assessment of Multiple Systematic Reviews system; the quality of the scientific evidence for the suicide preventions/interventions was assessed using U.S. Preventive Services Task Force criteria. The reviews were limited to peer-reviewed publications with human subjects published in English.

Evidence synthesis: Ninety-eight systematic reviews and 45 primary sources on suicide prevention/interventions published between January 2000 and September 2012 were evaluated. The results suggest that the quality of both the systematic reviews and the scientific evidence for suicide preventions/interventions were mixed. The majority of the systematic reviews and prevention/interventions were evaluated as fair to poor in quality.

Conclusions: There are many promising suicide prevention/intervention trials, but research findings are often inconclusive because of methodologic problems. Methodologic problems across systematic reviews include not conducting hand searches, not surveying gray literature, and being unable to aggregate data across studies. Methodologic problems with the scientific quality of the prevention/intervention trials include paucity of information on sample demographic characteristics, poorly defined outcomes, and excluding actively suicidal participants. Suggestions for ways to improve the quality of the systematic reviews and suicide preventions/interventions are provided.
(Am J Prev Med 2014;47(3S2):S115–S121)

Introduction

Globally, suicide represents an important public health concern in many countries. Each year, nearly 1 million people die by suicide, which translates into a global mortality rate of 16/100,000 deaths each year. Suicide death rates have increased by 60% in the last 45 years.[1] The most recent data indicate that suicide is the tenth-leading cause of death in the U.S.; there are more than 38,000 suicide deaths in the U.S. each year.[2] Suicide accounts for 1.5% of the global burden of disease, which represents 20 million years of health lost because of death and disability.[3]

The Research Prioritization Task Force (RPTF) of the National Action Alliance for Suicide Prevention (Action Alliance) conducted a comprehensive review of the literature on suicide preventions/interventions to help inform the prioritization of the research agenda for suicide prevention. The RPTF felt it was important to understand the current state of the science on suicide prevention to provide some context for future directions in suicide prevention research. Although there have been several systematic reviews on suicide preventions/interventions since the first U.S. National Strategy for Suicide Prevention[4] highlighted the need for more effective

From the Department of Psychology (Molock), George Washington University; Counseling Center (Gray), Howard University, Washington, District of Columbia; Substance Abuse and Mental Health Services Administration (Booth, Heekin), Bethesda, SRA International (Barksdale), Rockville, Maryland; and the Department of Behavioral Health and Intellectual Disability (Matlin), Philadelphia, Pennsylvania

Address correspondence to: Sherry D. Molock, PhD, Department of Psychology, George Washington University, Washington DC 20052. E-mail: smolock@gwu.edu.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.05.023

suicide preventions/interventions, very few reviews have conducted a comprehensive review across different types of treatments (e.g., biological, psychosocial, community-based) with heterogeneous populations. Thus, this review attempted to focus on demographic groups with the greatest burden (e.g., elderly, individuals with substance abuse) to allow us to focus on (1) impact—how we can significantly reduce suicide rates; (2) "boundaried" populations—where at-risk groups typically receive treatment; (3) underserved populations—what particular groups are underserved in typical systems of care (e.g., specialty mental health services), where providers are most likely to reach such groups and provide quality care; and (4) pointing out gaps in treatment and identifying innovative ways to provide treatment.

The RPTF also searched gray literature and conducted hand searches of some of the premier peer-reviewed journals because recent literature on the methodology used in systematic reviews suggests that these two techniques can help to minimize selection, location, and publication bias.[5,6] Gray literature refers to papers, reports, and other documents that are not distributed or indexed by commercial publishers. Gray literature needs to be carefully scrutinized because it is not peer reviewed, but it can help to reduce publication bias as published studies in medicine and social sciences tend to only publish positive findings, which may result in inflated treatment and intervention effect sizes.[7] Systematic reviews typically rely on electronic sources from established databases (e.g., MEDLINE), which can result in location and selection bias. For example, studies that are incorrectly marked may be missed in electronic searches. Hand searching can help minimize these biases because it involves manually searching the entire content of a journal to identify all the research on a particular topic, whether it appears in an article, abstract, brief reports, or editorial comments (thecochranelibrary.com/).

Evidence Acquisition

The RPTF literature review team initially searched the Cochrane Library to identify relevant systematic reviews of suicide prevention trials. The Cochrane Library—an internationally recognized resource in evidence-based health practice research—is a collection of databases in human health care and health policy and includes the Database of Systematic Reviews, which contains systematic reviews and meta-analyses that summarize and interpret the results of intervention trials (thecochranelibrary.com/). The RPTF literature review team also searched the Cochrane Central Register of Controlled Trials (CENTRAL), which is derived from regular systematic searches of bibliographic databases including MEDLINE; Excerpta Medica Database (EMBASE); PsycINFO; and Science Citation Index. As a crosscheck for all relevant literature, the team searched PubMed; EMBASE; PsycINFO; as well as the Web of Science (includes the Science Citation Index and Social Science Citation Index); Scopus; and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). For comprehensive database searches, the key concepts were identified as *suicide*, *suicide attempts*, *suicidal ideation*, *suicide risk*, *self-harm*, *self-injurious behavior*, *intervention*, *prevention*, *systematic review*, *meta-analysis*, *controlled trials*, *cohort studies*, and *case control studies*. Relevant Medical Subject Headings (MeSH) were identified using the U.S. National Library of Medicine's MeSH Browser[8] and relevant keywords for searching the titles and abstracts of articles.

Search filters containing MeSH and keywords were iteratively developed and tested in PubMed, and subsequently adapted to search other databases. Articles were limited to peer-reviewed articles involving human subjects between January 1, 2000, and September 30, 2012; literature alerts were set up to identify new studies from October 1, 2012, forward. Additionally, the RPTF team searched for gray literature from relevant organizations or their websites and through consultation with key stakeholders and content experts. Additional citations were sought through the reference lists of relevant documents, as well as hand searching for primary studies in peer-reviewed journals that were targeted because they publish the highest percentage of empirical work on suicidology. These journals included *Suicide & Life Threatening Behavior*, *Crisis—The Journal of Crisis Intervention and Suicide Prevention*, *British Journal of Psychiatry*, *Journal of Affective Disorders*, *Acta Psychiatrica Scandinavica*, *Archives of Suicide Research*, and the *American Journal of Public Health*. The RPTF did not further search or review the references in the articles in the hand-searched material. Further details of the literature search protocol are available from the authors.

Abstracts were screened for relevance by doctoral-level researchers who were trained to conduct critical appraisals using the guidelines set forth by the Oxford Centre for Evidence Based Medicine (www.cebm.net/); the 1991 Oxman and Guyatt guidelines for systematic reviews[9]; the 2007 U.S. Preventive Services Task Force (USPSTF)[10] criteria for quality ratings of evidence-based interventions; and the 2006 National Institute of Clinical Excellence's (NICE)[11] guidelines for critical appraisal of evidence. Although there is some overlap in the three rating systems, they also have unique features that would allow the RPTF to conduct a more comprehensive review; the Assessment of Multiple Systematic Reviews (AMSTAR) and NICE guidelines address the methods

used to conduct systematic reviews, while the USPSTF provides a detailed tool to assess the scientific quality of other types of studies (e.g., RCTs). If an article met the selection criteria, the full paper was reviewed. Data were extracted using an extraction template developed for this study and checked for completeness and accuracy by members of the review team (Table 1). The quality of the systematic reviews was evaluated using the Revised AMSTAR (R-AMSTAR) system, a widely used assessment tool that allows one to quantify the evaluation of

Table 1. Template for data extraction

Data fields

Quality of review (AMSTAR and USPSTF)
• A prior design used
• Duplicate study selection and data extraction
• Comprehensive literature search performed
• Status of publication (gray literature) used as inclusion criteria
• List of included and excluded studies provided
• Characteristics of included studies provided
• Scientific quality of included studies assessed and documented
• Scientific quality of included studies used appropriately in formulating conclusions
• Appropriate methods used to combine findings of studies
• Assessed likelihood of publication bias
• Conflict of interest stated
• Other criteria (assessed but not included in scoring):
  ○ Inclusion of international and domestic peer-reviewed journals
  ○ Search terms included
  ○ Validity criteria reported
  ○ Conclusions of review are warranted given evaluation of studies

Quality of scientific evidence (USPSTF criteria) • Good: Includes well-designed, well-conducted studies in representative populations that directly assess effects on health outcomes • Fair: Evidence is sufficient to determine outcomes but strength of evidence is limited by number, quality of consistency of individual studies, generalizability of intervention, or indirect nature of evidence on outcomes • Poor: Insufficient evidence to assess the effects of outcomes because of limited number or power of studies, important flaws in the design of the study, gaps in chain of evidence, or lack of information on important outcomes
Demographic characteristics of participants • Age, gender, race/ethnicity, sexual orientation, rural, urban, suburban communities
Mental health characteristics of participants • Community-based sample, clinical sample, diagnoses
Characteristics of intervention • Universal, selected, indicated • Dose/duration of intervention • Follow-up • Intervention settings: medical facilities, outpatient mental health settings, schools, churches, communities
Outcomes • Risk factors • Suicide ideation • Suicide attempts • Suicide deaths
Feasibility of prevention/intervention
Generalizable to other settings/sites

AMSTAR, Assessment of Multiple Systematic Reviews; USPSTF, U.S. Preventive Services Task Force

Table 2. Characteristics of systematic reviews and hand-searched primary sources, *n* (%)

	Systematic reviews	Primary sources
Study type		
Cohort study	0 (0)	11 (23.9)
Gray literature	1 (1.0)	0 (0)
Literature reviews	0 (0)	3 (6.6)
Meta-analysis	18 (18.6)	0 (0)
Quasi-experimental	0 (0)	21 (45.6)
RCT	0 (0)	11 (23.9)
Systematic reviews	78 (80.4)	0 (0)

the methodologic quality of systematic reviews. The R-AMSTAR assesses each review based on 11 questions using a Likert-type scale that ranges from 1 (*satisfies none of the criteria*) to 4 (*satisfies all of the criteria*); scores range from 11 to 44.[12] Based on the R-AMSTAR scores, systematic reviews could be rated as excellent (meets 90%–100% of criteria); good (meets 80%–89% of criteria); fair (meets 60%–79% of criteria); or poor (meets <60% of criteria). The quality of the scientific evidence for the suicide prevention/interventions in both the systematic reviews and hand-searched articles were evaluated using the criteria recommended by the USPSTF.[13] The doctoral-level researchers were randomly assigned to code half of the systematic reviews so that each review was coded by two raters. The calculated inter-rater agreement across the reviews was 0.86; discrepancies between coders were resolved via discussion. The hand-searched articles were coded by two doctoral students in clinical psychology whose training focuses on suicide prevention research. The inter-rater agreement for coding the primary sources was 0.88 and discrepancies in their coding were also resolved by discussion.

Evidence Synthesis

Table 2 summarizes the results of the comprehensive reviews based on type of study. The majority of the retrieved studies were systematic reviews; the majority of the studies that were extracted via hand searching had quasi-experimental designs, followed by an equal number of cohort studies and RCTs. Table 3 summarizes the characteristics of the systematic reviews in terms of the use of inclusion/exclusion criteria, the geographic regions in which the studies were conducted, and how the reviews addressed selection biases in their studies. Although most of the systematic reviews provided inclusion and exclusion criteria, 20% listed no criteria. The majority of systematic reviews surveyed international and U.S. studies and did not exhibit selection bias (e.g., did not include gray literature searches) in their reviews. Most of the international studies were conducted in the United Kingdom, Australia, and Japan. The most common reasons for selection bias in the systematic reviews included not conducting hand searches and conducting limited searches that only involved one to two databases. Using the R-AMSTAR criteria for evaluating reviews, 19% of the systematic reviews were evaluated as having excellent quality, 21% good quality, 37% fair quality, and 23% poor quality. The most common problem areas for the systematic reviews were not including gray literature in the searches, not listing included or excluded materials, and not reporting the methods used to combine studies in meta-analyses.

Table 4 summarizes the findings on the assessment of the quality of the scientific evidence for suicide preventions/interventions based on both the systematic reviews and hand-searched articles. The majority of the prevention/interventions were assessed as having fair to poor scientific evidence across seven types of interventions: access to treatment (75%); community-based programs (78.9%); biological treatments (59.5%); psychosocial treatments (66.1%); screenings (71.7%); and training providers (76.6%). Although few in number, the eighth type of study that focused on restricting access to lethal means (e.g., placing barriers in subway systems) showed stronger scientific evidence compared to the other types of interventions; a little over 83% (n=5) of these studies were rated as having good to fair scientific evidence.

Table 3. Characteristics of systematic reviews

Cited inclusion/exclusion criteria

- Inclusion: 17.2%
- Inclusion and exclusion: 54.8%
- No criteria included: 20.2%
- Not applicable: 5.1%

Location of reviewed studies

- International: 2.9%
- International and U.S.: 74%
- U.S. only: 5.8%
- No information: 17.3%

Selection bias

- Yes: 21%
- Unclear: 9.6%
- No: 65.4%
- Not applicable: 4.8%

Table 4. Quality of evidence for interventions, *n* (%)

Quality of evidence	Access to treatment	Means restriction	Community	Biological treatment	Psychosocial treatment	Screenings	Training
Good			4 (21.1)	7 (16.7)	11 (16.2)	1 (14.3)	2 (11.7)
Good to fair	1 (25)	5 (83.3)		10 (23.8)	12 (17.7)	1 (14.3)	2 (11.7)
Fair		1 (16.7)	11 (57.9)	15 (35.7)	33 (48.5)	3 (42.8)	11 (64.7)
Fair to poor	2 (50)		2 (10.5)	5 (11.9)	7 (10.3)	1 (14.3)	1 (5.8)
Poor	1 (25)		2 (10.5)	5 (11.9)	5 (7.3)	1 (14.3)	1 (5.8)
Total (*n*)	4	6	19	42	68	7	17

We were unable to focus the review on the demographic groups with the greatest burden of suicide or examine which interventions worked in boundaried versus undefined settings because very few of the reviews described the demographic characteristics of the study samples beyond age and sometimes gender. Similarly, the feasibility of implementing the interventions and generalizability of the interventions beyond the study site could not be assessed because this information was not described in the systematic reviews.

Although a detailed summary of each reviewed article is beyond the scope of this study, a more detailed summary of each article reviewed for this study can be found in Appendix A. This table lists the authors of the systematic reviews/primary reviews, year of publication, study type, quality of the systematic review/meta-analyses, a brief summary of the review/article, the quality of the scientific evidence of the interventions, and the type of interventions reviewed in the study.

Discussion

The RPTF literature review conducted a "review of reviews" to get a better sense of the current state of suicide prevention/intervention research to better inform recommendations for future directions for research. This review confirmed the difficulty and complexity in conducting research in the area of suicide. Although suicide ranges from the third- to 11th-leading cause of death among various age groups,[14] it is a relatively rare behavior. Additionally, patterns of suicidal behaviors are complex; for example, although suicide ideation is a known risk factor for suicide attempts and deaths, most people who experience suicide ideation do not go on to die by suicide. Recent research suggests that suicide ideators, suicide attempters, and those who die by suicide are three distinct groups.[15] Adding to the complexity of suicide prevention/intervention research is the fact that many of the studies do not have actively suicidal participants in the study, for ethical and practical reasons. Many studies on suicide focus on the reduction of risk factors, which can be problematic because many of the risk factors associated with suicide (e.g., depression, substance use) are ubiquitous and not unique to suicide.

The findings from our review suggest that there may be many promising suicide prevention/intervention approaches, but the research findings are inconclusive because of methodologic problems. Of the eight types of surveyed interventions, restricting access to lethal means seemed particularly promising, but this is based on a small number of studies, almost all of which did not use a control comparison community.

Somewhat surprisingly, there were methodologic problems with the ways the systematic reviews were conducted. Systematic reviews are an arduous undertaking, but some of the authors seemed to be unaware that there are standards and guidelines that should be followed in conducting a systematic review. Common methodologic problems included not using hand searches and not surveying gray literature, which would actually give the field more accurate effect sizes because gray literature is more likely to report what does not work.

It was particularly puzzling that so few reviews reported the demographic characteristics of the samples included in the reviewed research. Given that suicide rates vary across gender, age groups, race/ethnicity, geographic regions, and nationality, it was surprising that very few reviews reported on the sociodemographic characteristics of the sample. This paucity of information on basic demographic characteristics makes it difficult to assess the relative degree of suicide burden across different communities, which in turn makes it difficult to prioritize how to allocate resources for suicide prevention/intervention. The most commonly reported demographic characteristic was age, followed by gender. The absence of information on race/ethnicity is somewhat understandable in some of the international studies

that may have taken place in racially homogenous communities, but none of the reviews using U.S. samples and very few of the primary sources that were retrieved from the hand searches reported racial/ethnic information from their samples. Similarly, most reviews did not report on the settings in which the preventions/interventions occurred, which makes it difficult to assess the feasibility or address concerns regarding the dissemination of successful programs. Again, most of the primary sources that were retrieved through hand searches often did not describe the settings for the prevention intervention programs.

Another problem in both the systematic reviews and primary sources was that outcomes were often poorly defined and there were no standard criteria for outcomes. The terms *suicide ideation*, *attempts*, and *completions* are often used interchangeably, and most of these terms are not defined or operationalized in a study.[16] As previously noted, most of the studies were not designed to directly assess or intervene with suicidal ideation and behaviors, but were designed to address risk factors commonly associated with suicide. Relatedly, most of the studies did not include actively suicidal participants because of concerns about client safety and medical liability. There are also concerns about the methodologic rigor of the studies, as it is difficult to recruit and retain enough participants to have an adequately powered study.

Recommendations

There are many steps that can be taken to improve the quality of the research so that more definitive statements can be made about what does and does not work in the area of suicide prevention/intervention. Suggestions to improve the quality of reviews include describing the demographic characteristics of study participants; describing intervention characteristics (e.g., intervention settings dose/duration of the intervention; and using a common set of risk/protective factors and outcomes to facilitate aggregation of data across studies;

The field should consider providing guidelines for minimum criteria needed to conduct research on suicide prevention/intervention These guidelines could include consensus on the operationalization of terms for suicide (e.g., suicide ideation, suicide intent) and for consensus on terms for interventions/treatment/prevention (e.g., is there a difference between help-seeking behaviors and treatment seeking?). It would also be helpful if there were better agreement on a set of measures that could be used to assess not only outcomes but risk/protective factors as well. For example, when examining the research on the role of depression and suicide, are researchers talking about depressive symptoms, a syndrome, acute disorders, or chronic disorders?

There is also a need for studies that are specifically designed to assess specific suicide-related outcomes—ideation, intent, and attempts that can be associated with various interventions; developing appropriate and feasible ways to link vital statistics with, for example, healthcare and criminal justice databases to facilitate measurement of suicide-related outcomes would be helpful as well. It would also be helpful to strongly encourage researchers to address the feasibility and generalizability of research findings in their studies.

Conclusions

As noted earlier, suicide prevention/intervention research is particularly challenging because it focuses on a relatively rare behavior for which the underlying mechanisms are not clearly identified. As such, it is difficult to design interventions for complex phenomena with underlying processes that are not always well understood. However, the take-home message from this review should not be that treatment does not work or that we should "throw the baby out with the bath water." Researchers need to improve the science so we can actually find out what works. There has been a recent emphasis in funding more collaborative research approaches across institutions that focus on rapidly advancing the science in the areas of cancer (e.g., the National Cancer Institute's Cancer Center Support Grants)[17] and depression (National Network of Depression Centers; nndc.org/). These collaborative centers often facilitate infrastructure changes in the allocation of resources and help change norms/values in how scientists conduct research because the focus is on collaboration rather than competition. These collaborative models may also help teams become more open about discussing and reporting both successes and failures, and help researchers take bigger risks. Given the challenges that suicide research currently faces (e.g., low base rate behavior, underpowered studies, few systematically tested theories), the use of more collaborative research models may yield more useful findings in the field.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The authors would like to acknowledge David Jeffries and David Jean, who assisted with the hand-searched articles.

No financial disclosures were reported by the authors of this paper.

References

1. WHO. Public health action for the prevention of suicide: a framework. Geneva: WHO, 2012. apps.who.int/iris/bitstream/10665/75166/1/9789241503570_eng.pdf.
2. CDC. Leading causes of death reports, national and regional, 1999–2010. webappa.cdc.gov/sasweb/ncipc/leadcaus10_us.html.
3. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
4. USDHHS, Public Health Service. National strategy for suicide prevention: goals and objectives for action. Washington DC: USDHHS, Public Health Service, 2001. www.sprc.org/sites/sprc.org/files/library/nssp.pdf.
5. Armstrong R, Jackson N, Doyle J, Waters E, Howes F. It's in your hands: the value of handsearching in conducting systematic reviews of public health interventions. J Public Health 2005;27(4):388–91.
6. Egger M, Davey Smith G. Meta-analysis: bias in location and selection of studies. BMJ 1988;316:61–6.
7. Schlosser RW. Appraising quality of systematic reviews. Austin TX: Southwest Educational Development Laboratory, 2007. www.ktdrr.org/ktlibrary/articles_pubs/ncddrwork/focus/focus17/Focus17.pdf.
8. U.S. National Library of Medicine. MeSH Browser. nlm.nih.gov/mesh/mbinfo.html.
9. Oxman AD, Guyatt GH. Validation of an index of the quality of review articles. J Clin Epidemiol 1991;44(11):1271–8.
10. U.S. Preventive Services Task Force. uspreventiveservicestaskforce.org/uspstf08/methods/procmanual1.htm.
11. National Health Service, National Institute for Health and Clinical Excellence. Methods for development of NICE public health guidance. London: National Institute for Health and Clinical Excellence, 2006. www.nice.org.uk/nicemedia/pdf/CPHEMethodsManual.pdf.
12. Kung J, Chiappelli F, Cajulis OO, et al. From systematic reviews to clinical recommendations for evidence-based health care: validation of Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) for grading of clinical relevance. Open Dent J 2010;4:84–91.
13. U.S. Preventive Services Task Force. Appendix A: How the U.S. Preventive Services Task Force grades its recommendations: guide to Clinical Preventive Services. ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/guide/appendix-a.html.
14. CDC, National Center for Injury Prevention and Control. Web-Based Injury Statistics Query and Reporting System (WISQARS). cdc.gov/injury/wisqars.
15. Smith PN, Cukrowicz KC, Poindexter EK, Hobson V, Cohen LM. The acquired capability for suicide: a comparison of suicide attempters, suicide ideators, and non-suicidal controls. Depress Anxiety 2010;27(9):871–7.
16. Silverman MM, Berman AL, Sanddal ND, O'Carroll PW, Joiner TE. Rebuilding the Tower of Babel: a revised nomenclature for the study of suicide and suicidal behaviors. Part I: background, rationale, and methodology. Suicide Life Threat Behav 2007;37(3):248–63.
17. Policies and Guidelines for the P30 Cancer Center Support Grants. cancer.net/publications-and-resources/support-and-resource-links/general-cancer-organizations-and-resources/cancer-centers-coop-groups.

Appendix

Supplementary data

Supplementary material cited in this article is available online at http://dx.doi.org/10.1016/j.amepre.2014.05.023.

Improving National Data Systems for Surveillance of Suicide-Related Events

Data and Surveillance Task Force of the National Action Alliance for Suicide Prevention

Background: Describing the characteristics and patterns of suicidal behavior is an essential component in developing successful prevention efforts. The Data and Surveillance Task Force (DSTF) of the National Action Alliance for Suicide Prevention was charged with making recommendations for improving national data systems for public health surveillance of suicide-related problems, including suicidal thoughts, suicide attempts, and deaths due to suicide.

Purpose: Data from the national systems can be used to draw attention to the magnitude of the problem and are useful for establishing national health priorities. National data can also be used to examine differences in rates across groups (e.g., sex, racial/ethnic, and age groups) and geographic regions, and are useful in identifying patterns in the mechanism of suicide, including those that rarely occur.

Methods: Using evaluation criteria from the CDC, WHO, and the U.S.A.-based Safe States Alliance, the DSTF reviewed 28 national data systems for feasibility of use in the surveillance of suicidal behavior, including deaths, nonfatal attempts, and suicidal thoughts. The review criteria included attributes such as the aspects of the suicide-related spectrum (e.g., thoughts, attempts, deaths) covered by the system; how the data are collected (e.g., census, sample, survey, administrative data files, self-report, reporting by care providers); and the strengths and limitations of the survey or data system.

Results: The DSTF identified common strengths and challenges among the data systems based on the underlying data source (e.g., death records, healthcare provider records, population-based surveys, health insurance claims). From these findings, the DSTF proposed several recommendations for improving existing data systems, such as using standard language and definitions, adding new variables to existing surveys, expanding the geographic scope of surveys to include areas where data are not currently collected, oversampling of underrepresented groups, and improving the completeness and quality of information on death certificates.

Conclusions: Some of the DSTF recommendations are potentially achievable in the short term (<1–3 years) within existing data systems, whereas others involve more extensive changes and will require longer-term efforts (4–10 years). Implementing these recommendations would assist in the development of a national coordinated program of fatal and nonfatal suicide surveillance to facilitate evidence-based action to reduce the incidence of suicide and suicidal behavior in all populations.
(Am J Prev Med 2014;47(3S2):S122–S129) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

Data and surveillance form the foundation for the public health model of prevention.[1] They are essential for describing the public health issue, identifying risk and protective factors for adverse health conditions, and evaluating interventions.[2] Public health surveillance has been defined by the CDC as "the ongoing, systematic collection, analysis, interpretation, and dissemination of data about a health-related event for use in public health action to reduce morbidity and to improve health."[3]

The public health model of prevention includes four basic steps: (1) define and monitor the problem; (2) identify risk and protective factors; (3) develop and test prevention strategies; and (4) ensure widespread adoption of effective prevention programs.[1] To apply the

Members of the Data and Surveillance Task Force of the National Action Alliance for Suicide Prevention are listed in the acknowledgment section at the end of the article.

Address correspondence to: Alex E. Crosby, Division of Violence Prevention/CDC, 4770 Buford Hwy NE, MS:F-63, Atlanta GA 30341. E-mail: aec1@cdc.gov.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.05.026

public health model to suicide prevention, data systems to monitor the problem must be available.

However, monitoring suicidal behavior and outcomes at a national level can be challenging for several reasons. The reasons include a lack of clarity on what should be monitored.[4] Should systems monitor all self-directed violence (an all-encompassing term for a range of violent actions) such as suicides; nonfatal suicidal behavior (i.e., suicide attempts); non-suicidal self-harm (e.g., behaviors such as self-mutilation); suicidal thoughts, or some combination of these?

Another issue is that most of the data systems currently used to estimate trends in suicidal behavior were not designed solely to address this subject.[5] In these data systems, questions specific to suicide are often limited, and the collected data rarely provide the depth of information desired to inform effective prevention and intervention efforts. For example, some systems (e.g., hospital emergency department records) are designed to collect data on multiple health conditions, not just visits related to suicide. Altering these systems to enhance their capacity to collect suicide-related information may be difficult.[6]

Also data on suicides can be problematic because of geographic differences in death investigation methods and how equivocal cases are classified; lack of funding for coroner's or medical examiner's offices to conduct comprehensive investigations on all appropriate incidents, and differences in the extent to which potential suicides are investigated to accurately determine the cause of death.[7,8] In addition, timeliness of national estimates of suicides can be hindered by the complexity of the death certification and registration process.

The investigative and reporting processes at the state level often involve multiple parties, including vital registrars, medical examiners, coroners, physicians, toxicology laboratories, hospitals, nursing homes, and hospices. Data from the states must be aggregated at a national level to obtain national numbers that are complete and accurate. Because of the number of steps and processes involved, there is currently about a 1-year delay in determining the preliminary national suicide rate and a nearly 2-year delay for the final rate, making it difficult to implement timely adjustments to suicide prevention efforts or redirection of prevention resources.[7]

As one of the many task forces created through the National Action Alliance for Suicide Prevention (Action Alliance), the Data and Surveillance Task Force (DSTF) was established to help improve and expand the information available about suicide and suicidal behavior. The DSTF was charged with making recommendations for improving national data systems for suicide surveillance, particularly with regard to enhancing or expanding existing systems and improving the quality, timeliness, usefulness, and accessibility of data on suicide and suicidal behavior.

The DSTF reviewed the characteristics of existing data systems to identify their current usefulness in monitoring suicide and suicidal behavior and to identify gaps and areas for improvement. This report summarizes the findings from the review, discusses strengths and weaknesses related to data on suicide in the major types of available data sources, and provides recommendations for improving data timeliness, quality, and accessibility.

Methods

The DSTF focused the review on data systems that had the potential to provide national estimates on three aspects of self-harm: suicidal thoughts; nonfatal suicide behavior (i.e., suicide attempts); and suicides. Although several surveillance systems were identified that collect data on entire communities (e.g., the White Mountain Apache Tribally Mandated Suicide Surveillance System[9]) or selected metropolitan areas, states, or regions (e.g., National Addictions Vigilance Intervention and Prevention Program [NAVIPPRO™[10]], Researched Abuse, Diversion and Addiction-Related Surveillance [RADARS®] System[11]), these non-national systems were not reviewed. Data systems included in the review were operational as of November 2011.

The Task Force used existing guidelines[12–14] to focus the review process. Attributes considered included the aspects of the suicide-related spectrum (e.g., thoughts, attempts, and deaths) covered by the system; the segment of the population (e.g., youth, adults, military/veterans, or incarcerated individuals) included in the system; how the data are collected (e.g., census, sample, survey, administrative data files, self-report, or reporting by care providers); how often the data are collected (e.g., ongoing, annually, or periodically); the length of time before data are available for analysis and use; whether the quality of the data (e.g., response rates, reliability, validity, and completeness) has been assessed; how the data have been used; the strengths/limitations of the survey or data system; and whether and how the data system could be modified to improve the information on suicide events (e.g., expand to other populations, include additional questions, and expand coverage to more states).

Reviews were based on information provided on websites or from briefings made to the Task Force by individuals knowledgeable about the data system. The observations and conclusions made by the Task Force were not reviewed or confirmed by the agencies or organizations that operate the systems.

Results

A complete list of the reviewed data systems is provided in Table 1. The DSTF identified many common

characteristics in the strengths and challenges of different systems based on the underlying type of data involved (e.g., population based surveys, healthcare records). These generalized observations are summarized in Table 2. For example, although death certificate data are often captured from an in-depth investigation of the suicide, the information recorded on a death certificate might be limited and some demographic factors (e.g., race/ethnicity, veteran status) could potentially be misclassified because information is collected from next of kin or friends of the deceased.

Health provider records often provide more detailed data about the individual involved, but the data might not include all members of a population; thus, it is often difficult to calculate rates or determine prevalence. Population-based surveys are usually timely and flexible but can be expensive to administer and usually rely on self-report.

Discussion

The findings from the review of systems were used to develop recommendations submitted to the Action Alliance. This is a summary of the recommendations. First, use standard language and definitions on self-harm and suicidal thoughts and behavior in coding manuals and national surveys. For example, public and private organizations should adopt and promote the use of standard definitions such as those described in the CDC's *Self-Directed Violence Surveillance Uniform Definitions and Recommended Data Elements*[4] and the similarly worded Department of Veterans Affairs' Self-Directed Violence Classification System.[15]

Second, consider adding missing key variables or data elements (e.g., sociodemographics, mechanism of injury) to existing nonfatal data systems to enhance their usefulness for suicide-related surveillance. Some surveillance recommendation documents contain lists of data elements that could be considered for inclusion.[4,13–15] For example, suicidal thought and behavior questions could be added to the core items of national behavioral risk factor surveys on general health[16] and valid and reliable questions regarding sexual orientation/gender identity could be included on national surveillance systems.[17,18] Sexual orientation/gender identify has been identified as a risk factor for suicidal behavior in multiple studies yet is not routinely collected in national systems.[19,20]

Third, improve the ability to monitor changes at the regional, state, or county level or among subpopulations. This might be achieved through enhancements to existing mortality and morbidity data systems to expand the geographic scope to include areas where data are not currently collected or to oversample underrepresented groups.

Fourth, improve the timeliness and quality of information from death certificates. Several possibilities exist for this recommendation: develop guidelines for medical examiners, coroners, and others who investigate and certify deaths in order to standardize the investigation of suicides and possible suicides; identify the systems and processes in states with timely death registration and reporting to develop best practices and serve as a model for other states; ensure that all states have the resources (e.g., funding, trained staff) to implement electronic death registration systems that feed into the national vital statistics system; and investigate the feasibility of tracking national suicide mortality on a quarterly basis using mortality surveillance data from vital statistics.[21]

Fifth, endorse the use of external cause coding (a data element needed to identify suicide attempts) on medical records as a requirement for reimbursement by insurance carriers.[22] Sixth, support inclusion of suicide-related items in data systems that capture "real-time" information on hospital emergency department visits to improve the monitoring of trends in suicidal behavior. Collection of "real-time" data (i.e., data made available to analysts immediately after the event occurs) improves the ability of decision makers to respond efficiently and rapidly to potential public health problems.[23]

Seventh, encourage all states to include nonfatal suicidal behavior (suicide attempts) by youth aged 12−17 years as a health condition to be reported to the state health department (as per the Oregon model).[24] In 1987, the Oregon state legislature mandated that hospitals treating a child aged $\leq$17 years for injuries resulting from a suicide attempt report the attempt to the State Health Division, Oregon Department of Human Resources, and that the patient be referred for counseling.

Some of the recommendations proposed by the DSTF might be achievable in the short term ($<$1–3 years) by modifying existing data systems, whereas others involve more extensive changes and might require longer-term efforts (4–10 years). Short-term recommendations, such as adding already identified valid and reliable questions to some national surveys or incorporating standard language in coding systems and national surveys, may be feasible because consensus documents exist that provide guidance on these issues.[4,13–15] Longer-term recommendations such as standardizing death investigation practices across the U.S. or changing state health department requirements for reporting adolescent suicide attempts may

Table 1. Suicide-related systems reviewed, by category

Category	System name	Website	Administering organization
Deaths			
	Arrest-Related Death Survey	bjs.ojp.usdoj.gov/index.cfm?ty=tp&tid=82	Department of Justice, BJS
	Death Certificates from National Vital Statistics System	cdc.gov/nchs/nvss.htm	USDHHS, CDC
	Deaths-in-Custody Reporting Program	bjs.ojp.usdoj.gov/index.cfm?ty=tp&tid=19	Department of Justice, BJS
	Department of Defense Suicide Event Report (DoDSER—fatal section)	dodser.t2.health.mil/welcome	Department of Defense
	National Violent Death Reporting System (NVDRS)	cdc.gov/ViolencePrevention/NVDRS/index.htm	USDHHS, CDC
Healthcare provider records			
	Adolescent Suicide Attempt Data System (ASADS) Oregon	public.health.oregon.gov/PreventionWellness/SafeLiving/SuicidePrevention/Pages/ASADS2.aspx	Oregon Health Authority Public Health Division
	Biosense	cdc.gov/Biosense	USDHHS, CDC
	Department of Defense Suicide Event Report (DoDSER—nonfatal section)	dodser.t2.health.mil/welcome	Department of Defense
	Drug Abuse Warning Network (DAWN; no longer operational)	samhsa.gov/data/DAWN.aspx	USDHHS, SAMHSA
	Healthcare Cost and Utilization Project (HCUP)	hcup-us.ahrq.gov/overview.jsp	USDHHS, Agency for Healthcare Research and Quality
	National Ambulatory Medical Care Survey (NAMCS)	cdc.gov/nchs/ahcd.htm	USDHHS, CDC
	National Corrections Reporting Program	ncrp.info/SitePages/Home.aspx	Department of Justice
	National Electronic Injury Surveillance System—All Injury Program (NEISS-AIP)	cpsc.gov/library/neiss.html	USDHHS, CDC
	National Emergency Medical Services Information System (NEMSIS)	nemsis.org	National Association of State Emergency Medical Services Directors, National Highway Traffic Safety Administration, Health Resources and Services Administration

(continued on next page)

Table 1. Suicide-related systems reviewed, by category *(continued)*

Category	System name	Website	Administering organization
	National Hospital Ambulatory Medical Care Survey (NHAMCS)	cdc.gov/nchs/ahcd/about_ahcd.htm	USDHHS, CDC
	National Hospital Care Survey (NHCS)	cdc.gov/nchs/nhcs.htm	USDHHS, CDC
	National Hospital Discharge Survey (NHDS)	cdc.gov/nchs/nhds.htm	USDHHS, CDC
	National Suicide Prevention Lifeline	suicidepreventionlifeline.org	USDHHS, SAMHSA
	National Survey of Prison Health Care	Website not available Report using data: static.nicic.gov/Library/015999.pdf	Department of Justice
	National Trauma Data Bank (NTDB)	https://www.ntdbdatacenter.com/	American College of Surgeons
	Resource and Patient Management System (RPMS)	ihs.gov/RPMS/index.cfm?module=home&option=index&CFID=14067134&CFTOKEN=48279019	USDHHS, Indian Health Service
	Suicide Prevention Coordinator Reports	Website not available Report describing data: www.va.gov/opa/docs/Suicide-Data-Report-2012-final.pdf	U.S. Department of Veterans Affairs
Population-based surveys			
	Behavioral Risk Factor Survey System (BRFSS)	cdc.gov/brfss/	USDHHS, CDC
	National Co-morbidity Survey (NCS, 1990–1992) and Replication (NCS-R, 2001–2003)	hcp.med.harvard.edu/ncs/instruments.php	USDHHS, National Institute of Mental Health
	National Survey on Drug Use and Health (NSDUH)	icpsr.umich.edu/icpsrweb/SAMHDA/index.jsp	USDHHS, SAMHSA
	Youth Risk Behavior Surveillance System (YRBSS)	cdc.gov/HealthyYouth/yrbs/	USDHHS, CDC
	National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)	niaaa.census.gov/	USDHHS, NIH
Health insurance claims			
	Medicare/Medicaid	cms.gov/Research-Statistics-Data-and-Systems/Research/ResearchGenInfo/index.html	Centers for Medicare and Medicaid Services

BJS, Bureau of Justice Statistics; SAMHSA, Substance Abuse and Mental Health Services Administration

require greater coordination, effort, and support in order to be achieved.

The task force members believe that successful implementation of these recommendations will significantly enhance the development of a national coordinated program of fatal and nonfatal suicide surveillance. Such a coordinated program would facilitate evidence-based action to reduce the incidence of suicide and suicidal behavior in all populations.

Table 2. Use of existing data systems for suicide-related surveillance, selected strengths, and challenges by data source

Source: Death records	
Purpose: Medicolegal and public health	
Use for surveillance: To monitor mortality	
Characteristics: Types include death certificates, autopsy reports, and death investigation reports from medical examiners/coroners. Includes information on the manner and cause of death.	
Examples: National Vital Statistics System, National Violent Death Reporting System (NVDRS)	
Strengths	**Challenges**
• Intensive investigation by medical examiners/ coroners for some causes of deaths (e.g., suicide) • Intent of the injury is specified • Ongoing data collection	• Death certificates capture limited information • Death certificates cannot be easily modified owing to the need to conform to national and international standards • Processing of data, including assignment of codes for cause of death, can delay timeliness • Some demographic factors (e.g., race/ethnicity, veteran status) could potentially be misclassified because information is collected from next of kin or friends of the deceased • There can be variation among medical examiners/coroners in death investigation and certification practices
Source: Health care provider records	
Purpose: Administration, billing, clinical care, referral to medical and behavioral health care, risk assessments, and interventions provided by trained counselors	
Use for surveillance: To monitor morbidity and provide details on patient history, early warning, and case histories	
Characteristics: Types include hospital inpatient and emergency department records, syndromic events, trauma registries, and emergency medical service reports. These records provide information on the clinical condition of the injured person and on patient care. Generally, the collection of information is secondary to other activities (e.g., delivery of patient care).	
Examples: Healthcare Cost and Utilization Project (HCUP), National Hospital Ambulatory Medical Care Survey (NHAMCS), National Electronic Injury Surveillance System (NEISS), National Suicide Prevention Lifeline	
Strengths	**Challenges**
• Narrative fields can provide more detailed information (e.g., NHAMCS) • Data are derived from existing records; no de novo data collection required • Some data on charges or cost of care are available (e.g., HCUP) • Includes geographic details • Might be helpful for emerging health issues	• Limited to information available in the medical record • Depending on the data set, the number of records specific to suicide could be small • Comparison of data across systems can be difficult because systems may collect data in diverse formats or differ in how records are organized • Timeliness can be an issue owing to delays in processing administrative records • Key data elements are frequently missing or not collected (e.g., race, external cause of injury, circumstances of the injury event, risk/protective factors) • May only contain data on events or cases (numerator); rarely has information on the population at risk (denominator) • Generation of the surveillance data is not the primary function of the system that actually yields the data. Because the information is collected for other purposes, the use of standardized case definitions and the quality of the data collected can be challenging.
Source: Population-based surveys	
Purpose: Monitor behaviors or health status	
Use for surveillance: To identify broad populations at risk for health effects	
Characteristics: Involve well-defined, time-limited collection of information from the entire population (census) or a representative portion (sample). Can be designed to capture in-depth information on multiple topics. Surveys are excellent for providing baseline or "snapshot" data; however, use in monitoring trends requires repeated administration.	
Examples: National Survey on Drug Use and Health (NSDUH), Youth Risk Behavior Survey (YRBS)	

(continued on next page)

Table 2. Use of existing data systems for suicide-related surveillance, selected strengths, and challenges by data source *(continued)*

Strengths	Challenges
• Flexible, but changes to the structure of the survey (e.g., adding new questions) might take time • Anonymity of the respondent may promote truthful responses • Can be designed to focus on factors associated with suicidal behavior such as SES • Timeliness	• Depending on the sample design, the ability to provide estimates for subpopulations might be limited • Can be expensive to administer • Analysis can be complicated if the survey uses a complex sampling design • Relies on self-report, which may be inaccurate • As response rates decline, selection bias may increase, resulting in a reduction in the representativeness of the responses (particularly with telephone surveys) • Time/space constraints of survey administration may limit the number and types of questions that can be included
Source: Health insurance claims	
Purpose: Financial administration	
Use for surveillance: To monitor morbidity, provide details on medical history	
Characteristics: Data are maintained by insurance organizations and used to process claims	
Examples: Medicare, Medicaid	
Strengths	**Challenges**
• Can detect small changes in the occurrence of events because of the large number of records • Both initial visit and outcomes can be tracked • May provide information on the patient's medical history prior to the event • May be able to track continuity of care • Timeliness	• The system is not designed for surveillance • Only the population of persons insured by the carrier are included in the data set; patients who change insurance providers are no longer in the system • External cause of injury (used to identify suicide attempts) may be missing or limited • Access to the data may be limited depending on the affiliation of the user

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The following are members of the Data and Surveillance Task Force of the National Action Alliance for Suicide Prevention: Robin Ikeda, MD, MPH, CDC (co-lead); Holly Hedegaard, MD, MSPH, CDC (co-lead); Robert Bossarte, PhD, Center of Excellence at Canandaigua; Alexander E. Crosby, MD, MPH, CDC; Randy Hanzlick, MD, Fulton County, GA Medical Examiner, Emory University School of Medicine; Jon Roesler, MS, Minnesota Department of Health; Regina Seider, CDC; Patricia Smith, MS, Michigan Department of Community Health; Margaret Warner, PhD, CDC.

No financial disclosures were reported by the authors of this paper.

References

1. Potter LB, Powell KP, Kachur SP. Suicide prevention from a public health perspective. Suicide Life Threat Behav 1995;25(1):82–91.
2. Horan JM, Mallonee S. Injury surveillance. Epidemiol Rev 2003;25(1):24–42.
3. Thacker SB, Stroup DF. Future directions for comprehensive public health surveillance and health information systems in the U.S. Am J Epidemiol 1994;140(5):383–97.
4. Crosby AE, Ortega L, Melanson C. Self-directed violence surveillance: uniform definitions and recommended data elements, version 1.0. Atlanta GA: CDC, 2011. www.cdc.gov/violenceprevention/pdf/Self-Directed-Violence-a.pdf.
5. USDHHS, Public Health Service. National strategy for suicide prevention: goals and objectives for action. Washington DC: USDHHS, Public Health Service, 2001. www.sprc.org/sites/sprc.org/files/library/nssp.pdf.
6. Suicide Prevention Action Network. Strategies to improve nonfatal suicide attempt surveillance—recommendations from an expert roundtable. Washington DC: Suicide Prevention Action Network, 2006. www.safestates.org/associations/5805/files/SPANsurveillance06.pdf.
7. National Research Council. Vital statistics: summary of a workshop Michael J Siri and Daniel L. Cork, rapporteurs. Committee on National Statistics, Division of Behavioral and Social Sciences and Education. Washington DC: National Academies Press, 2009.
8. Goldsmith SK, Pellmar TC, Kleinman AM, Bunney WE, eds. Reducing suicide: a national imperative. Washington DC: National Academies Press, 2002.
9. Suicide Prevention Resource Center. White Mountain Apache Tribally Mandated Suicide Surveillance System. sprc.org/grantees/white-mountain-apachejohns-hopkins-university.
10. National Addictions Vigilance Intervention and Prevention Program. navippro.com/.
11. Researched Abuse, Diversion and Addiction-Related Surveillance (RADARS®) System. radars.org/.
12. CDC. Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group. MMWR 2001;50(RR-13):1–35; quiz CE1–7.

13. Holder Y, Peden M, Krug E, et al., eds. Injury surveillance guidelines. Geneva: WHO, 2001. whqlibdoc.who.int/publications/2001/9241591331.pdf.
14. State and Territorial Injury Prevention Directors' Association. Consensus recommendations for injury surveillance in state health departments. Marietta GA: State and Territorial Injury Prevention Directors' Association, 2007. ibis.health.state.nm.us/docs/Query/STIPDAConcensusRecommendations.pdf.
15. U.S. Department of Veterans Affairs. Mental Illness Research, Education and Clinical Centers Veterans Integrated Service Network 19. Self-Directed Violence Classification System. mirecc.va.gov/visn19/education/nomenclature.asp.
16. Remington PL, Smith MY, Williamson DF, Anda RF, Gentry EM, Hogelin GC. Design, characteristics, and usefulness of state-based behavioral risk factor surveillance: 1981–1987. Public Health Rep 1988;103(4):366–75.
17. King M, Semlyen J, Tai SS, et al. A systematic review of mental disorder, suicide, and deliberate self harm in lesbian, gay and bisexual people. BMC Psychiatry 2008;8:70.
18. Ridolfo H, Perez K, Miller K. Testing of sexual identity and health-related questions: results of interviews conducted May–July 2005. cdc.gov/qbank.
19. Badgett M. Best practices for asking questions about sexual orientation on surveys. Los Angeles CA: The Williams Institute, UCLA School of Law. williamsinstitute.law.ucla.edu/wp-content/uploads/SMART-FINAL-Nov-2009.pdf.
20. CDC. Sexual identity, sex of sexual contacts, and health-risk behaviors among students in grades 9–12—Youth Risk Behavior Surveillance, selected sites, U.S., 2001–2009. MMWR 2011;60(SS–7):1–134.
21. Weed JA. Vital statistics in the U.S.: preparing for the next century. Popul Index 1995;61(4):527–39.
22. National Center for Injury Prevention and Control. Recommended actions to improve external-cause-of-injury coding in state-based hospital discharge and emergency department data systems. Atlanta GA: USDHHS, CDC, 2009.
23. CDC. Syndromic surveillance: reports from a national conference, 2004. MMWR 2005;54(S). cdc.gov/Mmwr/preview/mmwrhtml/su5401toc.htm.
24. CDC. Fatal and nonfatal suicide attempts among adolescents—Oregon, 1988–1993. MMWR 1995;44(16):321–3cdc.gov/mmwr/preview/mmwrhtml/00036910.htm.

Data for Building a National Suicide Prevention Strategy

What We Have and What We Need

Lisa J. Colpe, PhD, MPH, Beverly A. Pringle, PhD

Suicide is a leading cause of death in the U.S. As both the rate and number of suicides continue to climb, the country struggles with how to reverse this alarming trend. Using population-based data from publically available sources including the Web-based Injury Statistics Query and Reporting System, National Survey on Drug Use and Health, the authors identified patterns of suicide that can be used to steer a public health–based suicide prevention strategy. That most suicide deaths occur upon the first attempt, for example, suggests that a greater investment in primary prevention is needed. The fact that definable subgroups receiving care through identifiable service systems, such as individuals in specialty substance use treatment, exhibit greater concentrations of suicide risk than the general public suggests that integrating suicide prevention strategies into those service system platforms is an efficient way to deliver care to those with heightened need. The data sets that reveal these patterns have both strengths (e.g., population-level) and weaknesses (e.g., lack of longitudinal data linking changing health status, intervention encounters, suicidal behavior, and death records). Some of the data needed for crafting a comprehensive, public health–based approach for dramatically reducing suicide are currently available or may be available in the near term. Other resources will have to be built, perhaps by enhancing existing federal surveillance systems or constructing new ones. The article concludes with suggestions for immediate and longer-term actions that can strengthen public data resources in the service of reducing suicide in the U.S.

(Am J Prev Med 2014;47(3S2):S130–S136) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

In 2010, suicide was the tenth-leading cause of death in the U.S., claiming more than twice as many lives as homicide.[1] On average, between 2001 and 2010, more than 33,000 Americans died each year from suicide.[2] The burden of suicide in the U.S. goes beyond deaths, however: Suicide attempts confer morbidity and economic burden on individuals, their families and friends, their workplaces, and on healthcare settings as well. Emergency department (ED) records show that 487,770 ED visits by youth and adults in 2011 were linked to a suicide attempt.[3]

Annual surveys conducted since 2008 indicate that an estimated 1.1 million adults (0.5% of the adult population) attempted suicide each year,[4,5] and an additional almost 400,000 youth (2.4% of high school students) report having made a serious suicide attempt (i.e., resulting in treatment by a doctor or nurse).[6] The discrepancy between the numbers of self-reported suicide attempts and self-harm injuries seen in the ED suggests there is a range in the severity of suicide attempts and whether and where suicide attempters receive treatment.

Although the U.S. lacks rigorous and consistent longitudinal data that capture the natural history of suicidal behavior, information from various studies and reports can be pieced together to form a picture—and the picture is grim. Data from the National Violent Death Reporting System (NVDRS) indicate that among suicide decedents with known histories, 19.8% had made a previous suicide attempt.[7] This suggests that some deaths may have been avoided if effective interventions for preventing repeat suicide attempts had been in place.

Taken further, the NVDRS report indicates that 80% of people who die by suicide use highly lethal means, such as firearms or hanging, that are likely to cause death the first time they are used. Thus, a key point of intervention for 80% of suicide decedents each year is not when they reveal themselves to be at risk after a

From the Division of Services and Intervention Research (Colpe), and Office for Research on Disparities and Global Mental Health (Pringle), National Institute of Mental Health, Bethesda, Maryland

Address correspondence to: Lisa J. Colpe, PhD, MPH, 6001 Executive Blvd, Room 7138/MSC9629, Bethesda MD 20892. E-mail: lisa.colpe@nih.gov.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.024

suicide attempt; rather, it is much earlier in the trajectory that leads up to that first suicide act.[8,9]

The vision of the National Action Alliance for Suicide Prevention (Action Alliance), an initiative launched by the USDHHS in 2010, is "a nation free from the tragic experience of suicide."[10] In pursuit of this vision, the Action Alliance's Research Prioritization Task Force (RPTF) has released a research agenda aimed at reducing suicide deaths and attempts by 20% in 5 years.[11]

To achieve this ambitious goal, a strategic approach to targeting intervention has been recommended.[11,12] One four-step approach involves prioritizing population subgroups with concentrated risk of suicide, identifying effective interventions ready for deployment and service platforms from which to launch them, estimating the potential impact of these interventions if deployed in real-world settings, and assessing the time horizons for taking implementation to scale.[12] This public health approach recognizes that suicide results from the complex interplay of many personal factors, such as poor mental health and substance abuse, and life experiences, such as abuse/trauma, physical illness, and financial distress, that affect a variety of people across the life span.[13]

A key to successful suicide prevention will be to expand the number and types of systems such as primary and mental health care clinics, schools, work places, hospitals, EDs, and criminal justice settings where at-risk populations can be identified and targeted early in the risk trajectory. These systems, in turn, can serve as platforms for the delivery of evidence-based prevention and intervention services and can monitor program effectiveness in reducing suicide. Decision makers with knowledge about evidence-based practices appropriate for their populations (e.g., universal, selective, or indicated) and reliable data for targeting interventions and assessing outcomes are better equipped to take strategic action to reduce suicide within and across the agencies and programs they lead.

What We Know

A Leading Cause of Death

Suicide statistics are generated from death certificate data collected by states and assembled into national record archives by the CDC.[1] Basic demographic data plus information about the method of death are recorded on each certificate of death. Suicide mortality statistics can be portrayed in multiple ways.

From a public health perspective, "leading causes of death" charts help to identify the most frequent types of illness, disease, or condition that lead to death along a developmental (age) spectrum. Suicide is within the top four leading causes of death among individuals aged 10–54 years, who comprise almost two thirds of the U.S. population. It is only as other illnesses and diseases become prevalent in older adults that suicide falls to the eighth-leading cause for 55–64-year-olds and usually outside of the top ten causes of death among those who are ≥65 years old.[1]

A Growing Problem

The latest data available indicate that the U.S. suicide rate has risen from 10.5 per 100,000 in 1999 to more than 12 per 100,000 in 2010 (Table 1). This increase, in conjunction with population growth over the same time frame (279 million to almost 309 million), has raised the national total number of suicides per year by 31%, from 29,199 in 1999 to 38,364 in 2010.[2]

Differences by Gender, Race, and Ethnicity

Death certificates also yield demographic information about people who die by suicide, which can be used to target intervention strategies. Table 2 provides a breakdown of suicide numbers by gender and race, and then provides numbers for the top three methods used by men and women—firearms, poisoning, and suffocation. Firearms and poisoning together account for more than two thirds of suicides. Adding suffocation increases the percentage of suicides covered to 77% for women and a full 96% for men.

Table 1. Annual number of suicide deaths, U.S., 1999–2010

Year	Number of suicide deaths	Population	Rate per 100,000
1999	29,199	279,404,181	10.5
2000	29,350	287,803,914	10.4
2001	30,622	285,081,556	10.7
2002	31,655	287,803,914	11.0
2003	31,484	290,326,418	10.8
2004	32,439	293,045,739	11.1
2005	32,637	295,753,151	11.0
2006	33,300	298,593,212	11.2
2007	34,598	301,579,895	11.5
2008	36,035	304,374,846	11.8
2009	36,909	307,006,550	12.0
2010	38,364	308,745,538	12.4

Data source: Web-Based Injury Statistics Query and Reporting System (WISQARS); fatal injury reports, national and regional, 1999–2010

Table 2. Method of suicide death by gender and race/ethnicity, U.S., 2009

	Number of suicides	Top 3 methods of suicide death		Total accounted for by 3 methods
Male	29,089	Firearm	16,962	96%
		Poisoning	3,573	
		Suffocation	7,300	
Female	7,820	Firearm	2,428	77%
		Poisoning	1,901	
		Suffocation	1,700	
White	33,425	Firearm	17,332	90%
		Poisoning	5,036	
		Suffocation	7,805	
Black	2,084	Firearm	1,034	88%
		Poisoning	274	
		Suffocation	537	
American Indian/Alaska Native	429	Firearm	161	96%
		Poisoning	61	
		Suffocation	188	
Hispanic	2,573	Firearm	955	90%
		Poisoning	305	
		Suffocation	1,050	

Data source: Web-Based Injury Statistics Query and Reporting System (WISQARS), 2009

Distributions within the cause of death categories vary somewhat among different racial/ethnic groups. Firearms are the most frequently used suicide method among whites and blacks, whereas suffocation is the most commonly used method among American Indian/Alaska Native and Hispanic subgroups.[2]

Age and Suicide

Age at death, which is also listed on death certificates, offers a glimpse of the patterns and magnitude of suicide across the life span. Suicide is one of the highest-ranking causes of premature mortality in the industrialized world.[14] Expressed in "potential years of life lost," the burden of suicide mounts as decedents get younger. Using age 65 years as a cut point for premature death, data in Table 3 indicate that close to 85% of all suicides (those occurring between age 10 and 64 years) incur 1–55 potential years of life lost. Table 3 also shows that although numbers of suicides in the older age groups (≥65 years) appear to decrease, the suicide rates remain substantially higher than the 11.8 per 100,000 overall rate for the nation.

In sum, suicide rates and patterns by age, gender, and race can be identified in existing mortality data records, and they indicate a substantial public health problem in the U.S. The total number of suicides in the U.S. has increased gradually but consistently over the past decade, while downward trends have been noted in European and Scandinavian countries during the same time period.[15–17]

Suicide rates rise steadily with age, then peak in the 50–64-year age range. Firearms account for the highest numbers of suicides among men and women, white and black. The great majority (80%) of suicides occur upon the first attempt. This and other information may be used to target prevention efforts on the methods used in suicides or high-risk subgroups across the life span, as well as to monitor the effects of state and federal policy changes and safety practices in the past, present, and future.[18–20]

Suicide Attempts

Data on the Nation's rates and incidents of suicide attempts are available from multiple sources. The National Survey on Drug Use and Health (NSDUH) has collected data on self-reported suicidal behavior including ideation, plans, attempts, and attempts requiring medical attention in the general population, defined as adults aged ≥18 years,[4,5] since 2008. The Youth Risk Behavior Surveillance System (YRBSS) collects information about suicidal

Table 3. Number and rate of suicide deaths by age group, U.S., 2009

	Age range (years)						
	All ages	10–19	20–34	35–49	50–64	65–79	≥85
Number of suicide deaths	36,909	1,928	8,022	10,889	10,194	4,019	1,839
Rate per 100,000 (age adjusted)	11.8	4.4	12.9	16.8	17.9	14.1	16.6

Data source: Web-Based Injury Statistics Query and Reporting System (WISQARS), 2009

behavior from youth aged 13–18 years in Grades 9–12.[6] The Web-Based Injury Statistics Query and Reporting System (WISQARS) yields medical record data on intentional self-harm injuries treated in U.S. hospital EDs, collected under the aegis of the Consumer Protection Safety Commission's National Electronic Injury Surveillance System (NEISS).[3]

A relatively new and promising research platform, the Mental Health Research Network is a consortium of 11 healthcare systems that hold longitudinal electronic medical records and insurance claim data for 11 million enrolled members, yielding information about health events and contacts that occur prior to suicide attempts and deaths.[21] This is a unique, valuable resource currently unmatched by federal data systems.

The charge to reduce suicide deaths and attempts by 20% in 5 years requires a strategic approach to targeting suicide prevention and intervention programs.[12] Such an approach could begin with identification of existing service delivery systems, such as EDs, schools, jails/prisons, workplaces, and mental health and substance treatment facilities that contain "boundaried populations" and can therefore provide access to subgroups with higher concentrations of suicide risk and become platforms for delivering care.[12] Information available from the aforementioned federal data systems are useful for identifying potential service system platforms, determining concentrations of risk for boundaried populations within these systems, and statistical modeling of the potential impact of preventive interventions on suicide attempt rates in these populations.[22]

Population data on suicide attempts collected through the NSDUH can be reassembled to reflect specific boundaried populations (Table 4). The data indicate that some boundaried populations exhibit greater concentrations of suicide risk than others. It is commonly known that most suicide decedents have had some form of serious mental illness[23] and around a quarter of suicide decedents were in contact with mental health services in the month before death, offering the possibility of intervention.[21,24]

Less well known are other boundaried populations that represent ready, potentially fruitful opportunities for

Table 4. Number and percentage with suicidal ideation and attempt among specific boundaried populations

	Estimated number in population	People with past year suicidal ideation		People with past year suicide attempt	
		n	%	*n*	%
Total U.S. population (adults aged ≥18 years), 2012	226,065,000	9,031,000	3.9	1,290,000	0.6
Sorted by service delivery platform					
Full-time employee[a]	116,652,000	3,514,000	3.0	344,000	0.3
Seen in emergency department[a]	66,023,000	3,941,000	6.2	728,000	1.1
Military veteran[a]	24,141,000	800,000	3.4	96,000	0.4
On Medicaid[a]	20,903,000	1,440,000	6.9	311,000	1.5
Full-time college student[a]	15,748,000	888,000	5.6	119,000	0.8
On probation or parole[a]	5,493,000	543,000	9.9	130,000	2.4
Outpatient mental health clinic[b]	3,257,000	847,000	26.2	206,000	6.4
Specialty substance use treatment[a]	2,613,000	446,000	19.4	122,000	5.3

Data source: National Survey on Drug Use and Health, 2008–2012
[a]Annual averages based on 2008–2012
[b]Annual averages based on 2008–2010

intervention. For example, although the observed self-reported rate of suicide attempt in the general population is 0.6%, the rate of past-year suicide attempt among the specialty substance use treatment population is 5.3%—a concentration of risk more than eight times higher than that seen in the general population. Similarly, greater concentrations of suicide risk are seen among people on probation or parole, on Medicaid, and among those seen in an ED in the past year.

Proportionally lower concentrations of suicide risk are observed among people who are employed full-time (0.3%); however, the utility of an employer-based intervention platform should not be dismissed based on that information alone, because the 344,000 annual attempts among full-time workers represents almost one third of annual suicide attempts estimated for the nation. Further analysis of these data from this perspective could point to a set of boundaried populations for which suicide prevention interventions would yield the greatest public health benefit in terms of lives saved.[12]

Breakthroughs Needed

Federal data systems collect basic historic and demographic information on suicide decedents and attempters along with, in some cases, clues to where concentrations of suicide attempters may be identified and targeted for intervention. A strength of these surveillance systems is that they provide information on large numbers of individuals in the general population—data that may be examined and combined to inform the practices of those serving vulnerable populations, monitored to determine trends over time, and used to determine meaningful public health correlates of suicide such as mental illness, substance abuse, physical illness, financial distress.

In order to reduce suicide, however, these surveillance systems need to do more—they need to yield data that are timely, accurate, and much more useful for predicting risk, identifying needs, targeting care, and detecting intervention effects.[15] Delays of 3 or more years are common in the release of national mortality data, and the reliability of official suicide numbers and rates are subject to error because of variability in defining suicide and in determining and reporting manner of death.[25–27]

Furthermore, no federal data system follows general populations over time and links changing health status, intervention encounters, and information about suicidal behavior to mortality records. Recent advances in the use of electronic records (i.e., health, program participation, and research records) and the capacity for linkage to mortality records portend a brighter future for suicide research in the U.S. Some existing, self-contained data systems within specific care systems including the Mental Health Research Networks, Department of Defense/military services, Veterans Affairs (VA) healthcare system, and possibly other health insurance/service delivery care systems, permit in-depth, longitudinal examination of key modifiable precursors to suicidal behavior that can serve as markers for suicide risk and targets for interventions.

These data systems cover only selected segments of the U.S. population; nevertheless, they could be melded into a coordinated data platform for identifying suicide risk factors by tracing the onset of suicidal behaviors longitudinally in large groups of participants who have not yet developed overt suicidal behavior. Consideration of such a coordinated approach underscores the would-be benefits of using common measures of suicidal behaviors and key correlates across studies to facilitate data pooling and interpretation across service systems. The use of common data elements, data banking, and data sharing are core methodologic research strategies recommended by the RPTF.

Deeper knowledge about the complex nature of suicidal behavior and how to prevent it will require a much more concentrated effort using epidemiologic data resources that permit retrospective and prospective analyses of precursors to suicidal events,[28] including detailed information about the treatment or interventions individuals receive along the way. Denmark and Sweden have developed national registries that can be used to explore a wide variety of epidemiologic questions regarding suicide risk and behavior at the population level.[29,30]

Data resources for the U.S. population will have to be built, perhaps by enhancing existing federal healthcare and surveillance data systems or creating new ones. Thus, although some pressing research objectives may be accomplished in the short term using existing data resources, other longer-term, complex research objectives may not be achieved until more comprehensive data resources become available.

Short-Term Research Objectives

Short-term research goals outlined by the RPTF—such as (1) developing risk algorithms from healthcare data for detecting suicide risk; (2) improving care efficiencies and decision-making tools by identifying valid screening approaches; or (3) identifying feasible and effective interventions[11]—may be tested within research platforms based in self-contained healthcare and administrative data systems such as those maintained by VA Health,[31] the Mental Health Research Network,[21] and the Army Study to Assess Risk and Resilience in Servicemembers.[32]

These data systems would permit retrospective examination of the pathways leading to suicide events and development of predictive algorithms and screeners that could be tested prospectively to determine their validity

and then disseminated for broad use. Healthcare data systems may also be used to monitor risk trajectories and outcomes for people who have been enrolled in suicide prevention interventions. Linking research data systems to mortality records will be critical for strengthening the ability to determine cause of death outcomes of interest to the care systems.

Long-Term Research Objectives

Longer-term research goals identified by the RPTF—such as (1) determining whether processes that reduce risk conditions (e.g., insomnia, addiction, pain) also mitigate suicide; (2) developing screening approaches for low-, moderate-, and high-risk individuals so that preventive interventions can be more finely calibrated based on risk level; or (3) identifying which interventions that are launched outside of healthcare settings reduce suicide risk[11]—will require the development of additional data resources. Multiple data networks that are linked by common data elements will be needed in order to test suicide prevention programs, pair immediate and longer-term interventions with specific risk groups, and evaluate the impact of programs and interventions on overall suicide death and attempt rates over time.

In conclusion, the rate and number of suicides in the U.S. continue to climb despite the many concerted efforts to halt the trend. The RPTF recommends a fresh, strategic, public health–based approach to suicide prevention. Such an approach will have the greatest chance of success if it is based on sophisticated analysis of complex, population-based data (i.e., longitudinal data linking health status, intervention encounters, suicidal behavior, and death records) from a wide variety of service delivery system platforms. Some of the data and platforms needed for crafting a comprehensive, public health–based approach to dramatically reduce suicide are currently available or may be available in the near term. Other data resources will have to be created, perhaps by enhancing existing federal surveillance systems or constructing new ones.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The views expressed in this manuscript do not necessarily represent the views of the National Institute of Mental Health or the Federal Government.

No financial disclosures were reported by the authors of this paper.

References

1. CDC, National Center for Injury Prevention and Control. 10 leading causes of death by age group, U.S.—2010. Atlanta GA: CDC, 2011. www.cdc.gov/injury/wisqars/pdf/10LCID_All_Deaths_By_Age_Group_2010-a.pdf.
2. CDC, National Center for Injury Prevention and Control. Fatal injury reports, national and regional, 1999–2010. webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html.
3. CDC, National Center for Injury Prevention and Control. Nonfatal injury reports. self-harm all injury causes, nonfatal injuries and rates per 100,000, 2011, U.S., All Races, Both Sexes, All Ages. webappa.cdc.gov/sasweb/ncipc/nfirates2001.html.
4. Substance Abuse and Mental Health Services Administration. Results from the 2009 National Survey on Drug Use and Health: mental health findings. Rockville MD: Center for Behavioral Health Statistics and Quality, 2010. NSDUH Series H-39, HHS Publication No. SMA 10-4609.
5. Substance Abuse and Mental Health Services Administration. Results from the 2010 National Survey on Drug Use and Health: mental health findings. Rockville MD: Substance Abuse and Mental Health Services Administration, 2012. NSDUH Series H-42, HHS Publication No. SMA 11-4667.
6. CDC. Youth risk behavior surveillance—U.S., 2011. MMWR Surveill Summ 2012;61(4):11–2.
7. CDC. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2009. MMWR Surveill Summ 2012;61(6):1–43.
8. Caldwell D. The suicide prevention continuum. Pimatisiwin 2008;6(2):145–53.
9. Rosenman SJ. Preventing suicide: what will work and what will not. Med J Austral 1998;169(2):100–2.
10. National Action Alliance for Suicide Prevention. http://actionalliance forsuicideprevention.org/about-us.
11. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
12. Pringle B, Colpe LJ, Heinssen RK, et al. A strategic approach for prioritizing research and action to prevent suicide. Psychiatr Serv 2013;64(1):71–5.
13. Nock MK, Borges G, Bromet EJ, Cha CB, Kessler RC, Lee S. The epidemiology of suicide and suicidal behavior. In: Nock MK, Borges G, Ono Y, eds. Suicide: global perspectives from the WHO World Mental Health Surveys. Cambridge: Cambridge University Press, 2012.
14. Gunnell D, Middleton N. National suicide rates as an indicator of the effect of suicide on premature mortality. Lancet 2003;362(9388):961–2.
15. Värnik P. Suicide in the world. Int Environ Res Public Health 2012;9(3):760–71.
16. Titelman D, Oskarsson H, Wahlbeck K, et al. Suicide mortality trends in the Nordic countries 1980–2009. Nord J Psychiatry 2013;67(6):414–23.
17. WHO Regional Office for Europe. SDR, Suicide and Self-Inflicted Injury, All Ages Per 100,000. data.euro.who.int/hfadb/.
18. Barber C, Miller M. Toward a research agenda on reducing a suicidal person's access to lethal methods of suicide. Am J Prev Med 2014.
19. Searles VB, Valley MA, Hedegaard H, Betz ME. Suicides in urban and rural counties in the U.S., 2006–2008. Crisis 2014;35(1):18–26.
20. McGinty EE, Webster DW, Barry CL. Gun policy and serious mental illness: priorities for future research and policy. Psychiatr Serv 2014;65(1):50–8.
21. Ahmedani BK, Simon GE, Stewart C, et al. Health care contacts in the year before suicide death. J Gen Intern Med 2014;29(6):870–7.
22. Lynch F. Population health outcomes from psychotherapeutic interventions for suicide attempt. Am J Prev Med 2014;47(3S2):S137–S143.

23. McLean J, Maxwell M, Platt S, Harris F, Jepson R. Risk and protective factors for suicide and suicidal behaviour: a literature review. Glasgow: Scottish Executive Social Research, 2008.
24. Luoma JB, Martin CE, Pearson JL. Contact with mental health and primary care providers before suicide: a review of the evidence. Am J Psychol 2002;159(6):909–16.
25. Rockett IRH. Counting suicides and making suicide count as a public health problem. Crisis 2010;31(5):227–30.
26. Carr JR, Hoge CW, Gardner J, et al. Suicide surveillance in the U.S. military—reporting and classification biases in rate calculations. Suicide Life Threat Behav 2004;34(3):233–41.
27. Sainsbury P, Jenkins JS. The accuracy of officially reported suicide statistics for purposes of epidemiological research. J Epidemiol Community Health 1982;36(1):43–8.
28. Glenn C, Nock M. Improving the short term prediction of suicidal behavior. Am J Prev Med 2014;47(3S2):S176–S180.
29. Sørensen HJ, Mortensen EL, Wang AG, Juel K, Silverton L, Mednick SA. Suicide and mental illness in parents and risk of suicide in offspring. Soc Psychiatry Psychiatr Epidemiol 2009;44(9):748–51.
30. Mittendorfer-Rutz E, Rasmussen F, Lange T. A life-course study on effects of parental markers of morbidity and mortality on offspring's suicide attempt. PLoS One 2012;7(12):e51585.
31. Kemp J, Bossarte R. Surveillance of suicide and suicide attempts among veterans: addressing a national imperative. Am J Public Health 2012;102(S1):e4S–e5S.
32. Kessler RC, Colpe LJ, Fullerton CS, et al. Design of the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). Int J Methods Psychiatr Res 2013;22(4):267–75.

Population Health Outcome Models in Suicide Prevention Policy

Frances L. Lynch, PhD, MSPH

Background: Suicide is a leading cause of death in the U.S. and results in immense suffering and significant cost. Effective suicide prevention interventions could reduce this burden, but policy makers need estimates of health outcomes achieved by alternative interventions to focus implementation efforts.

Purpose: To illustrate the utility of health outcome models to help in achieving goals defined by the National Action Alliance for Suicide Prevention's Research Prioritization Task Force. The approach is illustrated specifically with psychotherapeutic interventions to prevent suicide reattempt in emergency department settings.

Methods: A health outcome model using decision analysis with secondary data was applied to estimate suicide attempts and deaths averted from evidence-based interventions.

Results: Under optimal conditions, the model estimated that over 1 year, implementing evidence-based psychotherapeutic interventions in emergency departments could decrease the number of suicide attempts by 18,737, and if offered over 5 years, it could avert 109,306 attempts. Over 1 year, the model estimated 2,498 fewer deaths from suicide, and over 5 years, about 13,928 fewer suicide deaths.

Conclusions: Health outcome models could aid in suicide prevention policy by helping focus implementation efforts. Further research developing more sophisticated models of the impact of suicide prevention interventions that include a more complex understanding of suicidal behavior, longer time frames, and inclusion of additional outcomes that capture the full benefits and costs of interventions would be helpful next steps.

(Am J Prev Med 2014;47(3S2):S137–S143)

Introduction

Suicide is the tenth-leading cause of death in the U.S., with more than 36,000 deaths as a result of suicide in 2009.[1] The cost of completed suicide is immense, including lost life and potential of the individuals who die from suicide as well as the long-lasting impact of suicide on families and communities. In addition, people who attempt suicide often have significant medical costs, lost time from work, and other impairments in functioning following an attempt.[2,3]

Recently, a public–private partnership, the National Action Alliance for Suicide Prevention (Action Alliance), launched an initiative to apply a comprehensive public health approach to quickly and substantially reduce suicide deaths in the U.S. A part of this initiative, the Action Alliance's Research Prioritization Task Force (RPTF) is charged with defining a research agenda that, if fully implemented, could reduce suicide attempts and deaths by 20% in 5 years.[4] Part of the RPTF initiative is to map the burden of suicide in the U.S., including four steps to improving the evidence base related to suicide prevention: (1) develop a taxonomy of high-risk target subgroups; (2) identify and pair effective practices and policies with specific high-risk groups; (3) estimate the potential impact of implementing effective interventions within targeted intervention platforms; and (4) estimate time horizons for intervention implementation and future research.[4] This paper explores the third step and focuses on one approach that has frequently been used in decision making: models of population health outcomes.

From the Center for Health Research, Kaiser Permanente Northwest, Portland, Oregon

Address correspondence to: Frances L. Lynch, PhD, Center for Health Research, 3800 North Interstate, Portland OR 97227. E-mail: frances.lynch@kpchr.org.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.022

Models of Population Health Outcomes

Population health outcome models are statistical models that estimate the likely health outcomes that could be achieved by alternative interventions aimed at addressing a specific health issue.[5–7] Health outcome models use estimates from rigorous scientific studies, data on population characteristics, clinical settings, and population risk factors to project likely health outcomes of alternative interventions. Models can be very sophisticated and incorporate many aspects of the disease course, or may be much simpler and focus on a narrower clinical or health policy question.

Estimating Outcomes in the Context of Suicide Prevention

Because death by suicide is a rare event, longitudinal studies of suicide preventive interventions are often small and relatively brief. Therefore, it is difficult for individual studies to follow a sufficient number of subjects to examine important outcomes related to suicide. Models could provide a way to begin to understand the population impact of implementing effective interventions in a population. In addition, the modeling process can help to identify important gaps in knowledge for future research. To date, there is little research estimating population health outcomes related to suicide prevention.[8]

The purpose of this paper is to begin a conversation about health outcome modeling of suicide prevention interventions and to identify gaps in current research that, if filled, could help guide future efforts. The approach is illustrated using the example of one specific policy question: If we optimally delivered evidence-based psychotherapeutic interventions designed to prevent suicide reattempt in emergency department (ED) settings, how many suicide attempts and deaths could we avert in 1 year? In 5 years?

Methods

To address this question, a simple health outcome model was developed. Similar models have been used in previous studies of psychiatric interventions.[9,10] The model is a Markov cohort simulation. Models were constructed in Microsoft Excel 2007. The structure of the model is shown in Figure 1. The cycle length of the model is 1 year. The model estimated suicide attempts and suicide deaths for each therapeutic scenario over 1- and 5-year time frames, as defined by the RPTF.

Data Sources

The sample of individuals who could potentially benefit from a psychotherapeutic intervention following a suicide attempt was obtained from the U.S. Consumer Product Safety Commission (CPSC) injury surveillance and follow-back system, the National

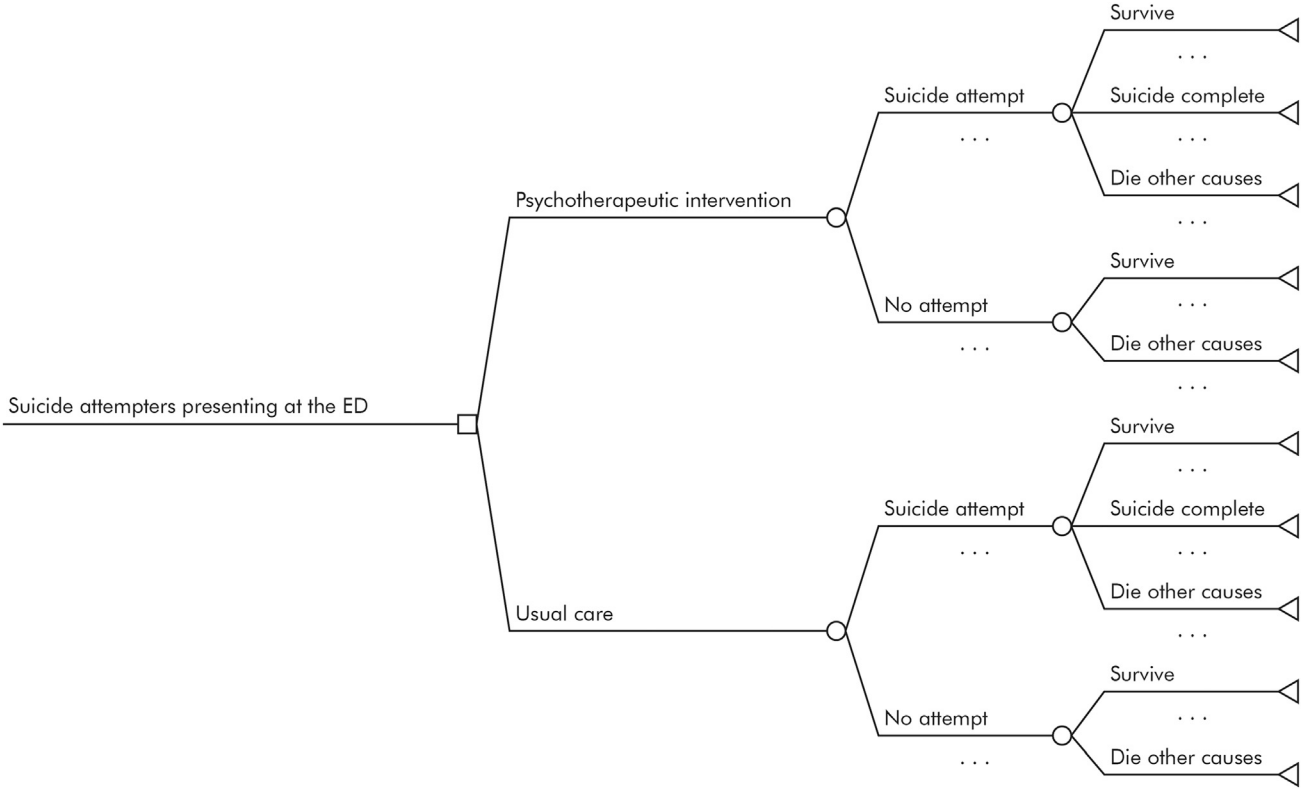

Figure 1. Structure of the model
ED, emergency department

Electronic Injury Surveillance System (NEISS). Since 2000, NEISS includes data on fatal and nonfatal injuries related to suicide. In 2010, NEISS estimated that 390,359 people had a visit to an ED for suicide attempt. Some individuals may have had multiple attempts in that year. The model adjusted for risk of additional attempts and risk of suicide death following an attempt using epidemiologic work on these risks.[11] Specifically, we assumed that in the year following an attempt, there was a 15% risk of nonfatal reattempt and 2% risk of death from suicide. Information on other causes of death were obtained from the CDC,[12] with an average risk of 0.7% for death from other causes.

To estimate the effectiveness of psychotherapeutic interventions for the prevention of suicide attempt and death, a recent systematic evidence review of suicide screening and prevention interventions was used.[1] This review by O'Connor et al.[1] estimated the effectiveness of psychotherapeutic approaches to suicide prevention based on 11 psychotherapy trials in adults. Approaches included cognitive behavioral treatment (CBT); interventions that incorporate elements of CBT (e.g., dialectical behavior therapy); and other non-CBT treatments such as psychodynamic or interpersonal therapy. This review estimated that the effect for all adult psychotherapy trials reporting suicide attempts demonstrated a 32% reduction in suicide attempts following intervention (relative risk [RR]=0.68, 95% CI=0.56, 0.83).[1] Another recent systematic review also suggested psychotherapeutic interventions are beneficial.[8] This review found a similar pattern of results to O'Connor and colleagues,[1] estimating a 24% reduction in suicide attempts following intervention (RR=0.76, 95% CI=0.61, 0.96). However, this review included studies directed at youth aged <18 years. The focus of this analysis is on adults; thus, estimates from O'Connor et al.[1] were used.

Because previous studies of suicide prevention intervention have observed few deaths, the systematic review could not assess whether or not psychotherapeutic interventions reduced the risk of suicide death.[1] Other models of the impact of depression treatment on the risk of suicide death have estimated the RR of no treatment versus treatment to be 1.8.[13] However, this estimate is not specific to persons with a prior suicide attempt, and we found no other estimate of this parameter in the literature. Given that there were no specific data available, we assumed the same impact for suicide attempt and suicide death following intervention (RR=0.68).

Modeling Approach

The number of people aged 18–64 years who attempted suicide in 2010, as identified by the NEISS, was modeled through a simple Markov chain with 1-year cycles for a period of 5 years or until they were predicted to have died. The comparator program was usual ED care. All individuals entered the cycle with an attempt, and all people entered the model in the health state of alive having survived a recent suicide attempt. From there, probabilities of suicide attempt, suicide death, and death from other causes determined who made transitions to other health states over time. Other health states included survive with additional suicide attempt, survive no additional suicide attempt, dead from suicide, and dead from other causes. For the first year of the model, transition probabilities were 15% risk of nonfatal reattempt, 2% risk of death from suicide, and 0.7% risk of death from other causes.

Definition of being seen for suicide attempt, as opposed to being seen for another concern, was determined by the NEISS system. The age of 18 years was chosen as the lower age limit for our models because it is the commonly accepted threshold for legal adulthood, and there are no known effective, evidence-based suicide psychotherapeutic suicide prevention interventions for children and adolescents to date.[1] The age of 64 years was chosen as the upper age limit because the lethality of suicide attempt rises substantially among individuals aged >64 years, and most studies in the systematic reviews did not include people aged >64 years.[1]

The model estimated the total number of suicide attempts and deaths that could be averted over the 1- and 5-year time frames if the intervention was provided every year for 5 years to all people coming to ED settings with a suicide attempt. Five-year estimates include five cohorts of individuals entering the system beginning with Year 1 and ending with Year 5. The model terminated prior to final absorption state (e.g., death) such that a half-cycle correction is often used.[14] However, this model is only intended to show the incremental difference between the two interventions such that the half-cycle correction is unlikely to have a significant influence and is not included.[15]

The focus of this modeling exercise was to estimate health outcomes that could be achieved under optimal circumstances. Therefore, our main analysis assumes optimal conditions including that all people coming to ED settings with a suicide attempt would receive the intervention, that the intervention will be effective as demonstrated in research studies, and that it could be implemented in typical ED settings.

However, experts have suggested that there are substantial differences in the outcomes achieved by interventions as they move from research into clinical practice.[16,17] For instance, Glasgow and colleagues[16] suggest five areas that are critical to effective implementation. *Reach* measures the participation rate among those approached. *Effectiveness* is the impact of the intervention on outcomes of interest. *Adoption* refers to how many organizations choose to offer an intervention, which is influenced by factors such as the cost of the intervention and its fit with the organization's culture. *Implementation* refers to the degree to which typical clinical settings can deliver the intervention with high quality and consistency. *Maintenance* refers to how long the effect lasts over time for participants and how well the intervention becomes integrated into usual care practice.

As an intervention moves into clinical practice, some of these factors may not be optimal. Subanalyses were conducted to begin to examine how estimates might change if circumstances were not "optimal." Data were only available on some of these factors. Specifically, several studies have suggested that treatment effects observed in research studies decrease as treatments are implemented in practice.[17,18] This may in part be due to bias toward publishing positive effects in psychotherapy trials.[19,20] Other studies have observed that without the incentives and attention of researchers, fewer people may agree to participate in an intervention.[16] Subanalyses were conducted to see how outcomes might change if reach of the intervention is reduced to 80% of people, if there was a 30% decrease in effectiveness of the intervention, or both.

Results

Table 1 presents the input parameters that were used in the model related to health outcomes. Table 2 presents

Table 1. Model input parameter values for health outcome model

Parameter	Values used in model	Source
Populations	Defines populations that might benefit from the intervention being evaluated	
Adults (aged 18–64 years) with past-year suicide, and an ED visit linked to suicide attempt	390,359	NEISS 2010
Rates of key events		
Proportion who attempt suicide and survive in year following attempt	15% in the first year following attempt, cumulative risk at the end of 5 years=25%	Owens et al. 2002[11]
Proportion who die of suicide attempt in year following attempt	2% in the first year following attempt, cumulative risk at the end of 5 years=3%	Owens et al. 2002[11]
Other causes death rate	Rate varies by age, average rate=0.0073	CDC Website Kochanek et al. 2011[12]
Intervention-related parameters		
Effectiveness of intervention (RR)	RR=0.68 (95% CI=0.56, 0.83)	AHRQ-EPC Task Force report 2012 O'Connor et al. 2013[1]
Decay rate of intervention effectiveness	100% in Year 1, decays to zero effect by 5 years	ACE suicide review
Hospital and ED-based clinicians are able to refer directly to PST	No delay in linking patients to services	ACE suicide review
No dose effect of intervention	Anyone receiving any intervention benefits at indicated efficacy	ACE suicide review
Uptake of intervention	Main analysis=100%, subanalysis=80% Uptake refers to the number of people who are likely to accept the intervention	Group discussion

ACE, Assessing Cost Effectiveness of Prevention; AHRQ-EPC, Agency for Healthcare Research and Quality Evidence-Based Practice Center; ED, emergency department; NEISS, National Electronic Injury Surveillance System; PST, psychotherapeutic intervention; RR, relative risk

the results of the model for health outcomes, under optimal conditions. The model estimated that over 1 year, implementing evidence-based psychotherapeutic interventions would decrease the number of suicide attempts by 18,737. If the intervention was offered over 5 years, the intervention would reduce the number of attempts by 109,306. Over 1 year, the model estimated that this would result in about 2,498 fewer deaths from

Table 2. Health outcomes for psychotherapeutic interventions in ED setting, adults aged 18–64 years

Type of outcome	Estimated suicide attempts and suicide deaths averted	Actual suicide attempts seen in the ED: NEISS 2010	Estimated % of total attempts averted	Actual suicide deaths: WISQARS 2010	Estimated % of total suicide deaths averted
Optimal implementation					
Nonfatal suicide attempts averted in 1 year	18,737	390,359	5		
Nonfatal suicide attempts averted in 5 years	109,306	1,951,795	6		
Suicide deaths averted in 1 year	2,498			31,354	8
Suicide deaths averted in 5 years	13,928			156,770	9

ED, emergency department; NEISS, National Electronic Injury Surveillance System; WISQARS, Web-Based Injury Statistics Query and Reporting System

Table 3. Subanalyses of health outcome estimates

Type of outcome	Estimated suicide attempts and suicide deaths averted	Suicide attempts seen in the ED: NEISS 2010	Estimated % of total attempts averted	All suicide deaths, ages 18–64 years: WISQARS 2010	Estimated % of total suicide deaths averted
80% reach (full effectiveness)					
Nonfatal suicide attempts averted in 1 year	14,990	390,359	4		
Nonfatal suicide attempts averted in 5 years	84,447	1,951,795	4		
Suicide deaths averted in 1 year	1,999			31,354	6
Suicide deaths averted in 5 years	11,146			156,770	7
100% reach (30% reduction in effectiveness)					
Nonfatal suicide attempts averted in 1 year	7,026	390,359	2		
Nonfatal suicide attempts averted in 5 years	44,122	1,951,795	2		
Suicide deaths averted in 1 year	937			31,354	3
Suicide deaths averted in 5 years	5,884			156,770	4
80% reach (30% reduction in effectiveness)					
Nonfatal suicide attempts averted in 1 year	5,621	390,359	1		
Nonfatal suicide attempts averted in 5 years	35,301	1,951,795	2		
Suicide deaths averted in 1 year	749			31,354	2
Suicide deaths averted in 5 years	4,704			156,770	3

ED, emergency department; NEISS, National Electronic Injury Surveillance System; WISQARS, Web-based Injury Statistics Query and Reporting System

suicide, and over 5 years about 13,928 fewer suicide deaths.

Table 3 presents the results of our subanalyses exploring how outcomes might change if circumstances were less than optimal. The first subanalysis explored how estimates change if reach (agreement to participate in the intervention) dropped from 100% to 80%. Under this assumption, the model estimated that over 1 year about 14,490 attempts would be averted, and over 5 years, 84,447 attempts would be averted. Over 1 year, the intervention would avert about 1,999 deaths from suicide, and over 5 years, 11,146 suicide deaths would be averted. The second subanalysis explored how estimates change if the effectiveness of intervention were reduced by 30%. Under this assumption, the model estimated that over 1 year, the number of suicide attempts averted would be 7,026, and over 5 years, 44,122 attempts would be averted. Over 1 year, the intervention would avert about 937 suicide deaths, and over 5 years, 5,884 suicide deaths. The final subanalysis explored how estimates change if reach were reduced to 80% and effectiveness reduced 30%. Under these assumptions, the model estimated that over 1 year, 5,621 attempts would be averted, and over 5 years, 35,301 attempts would be averted. Over 1 year, 749 deaths from suicide would be averted, and over 5 years, 4,704 suicide deaths would be averted.

Discussion

The purpose of this paper is to illustrate how information from a health outcome model might aid in setting priorities related to suicide prevention. It is not intended to be a definitive model of health outcomes from suicide prevention, but rather to provide a first step in identifying gaps in available research that if filled could improve future models. Because this paper is primarily intended to provide an example of what types of information a health outcome model could provide, it does not provide some information that could be important for decision makers. For instance, comprehensive assessment of statistical precision is not investigated. In addition, the model was simple and thus may not include all relevant factors.

The model was limited by lack of data on several epidemiologic parameters related to suicidal behavior. More data on the relationship among suicide ideation, suicide attempt, and completed suicide would allow for a more accurate model. In particular, information about

accumulation of risk across multiple attempts is needed. Models were also limited by the lack of availability of data on subgroups (e.g., women, racial/ethnic subgroups).

The models were also limited by currently available research on the effectiveness of psychotherapeutic interventions for suicide attempts. In particular, more information on the impact of psychotherapeutic interventions on preventing death from suicide death is needed. Many of the studies in recent systematic reviews[1,8] had small samples; some focused on subsamples (e.g., women only); and a number of different types and amounts of psychotherapy were tested.

Understanding the impact of these factors could improve future models. For instance, women attempt suicide more frequently than men, and interventions to prevent reattempt may be more successful in women. These limitations suggest caution in interpretation of the effectiveness of these interventions. However, it is also important to consider that some of these factors, such as small samples, are in part due to the nature of the problem under consideration and thus may be difficult to resolve.

Additional information on intervention effectiveness could also improve models. For example, if a person has received a psychotherapeutic intervention and comes to an ED with a new attempt, will repeating the intervention have additional effect? Could psychotherapeutic interventions work for persons presenting at other clinical settings (e.g., outpatient mental health, substance abuse programs)?

The models focused on two key outcomes identified by the RPTF: suicide attempts and suicide deaths. However, these outcomes do not fully capture the benefits associated with the psychotherapeutic interventions. For instance, O'Connor et al.[1] reported that psychotherapeutic suicide prevention interventions also reduce depression symptoms. Further, some research has indicated that persons who attempt suicide die of other causes (e.g., accidents, illnesses) at a higher rate,[21] and prevention programs might also alter this risk. In addition, suicide attempts and suicide death have significant consequences for family and friends, and these may have important and lasting health implications for these people. Thus, the current results include only partial representation of the potential benefits of these interventions.

The model was also limited by lack of information about implementation. It is unknown what the likely participation rate for psychotherapeutic interventions would be in typical ED settings. A related concern is the assumption that the intervention will be equally effective as in research studies.[16–18] The modeling approach attempted to address these issues by conducting subanalyses to see how results changed if some factors were less optimal. However, there could be a variety of reasons why health outcomes might be different in real-world settings, including lack of appropriate training and supervision of intervention staff or lack of funding for the intervention. Systematic discussion of such factors might also aid in setting priorities for suicide prevention.

The model also did not consider the costs associated with providing an intervention. Cost is important because most health policy decisions are made within a context of constrained budgets. Use of cost information in decision making has been described by several expert groups[22,23] and is used in public health policy decisions in a number of contexts.[8,24–26] One recent example is the Assessing Cost Effectiveness of Prevention (ACE) Australia project (sph.uq.edu.au/bodce-ace-prevention). The ACE project used decision analytic modeling to evaluate the relative costs and health outcomes associated with alternative prevention strategies across the health system.[25–27]

Cost information is likely important from both the system and the patient perspective. Most research studies pay for the cost of the research treatment; thus, patient financial costs are typically minimal. However, in practice, most people would pay copayments, or if uninsured, the entire cost of the treatment. This could be a significant barrier to optimal implementation. From the health systems perspective, implementation of universal psychotherapeutic interventions for suicide prevention would require significant investment. This investment might reduce some future health care costs, (e.g., hospitalizations due to future attempts), but few studies document any types of costs related to suicide prevention interventions to date.

Conclusions

Achieving the goal of reducing suicide deaths and attempts by 20% within 5 years[4] requires information on the likely impact of different approaches in order to prioritize where to focus implementation efforts. Further research developing more sophisticated models of the impact of suicide prevention interventions could aid this effort. Inclusion of more complex understanding of suicidal behavior, longer time frames, and inclusion of outcomes that capture the full benefits and costs of interventions would be helpful next steps.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention.

This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

This work was funded by a contract HHSN 271201200563P from the U.S. National Institute of Mental Health.

No financial disclosures were reported by the author of this paper.

References

1. O'Connor E, Gaynes B, Burda BU, Soh C, Whitlock EP. Screening for and treatment of suicide risk relevant to primary care: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med 2013;128(10):741–54.
2. Corso PS, Mercy JA, Simon TR, Finkelstein EA, Miller TR. Medical costs and productivity losses due to interpersonal and self-directed violence in the U.S. Am J Prev Med 2007;32(6):474–82.
3. Yang B, Lester D. Recalculating the economic cost of suicide. Death Stud 2007;31(4):351–61.
4. Pringle B, Colpe LJ, Heinssen RK, et al. A strategic approach for prioritizing research and action to prevent suicide. Psychiatr Serv 2013;64(1):71–5.
5. Glass TA, McAtee MJ. Behavioral science at the crossroads in public health: extending horizons, envisioning the future. Soc Sci Med 2006;62(7):1650–71.
6. Leischow SJ, Milstein B. Systems thinking and modeling for public health practice. Am J Public Health 2006;96(3):403–5.
7. Mabry PL, Olster DH, Morgan GD, Abrams DB. Interdisciplinarity and systems science to improve population health: a view from the NIH Office of Behavioral and Social Sciences Research. Am J Prev Med 2008;35(2S):S211–S224.
8. National Institute for Health and Clinical Excellence (NICE). Self-harm: the NICE guideline on longer-term management. London: The British Psychological Society and The Royal College of Psychiatrists, 2012. www.nice.org.uk/nicemedia/live/13619/57205/57205.pdf.
9. Cougnard A, Verdoux H, Grolleau A, Moride Y, Begaud B, Tournier M. Impact of antidepressants on risk of suicide in patients with depression in real-life conditions: a decision analysis model. Psychol Med 2009;39(8):1307–15.
10. Palmer CS, Brunner E, Ruiz-Flores LG, Paez-Argraz F, Revicki DA. A cost-effectiveness clinical decision analysis model for treatment of schizophrenia. Arch Med Res 2002;33(6):572–80.
11. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. Br J Psychiatry 2002;181:193–9.
12. Kochanek KD, Xu J, Murphy SL, Minino AM, Kung HC. Deaths: final data for 2009. Natl Vital Stat Rep 2011;60(3):1–116. www.cdc.gov/nchs/data/nvsr/nvsr60/nvsr60_03.pdf.
13. Vos T, Corry J, Haby MM, Carter R, Andrews G. Cost-effectiveness of cognitive–behavioural therapy and drug interventions for major depression. Aust NZ J Psychiatry 2005;39(8):683–92.
14. Sonnenberg FA, Beck JR. Markov models in medical decision making: a practical guide. Med Decis Making 1993;13(4):322–38.
15. Briggs A, Sculpher M. An introduction to Markov modelling for economic evaluation. Pharmacoeconomics 1998;13(4):397–409.
16. Glasgow RE, Lichtenstein E, Marcus AC. Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. Am J Public Health 2003;93(8):1261–7.
17. Miller WR. Motivational interviewing and the incredible shrinking treatment effect. Addiction 2005;100(4):421.
18. Henggeler SW. Decreasing effect sizes for effectiveness studies—implications for the transport of evidence-based treatments: comment on Curtis, Ronan, and Borduin. J Fam Psychol 2004;18(3):420–3.
19. Niemeyer H, Musch J, Pietrowsky R. Publication bias in meta-analyses of the efficacy of psychotherapeutic interventions for depression. J Consult Clin Psychol 2013;81(1):58–74.
20. Cuijpers P, de Beurs DP, van Spijker BA, Berking M, Andersson G, Kerkhof AJ. The effects of psychotherapy for adult depression on suicidality and hopelessness: a systematic review and meta-analysis. J Affect Disord 2013;144(3):183–90.
21. Bergen H, Hawton K, Waters K, et al. Premature death after self-harm: a multicentre cohort study. Lancet 2012;380(9853):1568–74. Erratum in: Lancet 2012;380(9853):1558.
22. Gold MR, Siegel JE, Russell LB, Weinstein MC. Cost-effectiveness in health and medicine. University. New York: Oxford Press, 1996.
23. Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Methods for economic health evaluation of health care programmes. 3rd ed. Oxford: Oxford University Press, 2005.
24. Aos S, Lee S, Drake E, et al. Return on investment: evidence-based options to improve statewide outcomes (document no. 11-07-1201). Olympia WA: Washington State Institute for Public Policy, 2011.
25. Vos T, Carter R, Barendregt J, et al. Assessing Cost-Effectiveness in Prevention (ACE–Prevention): final report. Melbourne: University of Queensland, Brisbane and Deakin University, 2010.
26. Mihalopulos C, Vos T, Pirkis J, Carter R. The population cost-effectiveness of interventions designed to prevent childhood depression. Pediatrics 2012;129(3):e723–e730.
27. Carter R, Vos T, Moodie M, Haby M, Magnus A, Mihalopoulos C. Priority setting in health: origins, description and application of the Australian Assessing Cost-Effectiveness initiative. Expert Rev Pharmacoecon Outcomes Res 2008;8(6):593–617.

Epigenetics and Suicidal Behavior Research Pathways

Gustavo Turecki, MD, PhD

Suicide and suicidal behaviors are complex, heterogeneous phenomena that are thought to result from the interactions among distal factors increasing predisposition and proximal factors acting as precipitants. Epigenetic factors are likely to act both distally and proximally.

Aspirational Goal 1 aims to find clear targets for suicide and suicidal behavior intervention through greater understanding of the interplay among the biological, psychological, and social risk and protective factors associated with suicide. This paper discusses Aspirational Goal 1, focusing on the research pathway related to epigenetics, suicide, and suicidal behaviors. Current knowledge on epigenetic factors associated with suicide and suicidal behaviors is reviewed and avenues for future research are discussed. Epigenetic factors are a promising area of further investigation in the understanding of suicide and suicidal behaviors and may hold clues to identifying targets or avenues for intervention.

(Am J Prev Med 2014;47(3S2):S144–S151)

Introduction

Suicide and suicidal behaviors (SSBs) are complex, heterogeneous phenomena that, as contemporarily defined, are commonly manifested in the presence of mental illnesses.[1] SSBs are complex because they are multifactorial and not all individuals manifesting SSBs share the same underlying etiologic factors. In other words, risk factors for SSBs are not universal.[2]

Numerous models have been proposed over the years while attempting to understand SSBs. Despite the complexity and etiologic heterogeneity of these phenomena, most contemporary models of SSBs are remarkably similar and basically assume two levels of risk factors: those acting more distally and those acting more proximally.[3] On one end, risk factors acting more distally are thought to increase predisposition; on the other end, risk factors acting more proximally are thought to be precipitants.[3] These relationships are described in Figure 1. Examples of distal factors include genetic makeup and early-life adversity (ELA), whereas typical proximal factors are recent life events and last 6-month psychopathology including current substance (alcohol/drug) abuse.[3]

From the McGill Group for Suicide Studies, Douglas Mental Health University Institute, Department of Psychiatry, McGill University, Montreal, Quebec, Canada

Address correspondence to: Gustavo Turecki, MD, PhD, McGill Group for Suicide Studies, Douglas Mental Health University Institute, 6875 LaSalle Blvd, Montreal QC H4H 1R3, Canada. E-mail: gustavo.turecki@mcgill.ca.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.011

Aspirational Goal 1 aims to find clear targets for intervention through greater understanding of the interplay among the biological, psychological, and social risk and protective factors associated with suicide. This paper discusses this Aspirational Goal and focuses specifically on the research pathway related to epigenetics and SSBs.

Epigenetics

Epigenetics refers to the study of the epigenome, the chemical and physical modifications of the deoxyribonucleic acid (DNA) molecule that functionally regulate the collection of genes of an organism by altering the capacity of a gene to be activated and produce the messenger ribonucleic acid (mRNA) it encodes.[4] Epigenetic regulation of gene function allows for genomic plasticity, that is, the adaptation of the genome to the needs of the organism.

It has long been clear that epigenetic processes occur as a result of physical and chemical environmental signals. However, only recently has it been revealed that the social environment also triggers epigenetic responses.[4–6] As such, it is possible to conceptualize the epigenome as an interface through which the environment can influence genetic processes and, as a result, regulate behavior at least partially in response to environmental needs.[3]

Epigenetic Factors and Suicidal Behavior

Stable epigenetic factors are likely to act distally, increasing predisposition, whereas dynamic epigenetic factors and proteomic changes are likely to underlie

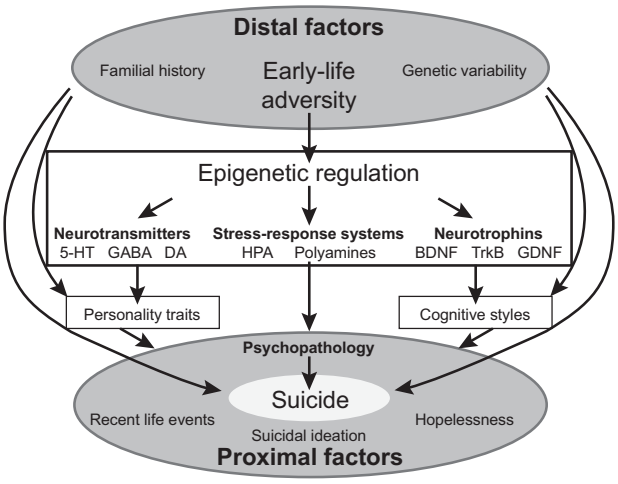

Figure 1. Proposed model for epigenetic factors acting distally on risk of suicide and suicidal behaviors

BDNF, brain-derived neurotrophic factor; DA, dopamine; GABA, γ-aminobutyric acid; GDNF, glial cell–derived neurotrophic factor; HPA, hypothalamus–pituitary–adrenal axis; HT, hydroxytryptamine; TrkB, tyrosine kinase B

psychopathological states that act more proximally, precipitating suicidal behavior. To date, however, most of the research investigating epigenetic factors in SSBs has focused on presumably stable epigenetic marks that are thought to act distally.

Specifically, DNA methylation is capable of inducing stable epigenetic marks. As epigenetic marks associate with genomic responses to environmental stimuli—and because SSBs are strongly associated with histories of ELA such as childhood sexual and physical abuse as well as parental neglect—most of the initial effort to investigate epigenetic factors associated with SSBs has focused on individuals with histories of ELA.

Variations in the early social environment, as modeled by maternal care in the rat (the frequency of pup licking/grooming [LG] over the first week of life), program the expression of genes that regulate behavioral and endocrine responses to stress[7–9] such that offspring of high-LG mothers show increased hippocampal glucocorticoid receptor (GR) expression and more modest responses to stress compared to the offspring of low-LG mothers. These differences persist after cross-fostering low- and high-LG offspring to high- and low-LG mothers, respectively, revealing that the early social environment determines individual differences in stress reactivity, which is transmitted via non-genomic mechanisms.[8] Maternal LG induces an epigenetic modification of an exon 1_7 GR promoter[10] such that increased maternal care associates with decreased methylation of the exon 1_7 promoter and increased hippocampal GR expression.

Encouraged by this groundbreaking animal work suggesting that the tone of the hypothalamus–pituitary–adrenal (HPA) axis is epigenetically programmed by the early-life environment[10] and that these mechanisms are evolutionarily conserved,[11] in addition to well-established evidence suggesting that HPA axis dysregulation increases risk of suicidal behaviors, the initial work investigating epigenetic factors in SSBs has focused on the epigenetic regulation of the HPA axis by the early environment. In addition, neurotrophic factors and their receptors, as well as other signaling systems, have been investigated.[3]

Stress Response Systems

Epigenetic Regulation of the HPA Axis by the Early-Life Environment, Suicide, and Suicidal Behaviors

Early-life adversity has been proposed to induce its long-term behavioral consequences partly by altering the neural circuits involved in the regulation of stress.[12] Depressed patients with a history of ELA have been reported to exhibit higher adrenocorticotropic hormone (ACTH) and cortisol levels following stress tasks and dexamethasone challenge.[12,13] Interestingly, in these studies,[12,13] both ACTH and cortisol levels did not differ significantly between depressed subjects without history of ELA and controls. Childhood abuse has also been shown to increase corticotropin-releasing hormone (CRH) levels[12,14] and decrease cerebrospinal fluid (CSF) oxytocin levels.[15]

Hypothalamus–pituitary–adrenal axis dysregulation has also been associated with increased suicide risk. For instance, in a 15-year follow-up study, Coryell et al.[16] showed that depressed patients who were admitted to a psychiatric unit and were non-suppressors to the dexamethasone suppression test had a 26.8% risk of dying by suicide at follow-up, compared to a 2.9% risk for controls. Several other studies have produced consistent data.

A large study[17] investigating 372,696 primary care patients who received oral glucocorticoids observed a hazard ratio of 6.89 (95% CI=4.52, 10.50) for SSBs in these patients when compared to those with the same underlying medical condition who were not treated with glucocorticoids. More recently, low hippocampal GR expression levels have been reported in individuals with a history of childhood abuse who died by suicide[18,19] but not in non-abused individuals who died by suicide.

The observations from studies in rats suggesting that maternal behavior regulate the tone of the HPA axis via methylation were recently translated to humans through studies investigating hippocampal tissue from individuals who died by suicide with and without a history of childhood adversity, as well as normal controls.[18,19] Notably, methylation levels in the exon 1F promoter of

the GR in abused individuals who died by suicide were significantly higher than among non-abused individuals who died by suicide and healthy controls.

In addition, similar to what was found in rats, a significant hypermethylation in a nerve growth factor inducible A (NGFI-A)–binding site was found in abused individuals who died by suicide but not in the other groups. This epigenetic mark was shown to repress the binding of NGFI-A to its cognate DNA sequence and decrease GR transcription.[19] A growing number of independent studies have been published with consistent results. Higher levels of methylation in the promoter of GR 1F have been reported in the infants of mothers reporting intimate partner violence during their pregnancy compared to those born from mothers who did not report intimate partner violence during pregnancy.[20]

Another study[21] reported significant correlations between GR 1F promoter methylation levels and parental loss, child maltreatment, and suboptimal parental care. Furthermore, DNA methylation levels in the GR 1F promoter were shown to be positively correlated with childhood sexual abuse, its severity, and the number of maltreatment events in individuals with major depressive disorder, and with repetition of severe types of abuse in patients with bipolar disorder.[22]

Together, this suggests that ELA may induce specific long-lasting epigenetic alterations affecting gene expression. In a different study[23] assessing the expression of several GR exon 1 variants expressed in the limbic system of depressed individuals who died by suicide, GR 1F and GR 1C hippocampal expression were significantly decreased in depressed individuals who died by suicide. NGFI-A protein levels in the hippocampus were significantly decreased in depressed individuals who died by suicide, suggesting that the decrease in GR expression found in these individuals may be mediated by different molecular pathways depending on the presence or absence of ELA.

More recently, a study[18] investigating other brain-expressed GR variants in the hippocampus of individuals who died by suicide according to histories of ELA indicated that the expression of the non-coding exons 1B, 1C, and 1H was significantly different in individuals who died by suicide with a history of ELA compared to non-ELA individuals who died by suicide and controls. The assessment of methylation levels in the promoter of GR 1C revealed methylation differences that were inversely correlated with GR 1C expression, in accordance with the previous findings reported by the same group on the 1F variant.

On the other hand, the GR 1H promoter showed site-specific hypomethylation, and methylation was positively correlated with human GR 1H expression. In other words, less methylation significantly correlated with lower expression, suggesting that active demethylation is also a functional mechanism that may be regulated by the early-life environment. Although this is a mechanism that has received less attention, more work is required to elucidate its potential implication in the context of ELA.

Other Stress Response Systems

Alterations in stress response systems other than the HPA axis have also been reported in suicide, particularly involving polyamines, which are highly regulated small molecules containing two or more amine (NH_2) groups.[24] Polyamines have a multitude of functions including regulation of gene transcription and posttranscriptional modifications, as well as modulation of several protein activities.[25] They are released following stressful stimuli, and in the mammalian brain, polyamines present a unique pattern of response known as the polyamine stress response (PSR).[26] The PSR can be induced by direct neuronal stimuli or in response to hormonal signals, such as glucocorticoids.

Both human and animal studies suggest that polyamine dysfunction is involved in psychopathology.[27] Studies investigating the effects of antidepressants indicate a role of the polyamine system in the antidepressant response, particularly the interaction of the polyamine agmatine or putrescine on *N*-methyl-D-aspartate (NMDA) receptors.[28–31] Several studies have indicated alterations in the mRNA and protein levels of several components of the polyamine system in cortical and subcortical brain regions of individuals who died by suicide,[32–35] as well as in peripheral samples from suicide attempters[36] and psychiatric patients.[37]

Interestingly, significant epigenetic regulation of some key polyamine genes in the brain have been reported.[38–40] Although preliminary evidence suggests differential epigenetic regulation of some of these genes in suicide,[38] further studies are necessary to understand if polyamine genes are regulated by the early environment in a similar fashion like that observed for HPA axis genes.

Neurotrophins, Suicide, and Suicidal Behaviors

Neurotrophins, also referred to as neurotrophic factors, are important candidate molecules for understanding the development of psychopathology because of their role in neuronal survival and plasticity, as well as their expression in brain regions from the limbic system, where emotions and related behaviors are processed. For instance, it is hypothesized that their alteration could partly underlie changes in plasticity observed in the brains of individuals who died by suicide as well as the mood symptoms observed in depressive patients.

Brain-derived neurotrophic factor (BDNF) has received most of the attention in neurobiological research of psychiatric conditions such as depressive disorders and suicide. For instance, patients who are depressed present low serum and brain BDNF expression levels,[41–43] and serum BDNF levels are normalized by antidepressant treatment.[44–46]

BDNF epigenetic regulation has been investigated in mice and rat models of stress-induced depressive symptoms,[47,48] as well as in a rat model of exposure to traumatic events.[49] Chronic social stress in mice decreases the expression of two specific BDNF transcripts (III and IV) in the hippocampus,[47] and maternal maltreatment decreases prefrontal cortex (PFC) BDNF mRNA expression in rats.[48] The BDNF expression alterations observed in chronic social stress in mice are mediated through increased histone H3K27 demethylation levels in transcripts III and IV promoters,[47] and site-specific DNA hypermethylation is found in transcripts IV and IX promoters of maltreated rats.[48]

In the latter study, site-specific hypermethylation seems to follow a developmental pattern such that exon IX promoter hypermethylation occurs immediately after the maltreatment regimen, whereas promoter IV methylation increases gradually to reach significantly altered levels only in adulthood. These findings illustrate that ELA or chronic stressors may alter different epigenetic mechanisms with common transcriptional consequences. On the other hand, these results may also highlight the heterogeneity of stress-induced epigenetic alterations between species.

Pharmacologic treatment with the tricyclic antidepressant imipramine reverses the effect of chronic stress on BDNF transcription in mice.[47] However, this reversal does not seem to be due to the normalization of histone H3K27 methylation levels but rather through an increase in both histone H3K4 methylation and histone H3K9 acetylation levels.

Consequently, these results suggest the existence of a compensatory mechanism in the reinstatement of basal BDNF levels by chronic imipramine treatment following chronic stress and emphasize the importance of chromatin hyperacetylation induced by antidepressant treatment. There is evidence in humans suggesting that antidepressants act by promoting an open chromatin structure (i.e., lower H3K27 methylation levels) in the promoter of BDNF in the prefrontal cortex,[50] and consistent results were found when investigating peripheral samples from depressed patients treated with the typical selective serotonin reuptake inhibitor citalopram.[51]

Recently, the methylation state of BDNF was also assessed in post-mortem brains from individuals who died by suicide. Keller and colleagues[52] used three different methods to quantify DNA methylation levels in a region encompassing part of non-coding exon IV and its promoter in the Wernicke area; their results showed that DNA methylation was significantly increased in individuals who died by suicide (n=44) compared to controls (n=33). In addition, BDNF expression in subjects with high DNA methylation levels was significantly lower than in those with low and medium DNA methylation levels, supporting the repressive effects of methylation within the promoter on transcription.

Transmembrane receptor tyrosine kinase B (TrkB) is the receptor for BDNF and has long been investigated in the neurobiology of mood and related disorders.[41,53–55] Lower TrkB expression has been reported in the prefrontal cortex of depressed subjects[56,57] and antidepressant treatment has been shown to increase its expression in cultured rat astrocytes.[58]

In investigating the astrocyte-expressed splice variant T1 of the TrkB gene, TrkB-T1, it has been recently reported that a subset of individuals who died by suicide with low levels of TrkB-T1 expression revealed two sites where methylation levels were higher compared to controls.[59] The methylation pattern at those two sites was negatively correlated with the expression of TrkB-T1 in individuals who died by suicide, and this effect was specific to the prefrontal cortex because no significant difference was found in the cerebellum.

In addition, individuals who died by suicide with low TrkB-T1 expression showed enrichment of histone H3K27 methylation in the TrkB promoter,[60] suggesting that this variant of TrkB may be under the control of epigenetic mechanisms involving histone modifications and DNA methylation. Taken together, these data suggest that epigenetic changes in BDNF and its TrkB-T1 receptor variant might participate in the vulnerability to chronic social stress and possibly to ELA and SSBs.

The γ-Aminobutyric Acid System

The γ-aminobutyric acid (GABA)ergic system has been the focus of many research studies in post-mortem brain samples of psychiatric patients, including those who died by suicide.[61–63] For example, reductions in reelin and glutamate decarboxylase 1 (GAD1, a GABA synthesis enzyme) mRNA[61] and an increase in DNA methyltransferase (DNMT) 1 expression[64,65] were previously reported in post-mortem brains of schizophrenic and bipolar subjects who died by suicide. Consistently, promoter hypermethylation was reported for both genes in accordance with the methylating role of DNMT1.[66,67]

More recently, the hippocampal expression of GAD1 has been shown to be regulated by the early environment through maternal care in rats.[68] These findings are in

accordance with the study by Poulter et al.[69] that examined the expression of DNMTs as well as the $GABA_A$ receptor α1 subunit in the brain of individuals who died by suicide. Three hypermethylated CpG sites within the α1 subunit promoter were identified in the prefrontal cortex of individuals who died by suicide and negatively correlated with DNMT3b protein expression. In addition, DNMT1 and DNMT3a levels have also been reported to be altered in the limbic system and brain stem of individuals who died by suicide. However, histories of ELA were not reported in this study, thus one cannot assume that these effects would be similar in abused individuals who died by suicide.

Genome-Wide DNA Methylation Alteration

Although promising data have been generated using hypothesis-driven approaches focusing on candidate gene systems to investigate epigenetic factors associated with suicide and the early-life environment, there is a need to better understand epigenetic patterns associated with SSBs at the genome-wide level.

In particular, two related studies using an antibody to identify methylated sequences at the genomic level followed by hybridization to a custom-made gene promoter array have been reported. One of these studies focused on individuals who died by suicide and had a history of severe ELA.[70] Hundreds of sites were identified as being differentially methylated, both hyper- and hypomethylated, associated with the phenotype.

Interestingly, differential methylation in abused individuals who died by suicide was enriched in genes involved in neuroplasticity, a finding consistent with the notion that adversity during childhood leads to plastic changes in the brain as a response to these negative environmental stimuli. Similar observations were made in another genome-wide study, in which an unselected sample of individuals who died by suicide was investigated.[71] In this study, methylation enriched in genes was related to learning and memory.

How May Epigenetic Changes That Are Distally Associated with Suicide and Suicidal Behaviors Increase Risk?

Figure 1 depicts a diagram of putative mediating mechanisms whereby epigenetic changes acting distally may stably increase lifelong risk of suicidal behavior. Importantly, this model is based on consistent data from human studies, which indicate that emotional and behavioral dysregulation are frequently reported in individuals with histories of ELA,[72] and that these personality traits seem to mediate, to varying degrees, the relationship between ELA and suicidal behavior.[73–75]

Moving Forward

The investigation of epigenetic factors in behavioral phenotypes is a fairly new field. As such, there remains much to understand about epigenetic processes underlying psychopathology and SSBs. In addition, knowledge on epigenetic mechanisms is rapidly evolving, constantly opening new horizons for new epigenetic research. Challenges for future research investigating epigenetic mechanisms in suicide can be grouped into three main categories, including (1) challenges related to the underlying theoretic paradigm; (2) challenges related to the study design; and (3) technical challenges. Figure 2 provides a list of the most important challenges that future epigenetic studies of SSBs should consider according to each of these three categories.

Potential Roadblocks

Although epigenetic research of SSBs is likely to grow exponentially over the next decade and there is tremendous potential for breakthroughs, a number of possible roadblocks should be considered. Epigenetic marks are tissue and cell population specific. In order to understand pathology, it would be important to first understand normative processes. Therefore, it would be necessary to generate extensive reference maps for different epigenetic processes that are representative of normal development for the multitude of cell populations and circuits of the brain related to SSBs.

Many studies[76–80] have already been conducted assuming that peripheral samples would model brain gene expression changes. Moreover, several studies[78,81,82] have assessed how representative peripheral expression studies are of central nervous system gene expression. Although conclusive evidence in this regard remains lacking, it is important to keep in mind that epigenetic marks are tissue specific and more variable between different tissues of the same individual than between the same tissue of different individuals.[83] However, there is also some evidence of within-individual epigenetic variant correlation across tissues.[83]

Another potential limitation is related to analytic capacity. Although technology advances rapidly, analytic and computational tools capable of processing and integrating multiple layers of epigenetic information move forward at a much slower pace. Overcoming such potential limitations will require significant effort coordinating different disciplines, including computational biology, mathematics, and engineering.

A further potential limitation is bench-related. Screening tools have advanced much more rapidly than the capacity to follow up on significant results and characterize their potential functional impact. Particularly, it is currently

- **Paradigm**
  - Theoretic modeling and investigation of distal epigenetic factors acting on suicide risk irrespective of early-life adversity
  - Investigation of stability/instability of distal epigenetic factors
  - Relative contribution of epigenetic changes to development of personality traits, psychopathology, and suicide risk
  - Investigation of proximal epigenetic changes and understanding their interaction with distal epigenetic factors
  - Mechanisms for potential intervention
- **Design**
  - What brain systems/circuits and cellular fractions are affected by epigenetic changes associated with increased suicide risk?—Conduct studies investigating different brain areas and cell populations
  - What sequences other than those from candidate systems are epigenetically regulated and increase suicide risk?—Conduct genome-wide studies
  - Are peripheral epigenetic marks valid markers of central epigenetic changes?—Conduct comparative studies using peripheral and central samples from the same subjects
  - Conduct prospective studies of epigenetic changes as a function of environmental stressors in longitudinal cohorts representative of the general population
  - Effect of possible covariates: better understand the role of gender, age, socioeconomic environment, substance of abuse, and other factors
- **Technical**
  - Conduct high-throughput, next-generation sequencing studies
  - Investigate different epigenetic marks and their effect on different RNA species
  - Obtain concomitant information on different epigenetic marks and RNA expression for the same samples
  - Conduct follow-up work using appropriate induced pluripotent stem cell models
  - Investigate potential for pharmacologic manipulation of epigenetic changes associated with suicide risk
  - Development of appropriate animal models

Figure 2. Most important challenges that should be considered by future epigenetic studies of suicide and suicidal behaviors

challenging to investigate interactions of molecular markers or the additive effects of several molecular processes. It is thus not surprising that most models remain relatively simple and unifactorial in spite of great technical advances. Although overcoming these potential barriers of progress will be challenging, these are all feasible undertakings.

Clinical Implications

As epigenetics allows modeling environmental influences on the individual's biology, it can aid in understanding how life events act distally and increase predisposition to SSBs, as well as how they act proximally and precipitate suicidal crises. This knowledge has tremendous clinical implications and the potential to help develop new avenues for intervention, including personalized treatment options such as monitoring of treatment efficacy.[84] Although the application of epigenetics to study behavior and psychopathology is recent, epigenetic research has already advanced the understanding of SSBs, particularly by shedding light on biological processes epigenetically regulated by ELA. These initial findings are promising; however, there remain a multitude of open questions to address and challenges to overcome in the future epigenetic investigation of SSBs.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The author is a Fonds de recherche du Québec - santé (FRQS) National Research Scholar and his epigenetic research is funded through the Canadian Institutes for Health Research, National Institute on Drug Abuse, FRQS, and the American Foundation for Suicide Prevention.

No financial disclosures were reported by the author of this paper.

References

1. Turecki G. Suicide. In: Stolerman IP, ed. Encyclopedia of psychopharmacology. Berlin Heidelberg: Springer-Verlag, 2010.
2. Ernst C, Mechawar N, Turecki G. Suicide neurobiology. Prog Neurobiol 2009;89(4):315–33.
3. Turecki G, Ernst C, Jollant F, Labonte B, Mechawar N. The neurodevelopmental origins of suicidal behavior. Trends Neurosci 2012; 35(1):14–23.
4. Petronis A. Epigenetics as a unifying principle in the aetiology of complex traits and diseases. Nature 2010;465(7299):721–7.
5. Labonte B, Turecki G. The epigenetics of suicide: explaining the biological effects of early life environmental adversity. Arch Suicide Res 2010;14(4):291–310.
6. Nagy C, Turecki G. Sensitive periods in epigenetics: bringing us closer to complex behavioral phenotypes. Epigenomics 2012;4(4):445–57.
7. Meaney MJ, Szyf M. Maternal care as a model for experience-dependent chromatin plasticity? Trends Neurosci 2005;28(9):456–63.
8. Liu D, Diorio J, Tannenbaum B, et al. Maternal care, hippocampal glucocorticoid receptors, and hypothalamic-pituitary-adrenal responses to stress. Science 1997;277(5332):1659–62.
9. Francis D, Diorio J, Liu D, Meaney MJ. Nongenomic transmission across generations of maternal behavior and stress responses in the rat. Science 1999;286(5442):1155–8.
10. Weaver IC, Cervoni N, Champagne FA, et al. Epigenetic programming by maternal behavior. Nat Neurosci 2004;7(8):847–54.
11. Suderman M, McGowan PO, Sasaki A, et al. Conserved epigenetic sensitivity to early life experience in the rat and human hippocampus. Proc Natl Acad Sci U S A 2012;109(S2):17266–72.
12. Heim C, Mletzko T, Purselle D, Musselman DL, Nemeroff CB. The dexamethasone/corticotropin-releasing factor test in men with major depression: role of childhood trauma. Biol Psychiatry 2008;63(4):398–405.
13. Heim C, Newport DJ, Heit S, et al. Pituitary-adrenal and autonomic responses to stress in women after sexual and physical abuse in childhood. JAMA 2000;284(5):592–7.
14. Carpenter LL, Tyrka AR, McDougle CJ, et al. Cerebrospinal fluid corticotropin-releasing factor and perceived early-life stress in depressed patients and healthy control subjects. Neuropsychopharmacology 2004;29(4):777–84.
15. Heim C, Young LJ, Newport DJ, Mletzko T, Miller AH, Nemeroff CB. Lower CSF oxytocin concentrations in women with a history of childhood abuse. Mol Psychiatry 2009;14(10):954–8.
16. Coryell W, Schlesser M. The dexamethasone suppression test and suicide prediction. Am J Psychiatry 2001;158(5):748–53.
17. Fardet L, Petersen I, Nazareth I. Suicidal behavior and severe neuropsychiatric disorders following glucocorticoid therapy in primary care. Am J Psychiatry 2012;169(5):491–7.
18. Labonte B, Yerko V, Gross J, et al. Differential glucocorticoid receptor exon 1(b), 1(c), and 1(h) expression and methylation in suicide completers with a history of childhood abuse. Biol Psychiatry 2012;72(1):41–8.
19. McGowan P, Sasaki A, D'Alessio A, et al. Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. Nat Neurosci 2009;12(3):342–8.
20. Radtke KM, Ruf M, Gunter HM, et al. Transgenerational impact of intimate partner violence on methylation in the promoter of the glucocorticoid receptor. Transl Psychiatry 2011;1:e21.
21. Tyrka AR, Price LH, Marsit C, Walters OC, Carpenter LL. Childhood adversity and epigenetic modulation of the leukocyte glucocorticoid receptor: preliminary findings in healthy adults. PLoS One 2012;7(1):e30148.
22. Perroud N, Paoloni-Giacobino A, Prada P, et al. Increased methylation of glucocorticoid receptor gene (NR3C1) in adults with a history of childhood maltreatment: a link with the severity and type of trauma. Transl Psychiatry 2011;1:e59.
23. Alt SR, Turner JD, Klok MD, et al. Differential expression of glucocorticoid receptor transcripts in major depressive disorder is not epigenetically programmed. Psychoneuroendocrinology 2010;35 (4):544–56.
24. Tabor CW, Tabor H. Polyamines. Annu Rev Biochem 1984;53:749–90.
25. Pegg AE, Casero RA Jr. Current status of the polyamine research field. Methods Mol Biol 2011;720:3–35.
26. Gilad GM, Gilad VH. Overview of the brain polyamine-stress-response: regulation, development, and modulation by lithium and role in cell survival. Cell Mol Neurobiol 2003;23(4–5):637–49.
27. Fiori LM, Turecki G. Implication of the polyamine system in mental disorders. J Psychiatry Neurosci 2008;33(2):102–10.
28. Zeidan MP, Zomkowski AD, Rosa AO, Rodrigues AL, Gabilan NH. Evidence for imidazoline receptors involvement in the agmatine antidepressant-like effect in the forced swimming test. Eur J Pharmacol 2007;565(1–3):125–31.
29. Aricioglu F, Kan B, Yillar O, Korcegez E, Berkman K. Effect of agmatine on electrically and chemically induced seizures in mice. Ann N Y Acad Sci 2003;1009:141–6.
30. Zomkowski AD, Santos AR, Rodrigues AL. Putrescine produces antidepressant-like effects in the forced swimming test and in the tail suspension test in mice. Prog Neuropsychopharmacol Biol Psychiatry 2006;30(8):1419–25.
31. Li YF, Gong ZH, Cao JB, Wang HL, Luo ZP, Li J. Antidepressant-like effect of agmatine and its possible mechanism. Eur J Pharmacol 2003;469(1–3):81–8.
32. Sequeira A, Gwadry FG, Ffrench-Mullen JM, et al. Implication of SSAT by gene expression and genetic variation in suicide and major depression. Arch Gen Psychiatry 2006;63(1):35–48.
33. Fiori LM, Bureau A, Labbe A, et al. Global gene expression profiling of the polyamine system in suicide completers. Int J Neuropsychopharmacol 2011;14(5):595–605.
34. Klempan TA, Rujescu D, Merette C, et al. Profiling brain expression of the spermidine/spermine N1-acetyltransferase 1 (SAT1) gene in suicide. Am J Med Genet B Neuropsychiatr Genet 2009;150B(7):934–43.
35. Chen GG, Fiori LM, Moquin L, et al. Evidence of altered polyamine concentrations in cerebral cortex of suicide completers. Neuropsychopharmacology 2010;35(7):1477–84.
36. Guipponi M, Deutsch S, Kohler K, et al. Genetic and epigenetic analysis of SSAT gene dysregulation in suicidal behavior. Am J Med Genet B Neuropsychiatr Genet 2009;150B(6):799–807.
37. Dahel K-d, Al-Saffar N, Flayeh K. Polyamine oxidase activity in sera of depressed and schizophrenic patients after ECT treatment. Neurochem Res 2001;26(4):415–8.
38. Fiori LM, Gross JA, Turecki G. Effects of histone modifications on increased expression of polyamine biosynthetic genes in suicide. Int J Neuropsychopharmacol 2011;15(8):1161–6.
39. Fiori LM, Turecki G. Epigenetic regulation of spermidine/spermine N (1)-acetyltransferase (SAT1) in Suicide. J Psychiatr Res 2011;45(9): 1229–35.
40. Fiori LM, Turecki G. Genetic and epigenetic influences on expression of spermine synthase and spermine oxidase in suicide completers. Int J Neuropsychopharmacol 2010;13(6):725–36.
41. Dwivedi Y, Rizavi HS, Conley RR, Roberts RC, Tamminga CA, Pandey GN. Altered gene expression of brain-derived neurotrophic factor and receptor tyrosine kinase B in postmortem brain of suicide subjects. Arch Gen Psychiatry 2003;60(8):804–15.
42. Pandey GN, Ren X, Rizavi HS, Conley RR, Roberts RC, Dwivedi Y. Brain-derived neurotrophic factor and tyrosine kinase B receptor signalling in post-mortem brain of teenage suicide victims. Int J Neuropsychopharmacol 2008;11(8):1047–61.
43. Brunoni AR, Boggio PS, Fregni F. Can the "yin and yang" BDNF hypothesis be used to predict the effects of rTMS treatment in neuropsychiatry? Med Hypotheses 2008;71(2):279–82.
44. Chen B, Dowlatshahi D, MacQueen GM, Wang JF, Young LT. Increased hippocampal BDNF immunoreactivity in subjects treated with antidepressant medication. Biol Psychiatry 2001;50(4):260–5.

45. Sen S, Duman R, Sanacora G. Serum brain-derived neurotrophic factor, depression, and antidepressant medications: meta-analyses and implications. Biol Psychiatry 2008;64(6):527–32.
46. Matrisciano F, Bonaccorso S, Ricciardi A, et al. Changes in BDNF serum levels in patients with major depression disorder (MDD) after 6 months treatment with sertraline, escitalopram, or venlafaxine. J Psychiatr Res 2009;43(3):247–54.
47. Tsankova NM, Berton O, Renthal W, Kumar A, Neve RL, Nestler EJ. Sustained hippocampal chromatin regulation in a mouse model of depression and antidepressant action. Nat Neurosci 2006;9(4):519–25.
48. Roth TL, Lubin FD, Funk AJ, Sweatt JD. Lasting epigenetic influence of early-life adversity on the BDNF gene. Biol Psychiatry 2009;65(9): 760–9.
49. Roth TL, Zoladz PR, Sweatt JD, Diamond DM. Epigenetic modification of hippocampal BDNF DNA in adult rats in an animal model of post-traumatic stress disorder. J Psychiatr Res 2011;45(7):919–26.
50. Chen ES, Ernst C, Turecki G. The epigenetic effects of antidepressant treatment on human prefrontal cortex BDNF expression. Int J Neuropsychopharmacol 2011;14(3):427–9.
51. Lopez JP, Mamdani F, Labonte B, et al. Epigenetic regulation of BDNF expression according to antidepressant response. Mol Psychiatry 2013;18(4):398–9.
52. Keller S, Sarchiapone M, Zarrilli F, et al. Increased BDNF promoter methylation in the Wernicke area of suicide subjects. Arch Gen Psychiatry 2010;67(3):258–67.
53. Duman RS, Monteggia LM. A neurotrophic model for stress-related mood disorders. Biol Psychiatry 2006;59(12):1116–27.
54. Kim YK, Lee HP, Won SD, et al. Low plasma BDNF is associated with suicidal behavior in major depression. Prog Neuropsychopharmacol Biol Psychiatry 2007;31(1):78–85.
55. Dwivedi Y, Rizavi HS, Zhang H, et al. Neurotrophin receptor activation and expression in human postmortem brain: effect of suicide. Biol Psychiatry 2009;65(4):319–28.
56. Aston C, Jiang L, Sokolov BP. Transcriptional profiling reveals evidence for signaling and oligodendroglial abnormalities in the temporal cortex from patients with major depressive disorder. Mol Psychiatry 2005;10(3):309–22.
57. Nakatani N, Hattori E, Ohnishi T, et al. Genome-wide expression analysis detects eight genes with robust alterations specific to bipolar I disorder: relevance to neuronal network perturbation. Hum Mol Genet 2006;15(12):1949–62.
58. Mercier G, Lennon AM, Renouf B, et al. MAP kinase activation by fluoxetine and its relation to gene expression in cultured rat astrocytes. J Mol Neurosci 2004;24(2):207–16.
59. Ernst C, Deleva V, Deng X, et al. Alternative splicing, methylation state, and expression profile of tropomyosin-related kinase B in the frontal cortex of suicide completers. Arch Gen Psychiatry 2009;66(1):22–32.
60. Ernst C, Chen ES, Turecki G. Histone methylation and decreased expression of TrkB.T1 in orbital frontal cortex of suicide completers. Mol Psychiatry 2009;14(9):830–2.
61. Guidotti A, Auta J, Davis JM, et al. Decrease in reelin and glutamic acid decarboxylase67 (GAD67) expression in schizophrenia and bipolar disorder: a postmortem brain study. Arch Gen Psychiatry 2000;57(11):1061–9.
62. Heckers S, Stone D, Walsh J, Shick J, Koul P, Benes FM. Differential hippocampal expression of glutamic acid decarboxylase 65 and 67 messenger RNA in bipolar disorder and schizophrenia. Arch Gen Psychiatry 2002;59(6):521–9.
63. Volk DW, Austin MC, Pierri JN, Sampson AR, Lewis DA. Decreased glutamic acid decarboxylase67 messenger RNA expression in a subset of prefrontal cortical gamma-aminobutyric acid neurons in subjects with schizophrenia. Arch Gen Psychiatry 2000;57(3):237–45.
64. Veldic M, Caruncho HJ, Liu WS, et al. DNA-methyltransferase 1 mRNA is selectively overexpressed in telencephalic GABAergic interneurons of schizophrenia brains. Proc Natl Acad Sci U S A 2004; 101(1):348–53.
65. Kundakovic M, Chen Y, Costa E, Grayson DR. DNA methyltransferase inhibitors coordinately induce expression of the human reelin and glutamic acid decarboxylase 67 genes. Mol Pharmacol 2007;71(3): 644–53.
66. Grayson DR, Jia X, Chen Y, et al. Reelin promoter hypermethylation in schizophrenia. Proc Natl Acad Sci U S A 2005;102(26):9341.
67. Tamura Y, Kunugi H, Ohashi J, Hohjoh H. Epigenetic aberration of the human REELIN gene in psychiatric disorders. Mol Psychiatry 2007;12 (6):519, 93–600.
68. Zhang TY, Hellstrom IC, Bagot RC, Wen X, Diorio J, Meaney MJ. Maternal care and DNA methylation of a glutamic acid decarboxylase 1 promoter in rat hippocampus. J Neurosci 2010;30(39):13130–7.
69. Poulter MO, Du L, Weaver IC, et al. GABAA receptor promoter hypermethylation in suicide brain: implications for the involvement of epigenetic processes. Biol Psychiatry 2008;64(8):645–52.
70. Labonte B, Suderman M, Maussion G, et al. Genome-wide epigenetic regulation by early-life trauma. Arch Gen Psychiatry 2012;69(7): 722–31.
71. Labonte B, Suderman M, Maussion G, et al. Genome-wide methylation changes in the brains of suicide completers. Am J Psychiatry 2013;170 (5):511–20.
72. van der Vegt EJ, van der Ende J, Ferdinand RF, Verhulst FC, Tiemeier H. Early childhood adversities and trajectories of psychiatric problems in adoptees: evidence for long lasting effects. J Abnorm Child Psychol 2009;37(2):239–49.
73. Johnson JG, Cohen P, Gould MS, Kasen S, Brown J, Brook JS. Childhood adversities, interpersonal difficulties, and risk for suicide attempts during late adolescence and early adulthood. Arch Gen Psychiatry 2002;59(8):741–9.
74. Fergusson DM, Woodward LJ, Horwood LJ. Risk factors and life processes associated with the onset of suicidal behaviour during adolescence and early adulthood. Psychol Med 2000;30(1):23–39.
75. Wanner B, Vitaro F, Tremblay RE, Turecki G. Childhood trajectories of anxiousness and disruptiveness explain the association between early-life adversity and attempted suicide. Psychol Med 2012;42(11): 2373–82.
76. Melas PA, Rogdaki M, Osby U, Schalling M, Lavebratt C, Ekstrom TJ. Epigenetic aberrations in leukocytes of patients with schizophrenia: association of global DNA methylation with antipsychotic drug treatment and disease onset. FASEB J 2012;26(6):2712–8.
77. Borovecki F, Lovrecic L, Zhou J, et al. Genome-wide expression profiling of human blood reveals biomarkers for Huntington's disease. Proc Natl Acad Sci U S A 2005;102(31):11023–8.
78. Glatt SJ, Everall IP, Kremen WS, et al. Comparative gene expression analysis of blood and brain provides concurrent validation of SELENBP1 up-regulation in schizophrenia. Proc Natl Acad Sci U S A 2005;102(43):15533–8.
79. Tsuang MT, Nossova N, Yager T, et al. Assessing the validity of blood-based gene expression profiles for the classification of schizophrenia and bipolar disorder: a preliminary report. Am J Med Genet B Neuropsychiatr Genet 2005;133B(1):1–5.
80. Dempster EL, Pidsley R, Schalkwyk LC, et al. Disease-associated epigenetic changes in monozygotic twins discordant for schizophrenia and bipolar disorder. Hum Mol Genet 2011;20(24):4786–96.
81. Sullivan PF, Fan C, Perou CM. Evaluating the comparability of gene expression in blood and brain. Am J Med Genet B Neuropsychiatr Genet 2006;141B(3):261–8.
82. Cai C, Langfelder P, Fuller TF, et al. Is human blood a good surrogate for brain tissue in transcriptional studies? BMC Genomics 2010;11:589.
83. Davies MN, Volta M, Pidsley R, et al. Functional annotation of the human brain methylome identifies tissue-specific epigenetic variation across brain and blood. Genome Biol 2012;13(6):R43.
84. Perroud N, Salzmann A, Prada P, et al. Response to psychotherapy in borderline personality disorder and methylation status of the BDNF gene. Transl Psychiatry 2013;3:e207.

Neurobiological Risk Factors for Suicide

Insights from Brain Imaging

Elizabeth T. Cox Lippard, PhD, Jennifer A.Y. Johnston, MA, Hilary P. Blumberg, MD

Context: This article reviews neuroimaging studies on neural circuitry associated with suicide-related thoughts and behaviors to identify areas of convergence in findings. Gaps in the literature for which additional research is needed are identified.

Evidence acquisition: A PubMed search was conducted and articles published before March 2014 were reviewed that compared individuals who made suicide attempts to those with similar diagnoses who had not made attempts or to healthy comparison subjects. Articles on adults with suicidal ideation and adolescents who had made attempts, or with suicidal ideation, were also included. Reviewed imaging modalities included structural magnetic resonance imaging, diffusion tensor imaging, single photon emission computed tomography, positron emission tomography, and functional magnetic resonance imaging.

Evidence synthesis: Although many studies include small samples, and subject characteristics and imaging methods vary across studies, there were convergent findings involving the structure and function of frontal neural systems and the serotonergic system.

Conclusions: These initial neuroimaging studies of suicide behavior have provided promising results. Future neuroimaging efforts could be strengthened by more strategic use of common data elements and a focus on suicide risk trajectories. At-risk subgroups defined by biopsychosocial risk factors and multidimensional assessment of suicidal thoughts and behaviors may provide a clearer picture of the neural circuitry associated with risk status—both current and lifetime. Also needed are studies investigating neural changes associated with interventions that are effective in risk reduction. (Am J Prev Med 2014;47(3S2):S152–S162) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

This paper reviews neuroimaging studies on neural circuitry associated with suicide-related thoughts and behaviors in an effort to recommend next research steps. Multiple neuroimaging methods have been employed to investigate the neural circuitry of suicide-related thoughts and behaviors. These include techniques to study brain structure, including structural magnetic resonance imaging (sMRI) for gray matter (GM) and white matter (WM) morphology and WM hyperintensities (WMHs, bright signals on T2-weighted MRIs), and diffusion tensor imaging (DTI) for structural integrity of WM connections. Several functional neuroimaging methods (single photon emission computed tomography [SPECT]; positron emission tomography [PET]; and functional magnetic resonance imaging [fMRI]) have been used to study regional brain activity, functional connectivity, and neurotransmitter function.

From the Department of Psychiatry (Cox Lippard, Johnston, Blumberg), Department of Diagnostic Radiology (Blumberg), and the Child Study Center (Blumberg), Yale School of Medicine, New Haven, Connecticut

Address correspondence to: Hilary P. Blumberg, MD, Yale Department of Psychiatry, 300 George Street, Suite 901, New Haven CT 06511. E-mail: hilary.blumberg@yale.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.009

Evidence Acquisition

A search was performed in PubMed for original research manuscripts written in English before March 2014. Combinations of the term *suicide* with terms *structural magnetic resonance imaging*, *functional magnetic resonance imaging*, *positron emission tomography*, *single-photon emission computed tomography*, *diffusion tensor imaging*, *gray matter*, or *white matter* were used. Fifty-seven pertinent articles that directly investigated the relationship between aspects of suicide behavior (i.e., attempt history, lethality, and suicide ideation) and neuroimaging findings were chosen and evaluated in a non-quantitative manner.

Evidence Synthesis

In the majority of studies, attempters and non-attempters with a particular diagnosis were compared to each other,

and sometimes to a healthy control (HC) group (summarized in Table 1). The most commonly studied diagnoses were major depressive disorder (MDD) and bipolar disorder (BD), followed by schizophrenia; borderline personality disorder (BPD); traumatic brain injury (TBI); and epilepsy. Studies of adults with attempts are discussed first, followed by adults with ideation. We then summarize findings in older adults and adolescents.

Structural Magnetic Resonance Imaging

Structural magnetic resonance imaging of gray and white matter morphology. Structural imaging has been the method most used in suicide research. Studies using sMRI converge in showing orbitofrontal cortex (OFC) GM decreases in attempters with MDD,[1] BD,[2] schizophrenia,[3] and BPD,[4] and amygdala GM increases in MDD[1] and schizophrenia.[5] The OFC and amygdala are highly interconnected regions, important in regulating emotions and impulses, suggesting that frontotemporal OFC–amygdala structural abnormalities may contribute to emotion and impulse dysregulation associated with attempts. In BPD, OFC decreases were of larger magnitude in attempters with higher medical lethality.[4]

GM findings have been reported in other frontal system components in attempters with schizophrenia,[3,6] BPD,[4] BD,[2] and MDD.[7–9] These include dorsal frontal regions, insula, thalamus, and basal ganglia, implicating more widely distributed frontotemporal anterior connection sites. A study of the cerebellum yielded negative findings.[10]

Studies using sMRI show abnormal frontotemporal WM connections. A study of schizophrenia showed increased inferior frontal WM volume in attempters with self-directed aggression.[11] The sMRI studies also show altered interhemispheric connections. Smaller genual corpus callosum (CC) volume in BD attempters was associated with increased Barratt Impulsivity Scale scores.[12] These studies suggest that WM abnormalities contribute to self-aggression and impulse dyscontrol of suicidal behavior.

White matter hyperintensities. Increased WMH prevalence has been reported in young/mid-adult MDD and BD attempters,[13–15] and in older adults and children. Etiologies contributing to WMHs may include cellular loss, ischemia, perivascular space dilation, ependymal loss, and vascular-related demyelination.[16–18]

Diffusion tensor imaging. The main reported DTI measure is fractional anisotropy (FA), which reflects the directional coherence of diffusion within WM bundles, their architecture, or structural integrity. Decreased frontal FA in BD and MDD attempters has been found.[19–21] In BD, orbitofrontal FA decreases were associated with impulsivity. In MDD attempters, disruptions were found in frontal cortex–basal ganglia WM connections that are important in behavioral control.[20,22] In veterans with TBI and attempt history, FA increases in frontal WM projections were associated with impulsivity.[23] These DTI data further support the contributions of anterior WM abnormalities to impulsive suicide behavior.

Functional Neuroimaging

Single photon emission computed tomography and positron emission tomography. A SPECT study showed blunted prefrontal cortex (PFC) regional cerebral blood flow (rCBF) responses during word generation in attempters,[24] consistent with the frontal findings described above. Lower frontal, insular, and caudate rCBF predicted attempts in a study with prospective assessment of suicide decedents.[25]

A regional cerebral metabolic rate of glucose (rCMRglu) PET study reported OFC hypometabolism in BPD attempters.[26] Additionally, in rCMRglu PET studies, fenfluramine challenges have probed the serotonin (5-HT) system. Results indicated hypometabolism in right dorsolateral PFC in attempters and in association with ideation.[27] Ventral PFC hypometabolism differentiated between high-lethality and low-lethality attempters.[28] These studies suggest linkages between PFC response, 5-HT, suicide ideation, and attempt medical lethality, thus extending results of postmortem, cerebrospinal fluid, peripheral, and neuroendocrine challenge studies implicating 5-HT in suicide attempts and their lethality.

SPECT and PET neurotransmitter studies in attempters have focused on 5-HT and frontal systems. Findings include alterations in OFC 5-HT synthesis[29]; 5-HT transporter (5-HTT) binding[30–32]; associations among 5-HTT binding and SLC6A4 genetic variations[33]; and basal ganglia volume[9] and lower frontal 5HT-2a receptor binding.[34,35] Associations have been reported between impulsivity and 5-HTT binding in whole brain, OFC, and other frontotemporal system components.[36,37] Additionally, an association between lower frontal 5HT-2a receptor binding and hopelessness has been reported.[35] Genetic, postmortem, neuroendocrine, and peripheral studies also implicate noradrenergic and dopaminergic systems, and neurotrophic mechanisms, suggesting the need for their study.

Functional magnetic resonance imaging. The few reported fMRI studies of attempters are in MDD. One study of men showed elevated OFC responses to angry faces, suggesting that male MDD attempters have increased sensitivity to disapproval or threat.[38] Male attempters also showed decreased left OFC activation

Table 1. Neuroimaging studies of groups with suicide attempters

Authors and year	Group with history of suicide attempts	Group(s) without attempts	Methods	Findings
Structural magnetic resonance imaging studies of gray matter and white matter				
Aguilar et al. 2008[3]	13 males with SCZ, mean age 37 years	24 DCs	VBM of GM density	↓ OFC and superior temporal GM density, relative to DCs
Baldacara et al. 2011[10]	20 with BD, mean age 40 years	20 DCs, 22 HCs	VBM of GM and WM brain volume; ROI volume	No significant differences in total brain volume or cerebellar volume
Benedetti et al. 2011[2]	19 with BD, mean age 45 years	38 DCs	VBM of GM volume	↓ GM volume in DLPFC, OFC, ACC, superior temporal, parietal and occipital cortex and ↑ in bilateral superior temporal gyrus, relative to DCs. With lithium ↑ GM volume in same regions (DLPFC, OFC, ACC, superior temporal, parietal, and occipital cortex) and ↓ in bilateral superior temporal gyrus
Giakoumatos et al. 2013[6]	148 with SCZ, SZA or BD-P, mean age 36 years	341 DCs, 262 HCs	VBM of GM volume	↓ GM volume in bilateral superior/middle frontal, and inferior/superior temporal regions, left superior parietal and supramarginal regions, and right insula and thalamus, relative to DCs and HCs. High (versus low) lethality showed ↓ in left lingual area and right cuneus
Matsuo et al. 2010[12]	10 females with BD, mean age 36 years	10 DCs, 27 HCs	ROI area	Anterior CC genu area associated with impulsivity
Monkul et al. 2007[1]	7 females with MDD, mean age 31 years	10 DCs, 17 HCs	ROI volume	↓ OFC GM, relative to HCs. ↓ amygdala volumes, relative to DCs
Rüsch et al. 2008[11]	10 with SCZ, mean age 30 years	45 DCs, 55 HCs	VBM of GM and WM	↑ bilateral inferior frontal WM volume, relative to DCs. In SCZ ↑ inferior frontal related to self-aggression
Soloff et al. 2012[4]	44 with BPD (25 high lethality), mean age 30 years	24 DCs, 52 HCs	ROI volume	↓ insula GM, relative to DCs. ↓ in high lethality attempters in OFC, middle/superior temporal gyrus, insula, fusiform gyrus, lingual gyrus, and parahippocampal gyrus
Spoletini et al. 2011[5]	14 with SCZ, mean age 43 years	36 DCs, 50 HCs	ROI volume	↑ amygdala, relative to DCs and HCs. In the SCZ group, ↑ amygdala volume associated with self-aggression
Vang et al. 2010[9]	7 (4 with MDD, 2 AD), mean age 38 years	6 HCs	^{123}I-β-CIT methods to separate 5-HTT and DAT uptake in ROIs	↓ GP and caudate, relative to HCs and correlated with 5-HTT binding. In attempters, GP volumes inversely correlated with non-impulsive temperament
Wagner et al. 2011[7]	15 with MDD (10 with suicide behavior, 5 with first-degree relatives with suicidal behavior), mean age 41 years	15 DCs, 30 HCs	VBM of GM density	↓ inferior frontal cortex, ACC, caudate, amygdala/hippocampus formation, relative to HCs. ↓ ACC and caudate, relative to DCs
Wagner et al. 2012[8]	Same sample as in Wagner et al. 2011 above	15 DCs, 30 HCs	Cortical thickness	↓ ventrolateral PFC, DLPFC, and ACC, relative to DCs and HCs

(continued on next page)

Table 1. Neuroimaging studies of groups with suicide attempters *(continued)*

Authors and year	Group with history of suicide attempts	Group(s) without attempts	Methods	Findings
Older adults				
Cyprien et al. 2011[49]	21 (85.7% MDD, 36.8% AXD, 10.5% BD), mean age 72 years	180 DCs, 234 HCs	ROI area	↓ posterior third of CC, relative to DCs and HCs
Dombrovski et al. 2012[47]	13 with MDD, mean age 66 years	20 DCs, 19 HC	ROI voxel counts	↓ putamen GM, relative to DCs and HCs. ↓ in associative and ventral striatum, relative to DCs. Suicide attempters with ↓ putamen GM had higher delayed discounting
Hwang et al. 2010[48]	27 males with MDD, mean age overall MDD sample 79 years	43 DCs, 26 HCs	VBM of GM and WM	↓ GM and WM volume in the frontal, parietal, and temporal regions, insula, lentiform nucleus, midbrain, and cerebellum, relative to DCs
Magnetic resonance imaging studies of hyperintensities on T2-weighted images				
Ehrlich et al. 2005[14]	62 MDD, mean age overall sample 27 years	40 DCs	Assessment of WMH	↑ PVH
Pompili et al. 2008[13]	44 with BD I or II or MDD, mean age 46 years	55 DCs	Assessment of WMH	↑ PVH
Older adults				
Ahearn et al. 2001[45]	20 MDD, mean age 66 years	20 DCs	Assessment of WMH	↑ subcortical GM hyperintensities, and trend toward more PVH
Children and adolescents				
Ehrlich et al. 2003[52]	43 inpatients with varying diagnoses mean age overall sample 15 years	110 DCs	Assessment of WMH	↑ deep WMH in right parietal lobe associated with suicide attempts
Ehrlich et al. 2004[53]	43 inpatients with varying diagnoses (25 MDD) mean age overall sample 15 years, mean age MDD subgroup 15 years	110 DCs (23 MDD)	Assessment of WMH	Within the MDD subgroup ↑ in WMH, particularly PVH
Diffusion tensor imaging studies				
Jia et al. 2010[20]	16 with MDD, mean age 34 years	36 DCs, 52 HCs	Voxel-based analyses of FA	↓ FA in the ALIC, relative to DCs and HCs, ↓ FA in the frontal lobe, relative to HCs, and ↓ FA in the lentiform nucleus, relative to DCs
Jia et al. 2013[22]	23 with MDD, mean age 36 years	40 DCs, 46 HCs	Tractography, ROI of FA	↓ mean percentage of fibers through the ALIC to the left OFC and thalamus, relative to DCs. ↓ FA in medial frontal cortex, OFC, thalamus, and total ALIC fibers, relative to HCs
Lopez-Larson et al. 2013[23]	19 with TBI, mean age 38 years	40 DCs, 15 HCs	ROI of FA	↑ FA in bilateral thalamic radiations, relative to DCs and HCs

(continued on next page)

Table 1. Neuroimaging studies of groups with suicide attempters *(continued)*

Authors and year	Group with history of suicide attempts	Group(s) without attempts	Methods	Findings
Mahon et al. 2012[19]	14 with BD, mean age 33 years	15 DCs, 15 HCs	Tract-based spatial statistical and voxel-based analyses	↓ FA in OFC WM, relative to DCs. In BD with attempts, OFC WM FA inversely correlated with motor impulsivity
Olvet et al. 2014[21]	13 with MDD, mean age 33 years	39 DCs, 46 HCs	ROI and tract-based spatial statistical of FA and ADC	↓ FA in dorsomedial PFC, relative to DCs and HCs. No difference in ADC
Single photon emission tomography studies				
Audenaert et al. 2001[34]	9 (4 with MDD, 4 AD, 1 brief psychotic disorder, 4 comorbid PDs), mean age 32 years	12 HCs	^{123}I-5-I-R91150 for 5-HT2a receptors in PFC	↓ PFC-binding potential of 5-HT2a receptors
Audenaert et al. 2002[24]	20 MDD, mean age 32 years	20 HCs	99mTc-Ethyl Cystine Dimer rCBF SPECT during letter and category fluency tasks	↓ PFC response during letter and category fluency paradigms, relative to HCs
Bah et al. 2008[33]	9 unmedicated males (6 with MDD, 1 AD, and/or 5 PDs), mean age 41 years	9 HCs	^{123}I-β-CIT for 5-HTT availability, assessment of *SLC6A4* polymorphisms	In attempters, ↓ 5-HTT availability associated with the "s" allele of 5-HTTLPR and 12 repeat allele of STin2
van Heeringen et al. 2003[35]	9 (3 with MDD, 4 AD, 1 brief psychotic and/or 4 PDs), mean age 32 years	13 HCs	^{123}I-5-I-R91150 for 5-HT2a receptors in PFC	↓ PFC-binding potential of 5-HT2a receptors. ↓ 5-HT2a binding associated with ↑ hopelessness and harm avoidance
Lindström et al. 2004[36]	12 (3 with MDD, 3 MDD + SA, 3 AD, 1 DE-NOS, 1 SP, 3 undiagnosed), mean age 39 years	12 HCs	^{123}I-β-CIT methods to separate 5-HTT and DAT uptake	No significant differences in 5-HTT or DAT. In attempters, ↑ impulsivity associated with ↓ whole brain 5-HTT binding.
Ryding et al. 2006[37]	12 (5 with MDD, 3 AD, 1 AXD and/or 6 PDs), mean age 39 years	12 HCs	^{123}I-β-CIT methods to separate 5-HTT and DAT uptake	In attempters, ↑ impulsivity associated with ↓ 5-HTT binding in OFC, temporal regions, midbrain, thalamus, basal ganglia, and cerebellum, and ↑ mental energy with ↓ DAT binding in basal ganglia
Willeumier et al. 2011[25]	21 scanned previously who completed suicide with mood disorders, mean age 36 years	36 DCs, 27 HCs	99mTc HMPAO SPECT to assess rCBF	↓ rCBF in superior PFC, operculum, postcentral gyrus, precuneus, caudate, and insula.↓ rCBF in the subgenual ACC in 18 of the 21 subjects
Positron emission tomography studies				
Cannon et al. 2006[30]	8 BD with current depressive episode, mean age 30 years (overall BD sample)	10 DCs, 37 HCs	5-HTT binding potential measured with ^{11}C-DASB	↓ 5-HTT binding in the midbrain and ↑ in the ACC, relative to DCs and HCs
Leyton et al. 2006[29]	10 high lethality suicide attempters (2 with mood disorder, 8 cluster B PD, 6 SA), mean age 38 years	16 HCs	Alpha-^{11}C-methyl-L-tryptophan trapping as index of 5-HT synthesis	↓ 5-HT synthesis in OFC and ventromedial PFC

(continued on next page)

Table 1. Neuroimaging studies of groups with suicide attempters *(continued)*

Authors and year	Group with history of suicide attempts	Group(s) without attempts	Methods	Findings
Miller et al. 2013[31]	15 with MDD, mean age 39 years	36 DCs, 32 HCs	^{11}C-DASB to quantify in vivo regional brain 5-HTT binding	↓ 5-HTT binding in midbrain, relative to DCs and HCs
Nye et al. 2013[32]	11 with MDD, mean age 39 years	10 HC	^{11}C-ZIENT PET to measure 5-HTT	↓ 5-HTT in the midbrain/pons and putamen
Oquendo et al. 2003[28]	16 with MDD with high-lethality attempts/ 9 MDD with low-lethality attempts, mean age 43 years/30 years		^{18}F-FDG PET, fenfluramine versus placebo challenge	↓ rCMRglu in ventral, medial, and lateral PFC, compared to low-lethality attempters, more pronounced after fenfluramine. ↓ ventromedial PFC activity associated with ↓ impulsivity and ↑ suicidal planning. ↓ rCMRglu associated with ↓ verbal fluency
Soloff et al. 2003[26]	13 females with BPD (12 with attempts), mean age 25 years	9 HCs	^{18}F-FDG PET during rest	Bilateral ↓ rCMRglu in the medial OFC
Sublette et al. 2013[27]	13 with MDD or BD, mean age 36 years	16 DCs	^{18}F-FDG PET, fenfluramine versus placebo	↓ rCMRglu in right DLPFC, more pronounced after fenfluramine. ↑ ventromedial PFC activity, not detected after fenfluramine. Suicide ideation correlated negatively with rCMRglu in an overlapping DLPFC region
Functional magnetic resonance imaging studies				
Jollant et al. 2008[38]	13 males with MDD, mean age 40 years	14 DCs, 16 HCs	Response to intense or mild, angry or happy face stimuli, compared to responses to neutral face stimuli	↑ response in lateral and ↓ in superior frontal cortex to angry versus neutral, ↑ anterior cingulate gyrus to mild happy versus neutral, ↑ cerebellum to mild angry versus neutral, relative to DCs
Jollant et al. 2010[39]	13 males with MDD, mean age 38 years	12 DCs, 15 HCs	Iowa Gambling Task, ROIs	↓ lateral OFC and occipital cortex activation during risky relative to safe choices, relative to DCs. Poorer gambling task performance, relative to DCs
Marchand et al. 2012[40]	6 males with MDD with self-harm, 5 with attempts, mean age 28 years (overall MDD sample)	16 DCs	Motor activation task	↓ putamen activation and altered functional connectivity in a network involving bilateral motor/sensory cortices and striatum, left temporal and inferior parietal lobule regions, and right posterior cortical midline structures
Reisch et al. 2010[41]	8 females with attempts, mean age 39 years	None	Activation during recall of mental pain and suicide action during recent suicide attempts	Recall of mental pain was associated with ↓ activation in DLPFC, rostral PFC, and premotor regions. Recall of suicidal action was associated with ↑ activation in the medial PFC, ACC, and hippocampus
Older adults				
Dombrovski et al. 2013[50]	15 with MDD, mean age 66 years	18 DCs, 20 HCs	Reward learning using reinforcement learning model, assessment of expected rewards	↓ pregenual cingulate response to high expected reward and associated with ↑ impulsivity

(continued on next page)

Table 1. Neuroimaging studies of groups with suicide attempters *(continued)*

Authors and year	Group with history of suicide attempts	Group(s) without attempts	Methods	Findings
Children and adolescents				
Pan et al. 2011[56]	15 with MDD, mean age 16 years	15 DCs, 14 HCs	Go–no-go response inhibition and motor control task	↓ ACC activation to go–no-go versus motor control, relative to DCs
Pan et al. 2013[55]	14 with MDD (sample noted to overlap with 2011 study), mean age 16 years	15 DCs, 15 HCs	Response to intense or mild, angry or happy face stimuli, compared to responses to neutral face stimuli	↑ ACC–DLPFC circuitry, primary sensory and temporal cortices to mildly angry faces, relative to DCs. Higher primary sensory cortex to mild angry, relative to HCs. ↓ in the fusiform gyrus to neutral faces during angry face runs, relative to DCs. ↓ in primary sensory cortex to intensely happy faces and in the anterior cingulate and medial PFC to neutral faces in the happy face runs. ↓ anterior cingulate–insula functional connectivity to mild angry faces, relative to DCs or HCs
Pan et al. 2013[57]	15 with MDD, mean age 16 years	14 DCs, 13 HCs	Iowa Gambling Task	↓ activation in thalamus during high-risk decisions relative to DCs and ↑ activation in caudate relative to HCs

^{11}C-DASB, (^{11}C)3-amino-4-(2-dimethylaminomethyl-phenylsulfanyl)benzonitrile; ^{11}C-ZIENT, (^{11}C)2β-carbomethoxy-3β-[4'-((Z)-2-iodoethenyl)phenyl]nortropane; ^{123}I-β-CIT, (^{123}I)β-carboxymethyoxy-3-β-(4-iodophenyl) tropane; ^{123}I-5-I-R91150, 4-amino-*N*-[1-[3-(4-fluorophenoxy); 5-HT, serotonin; 5-HT2a, serotonin 2a; 5-HTT, serotonin transporter; 5-HTTLPR, serotonin-transporter-linked polymorphic region; 99mTc, technetium-99m; ACC, anterior cingulate cortex; AD, adjustment disorder; ADC, apparent diffusion coefficient; ALIC, anterior limb of internal capsule; AXD, anxiety disorder; BD, bipolar disorder; BD-P, bipolar disorder with psychosis; BPD, borderline personality disorder; CC, corpus callosum; DAT, dopamine transporter; DC, diagnostic controls, i.e., subjects with the same diagnosis(es) as the group with attempts; DE-NOS, depressive episode not otherwise specified; DLPFC, dorsolateral prefrontal cortex; FA, fractional anisotropy; FDG, fluorodeoxyglucose; GM, gray matter; GP, globus pallidus; HC, healthy control subjects; HMPAO, hexamethylpropylene amine oxime; MDD, major depressive disorder; OFC, orbitofrontal cortex; PD, personality disorder; PET, positron emission tomography; PVH, periventricular hyperintensities; PFC, prefrontal cortex; rCBF, regional cerebral blood flow; rCMRglu, regional cerebral glucose metabolic rates; ROIs, regions of interest; SA, substance abuse; SCZ, schizophrenia; SLC6A4, serotonin transporter gene; SP, social phobia; SPECT, single photon emission tomography; STin2, serotonin transporter intron 2; SZA, schizoaffective disorder; TBI, traumatic brain injury; VBM, voxel-based morphometry; WM, white matter; WMHs, white matter hyperintensities

associated with risky gambling task choices.[39] When fMRI was performed during a motor task by attempters,[40] altered activation and functional connectivity within and between regions in a corticostriatal network were shown. In one of the few studies examining internal states and thoughts of suicide, fMRI showed frontal decreases during autobiographic recall of mental pain associated with previous attempts, and frontotemporal increases during recall of suicide actions.[41]

Suicidal Ideation

Study of suicidal ideation is important for understanding the development of risk for attempts. Of the few structural studies of suicide ideation, non-attempters with ideation did not show the WM abnormalities noted in attempters, although one DTI study of ideation in veterans with TBI did show FA reductions in the cingulum, a structure important in emotional memory.[13,42] The absence of frontal WM findings in non-attempters with ideation suggests that these findings are more closely associated with suicidal acts and possibly the more impulsive aspects of some attempts. It is possible that WM disruptions are a consequence of suicide attempt methods that could affect the brain, for example, as a consequence of hypoxia, although some studies have noted similar findings in attempters who did not use such methods.[13]

Brain dysfunction has shown some consistencies among ideators and attempters. Performance of a motor activation task by BDII ideators showed frontostriatal findings similar to those in attempters.[43] In another fMRI study of combat-exposed war veterans performing a stop task,[44] ideation was associated with higher frontal error–related activation.

Older Adult Attempters

Biopsychosocial features of aging may confer neurobiological risk for suicide. WMHs and other WM pathology may be more prevalent in older adult attempters.[45,46] Early findings of increased WMHs in older adults suggested pathologic processes (e.g., vascular disease) more prevalent in older adults.[16–18] However, recent studies reporting similarly increased WMHs in younger adults and adolescents suggest that alternative mechanisms may underlie WMHs. Although underlying mechanisms may differ, findings in adults aged over 60 years show consistencies with findings in younger adults. For example, older adult MDD attempters also show decreased basal ganglia GM and relationships to reward processing and behavioral control.[47,48] CC WM decreases have been reported in older adult attempters with mood and anxiety disorders, although in older attempters these were in the posterior third,[49] implicating more involvement of emotion and memory processes. Older adult attempters also show decreases in ventromedial PFC responses to rewards, associated with impulsivity.[50] In light of few comparison studies of older to younger adults, more research is needed on similarities and distinctions between the pathophysiology and neural circuitry underlying suicide behavior across life span stages.

Suicide Attempts and Ideation in Children and Adolescents

Neuroimaging research with adolescents is important, as adolescence is a critical period in suicide behavior development. Structural imaging studies of children and adolescents—with epilepsy,[51] as psychiatric inpatients,[52,53] or outpatients with BPD and MDD[54]—show some consistencies with studies in adults, suggesting these abnormalities may relate to development of suicide-related thoughts and behaviors. Findings include smaller OFC WM in young ideators,[51] more prevalent WMHs in MDD young attempters,[52,53] and smaller anterior cingulate GM and WM volumes in adolescents with more suicide attempts.[54]

An fMRI study in MDD adolescents showed increased responses to angry faces in frontal circuitry,[55] similar to that found in adults.[38] However, MDD adolescent attempters did not show differential neural responses during response inhibition on a go–no-go task or decision making in the context of risk.[56,57] These findings suggest increased sensitivity in frontal systems involved in negative emotion processing may characterize adolescent attempters.

Recommendations for Future Research

Despite highly varied methods and small samples, the structural and functional neuroimaging findings converge in implicating frontal neural systems and serotonergic functioning as central in suicide behavior, consistent with studies using non-imaging approaches. As neuroimaging studies are expensive, scanning time limited, and at-risk patients difficult to retain in studies, future neuroimaging efforts could benefit from more strategic approaches.

Common Data Elements

As illustrated above and in Table 1, there is substantial variation in age, gender, psychopathology, imaging methods and regions studied, activation paradigms, and behavioral constructs probed. Studies vary in defining "attempters." Although neuropsychological constructs related to emotion and impulse regulation have been

most studied, definitions of these constructs and methods to assess them have varied. Efforts to use common definitions of suicide behavior and neuropsychological processes, and methods to assess them, could lead to better synthesis across studies. Similarly, calibration of imaging hardware and analytic techniques will be needed. In efforts to link brain imaging to age, gender, and genetic, postmortem, neurotransmitter, neurotrophic, hormonal, and environmental findings and to elucidate commonalities and distinctions between suicide behavior in different psychiatric disorders, the use of common data elements could make cross-study comparisons more likely and of greater value. Future studies may benefit from including new analytic approaches, such as computer learning algorithms comparing imaging data on cases and controls, in larger samples.

However, this field is in its early stages and there is risk to premature focus. Although initial work has focused on frontal systems and related behavioral constructs such as impulsivity and 5-HT, and these have shown importance in attempters, the field is also in need of novel approaches to study other aspects of suicide. For example, few studies have focused on ideation. There is a critical need for investigators who develop ideation-related constructs and innovative methods to probe them.

Suicide Risk and Trajectories

Two major gaps in the study of individuals at risk for suicide over time were identified. First, longitudinal studies are critically needed of individuals at risk, especially beginning in youth, to study biopsychosocial factors and neural trajectories both associated with and not with future attempts. These could reveal predictors and trajectories associated with future attempts, as well as with resilience in individuals who do not make attempts. Second, neuroimaging studies before and after pharmacologic and behavioral interventions could be instrumental in promoting understanding of therapeutic mechanisms in treatment response.

Conclusions

It is an important time for research in the neural circuitry of suicide-related thoughts and behaviors. Important groundwork has been laid by initial neuroimaging studies. Despite the small size and heterogeneity of these studies, some convergent findings provide a promising start. The identification of associations among genetic and molecular mechanisms, brain circuitry, ideation, and behavior could be instrumental in identifying targets for prevention. Future neuroimaging efforts could be leveraged by more strategic use of common data elements and efforts to fill gaps in understanding of suicide risk trajectories. At-risk subgroups defined by risk experiences and psychopathology subtypes may provide a clearer picture of the neural changes associated with suicide risk status—both current and lifetime. Expanding research efforts that examine structural and functional changes related to intervention responses can inform risk and prevention models.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

Funding was received by HPB from the NIH (Grant Nos. R01MH69747, R01MH070902, RC1MH088366, RL1DA024856), American Foundation for Suicide Prevention, International Bipolar Foundation, National Alliance for Research in Schizophrenia and Depression and Women's Health Research at Yale, and ETCL from the NIH (Grant No. T32MH014276).

No financial disclosures were reported by the authors of this paper.

References

1. Monkul ES, Hatch JP, Nicoletti MA, et al. Fronto-limbic brain structures in suicidal and non-suicidal female patients with major depressive disorder. Mol Psychiatry 2007;12(4):360–6.
2. Benedetti F, Radaelli D, Poletti S, et al. Opposite effects of suicidality and lithium on gray matter volumes in bipolar depression. J Affect Disord 2011;135(1–3):139–47.
3. Aguilar EJ, Garcia-Marti G, Marti-Bonmati L, et al. Left orbitofrontal and superior temporal gyrus structural changes associated to suicidal behavior in patients with schizophrenia. Prog Neuropsychopharmacol Biol Psychiatry 2008;32(7):1673–6.
4. Soloff PH, Pruitt P, Sharma M, Radwan J, White R, Diwadkar VA. Structural brain abnormalities and suicidal behavior in borderline personality disorder. J Psychiatr Res 2012;46(4):516–25.
5. Spoletini I, Piras F, Fagioli S, et al. Suicidal attempts and increased right amygdala volume in schizophrenia. Schizophr Res 2011;125(1):30–40.
6. Giakoumatos CI, Tandon N, Shah J, et al. Are structural brain abnormalities associated with suicidal behavior in patients with psychotic disorders? J Psychiatr Res 2013;47(10):1389–95.
7. Wagner G, Koch K, Schachtzabel C, Schultz CC, Sauer H, Schlosser RG. Structural brain alterations in patients with major depressive disorder and high risk for suicide: evidence for a distinct neurobiological entity? Neuroimage 2011;54(2):1607–14.
8. Wagner G, Schultz CC, Koch K, Schachtzabel C, Sauer H, Schlosser RG. Prefrontal cortical thickness in depressed patients with high-risk for suicidal behavior. J Psychiatr Res 2012;46(11):1449–55.
9. Vang FJ, Ryding E, Traskman-Bendz L, van WD, Lindstrom MB. Size of basal ganglia in suicide attempters, and its association with temperament and serotonin transporter density. Psychiatry Res 2010;183(2):177–9.
10. Baldacara L, Nery-Fernandes F, Rocha M, et al. Is cerebellar volume related to bipolar disorder? J Affect Disord 2011;135(1–3):305–9.
11. Rusch N, Spoletini I, Wilke M, et al. Inferior frontal white matter volume and suicidality in schizophrenia. Psychiatry Res 2008;164(3):206–14.

12. Matsuo K, Nielsen N, Nicoletti MA, et al. Anterior genu corpus callosum and impulsivity in suicidal patients with bipolar disorder. Neurosci Lett 2010;469(1):75–80.
13. Pompili M, Innamorati M, Mann JJ, et al. Periventricular white matter hyperintensities as predictors of suicide attempts in bipolar disorders and unipolar depression. Prog Neuropsychopharmacol Biol Psychiatry 2008;32(6):1501–7.
14. Ehrlich S, Breeze JL, Hesdorffer DC, et al. White matter hyperintensities and their association with suicidality in depressed young adults. J Affect Disord 2005;86(2–3):281–7.
15. Serafini G, Pompili M, Innamorati M, et al. Affective temperamental profiles are associated with white matter hyperintensity and suicidal risk in patients with mood disorders. J Affect Disord 2011;129(1–3):47–55.
16. Thomas AJ, O'Brien JT, Davis S, et al. Ischemic basis for deep white matter hyperintensities in major depression: a neuropathological study. Arch Gen Psychiatry 2002;59(9):785–92.
17. Gunning-Dixon FM, Walton M, Cheng J, et al. MRI signal hyperintensities and treatment remission of geriatric depression. J Affect Disord 2010;126(3):395–401.
18. Fazekas F, Kleinert R, Offenbacher H, et al. Pathologic correlates of incidental MRI white matter signal hyperintensities. Neurology 1993;43(9):1683–9.
19. Mahon K, Burdick KE, Wu J, Ardekani BA, Szeszko PR. Relationship between suicidality and impulsivity in bipolar I disorder: a diffusion tensor imaging study. Bipolar Disord 2012;14(1):80–9.
20. Jia Z, Huang X, Wu Q, et al. High-field magnetic resonance imaging of suicidality in patients with major depressive disorder. Am J Psychiatry 2010;167(11):1381–90.
21. Olvet DM, Peruzzo D, Thapa-Chhetry B, et al. A diffusion tensor imaging study of suicide attempters. J Psychiatr Res 2014;51:60–7.
22. Jia Z, Wang Y, Huang X, et al. Impaired frontothalamic circuitry in suicidal patients with depression revealed by diffusion tensor imaging at 3.0 T. J Psychiatry Neurosci 2013;38(5):130023.
23. Lopez-Larson M, King JB, McGlade E, et al. Enlarged thalamic volumes and increased fractional anisotropy in the thalamic radiations in veterans with suicide behaviors. Front Psychiatry 2013;4:83.
24. Audenaert K, Goethals I, Van LK, et al. SPECT neuropsychological activation procedure with the verbal fluency test in attempted suicide patients. Nucl Med Commun 2002;23(9):907–16.
25. Willeumier K, Taylor DV, Amen DG. Decreased cerebral blood flow in the limbic and prefrontal cortex using SPECT imaging in a cohort of completed suicides. Transl Psychiatry 2011;1:e28.
26. Soloff PH, Meltzer CC, Becker C, Greer PJ, Kelly TM, Constantine D. Impulsivity and prefrontal hypometabolism in borderline personality disorder. Psychiatry Res 2003;123(3):153–63.
27. Sublette ME, Milak MS, Galfalvy HC, Oquendo MA, Malone KM, Mann JJ. Regional brain glucose uptake distinguishes suicide attempters from non-attempters in major depression. Arch Suicide Res 2013;17(4):434–47.
28. Oquendo MA, Placidi GP, Malone KM, et al. Positron emission tomography of regional brain metabolic responses to a serotonergic challenge and lethality of suicide attempts in major depression. Arch Gen Psychiatry 2003;60(1):14–22.
29. Leyton M, Paquette V, Gravel P, et al. Alpha-[^{11}C]methyl-L-tryptophan trapping in the orbital and ventral medial prefrontal cortex of suicide attempters. Eur Neuropsychopharmacol 2006;16(3):220–3.
30. Cannon DM, Ichise M, Fromm SJ, et al. Serotonin transporter binding in bipolar disorder assessed using [^{11}C]DASB and positron emission tomography. Biol Psychiatry 2006;60(3):207–17.
31. Miller JM, Hesselgrave N, Ogden RT, et al. Positron emission tomography quantification of serotonin transporter in suicide attempters with major depressive disorder. Biol Psychiatry 2013;74(4):287–95.
32. Nye JA, Purselle D, Plisson C, et al. Decreased brainstem and putamen SERT binding potential in depressed suicide attempters using [^{11}C]-zient PET imaging. Depress Anxiety 2013;30(10):902–7.
33. Bah J, Lindstrom M, Westberg L, et al. Serotonin transporter gene polymorphisms: effect on serotonin transporter availability in the brain of suicide attempters. Psychiatry Res 2008;162(3):221–9.
34. Audenaert K, Van LK, Dumont F, et al. Decreased frontal serotonin 5-HT 2a receptor binding index in deliberate self-harm patients. Eur J Nucl Med 2001;28(2):175–82.
35. van Heeringen C, Audenaert K, Van LK, et al. Prefrontal 5-HT2a receptor binding index, hopelessness and personality characteristics in attempted suicide. J Affect Disord 2003;74(2):149–58.
36. Lindstrom MB, Ryding E, Bosson P, Ahnlide JA, Rosen I, Traskman-Bendz L. Impulsivity related to brain serotonin transporter binding capacity in suicide attempters. Eur Neuropsychopharmacol 2004;14(4):295–300.
37. Ryding E, Ahnlide JA, Lindstrom M, Rosen I, Traskman-Bendz L. Regional brain serotonin and dopamine transporter binding capacity in suicide attempters relate to impulsiveness and mental energy. Psychiatry Res 2006;148(2–3):195–203.
38. Jollant F, Lawrence NS, Giampietro V, et al. Orbitofrontal cortex response to angry faces in men with histories of suicide attempts. Am J Psychiatry 2008;165(6):740–8.
39. Jollant F, Lawrence NS, Olie E, et al. Decreased activation of lateral orbitofrontal cortex during risky choices under uncertainty is associated with disadvantageous decision-making and suicidal behavior. Neuroimage 2010;51(3):1275–81.
40. Marchand WR, Lee JN, Johnson S, et al. Striatal and cortical midline circuits in major depression: implications for suicide and symptom expression. Prog Neuropsychopharmacol Biol Psychiatry 2012;36(2):290–9.
41. Reisch T, Seifritz E, Esposito F, Wiest R, Valach L, Michel K. An fMRI study on mental pain and suicidal behavior. J Affect Disord 2010;126(1–2):321–5.
42. Yurgelun-Todd DA, Bueler CE, McGlade EC, Churchwell JC, Brenner LA, Lopez-Larson MP. Neuroimaging correlates of traumatic brain injury and suicidal behavior. J Head Trauma Rehabil 2011;26(4):276–89.
43. Marchand WR, Lee JN, Garn C, et al. Striatal and cortical midline activation and connectivity associated with suicidal ideation and depression in bipolar II disorder. J Affect Disord 2011;133(3):638–45.
44. Matthews S, Spadoni A, Knox K, Strigo I, Simmons A. Combat-exposed war veterans at risk for suicide show hyperactivation of prefrontal cortex and anterior cingulate during error processing. Psychosom Med 2012;74(5):471–5.
45. Ahearn EP, Jamison KR, Steffens DC, et al. MRI correlates of suicide attempt history in unipolar depression. Biol Psychiatry 2001;50(4):266–70.
46. Sachs-Ericsson N, Hames JL, Joiner TE, et al. Differences between suicide attempters and nonattempters in depressed older patients: depression severity, white-matter lesions, and cognitive functioning. Am J Geriatr Psychiatry 2014;22(1):75–85.
47. Dombrovski AY, Siegle GJ, Szanto K, Clark L, Reynolds CF, Aizenstein H. The temptation of suicide: striatal gray matter, discounting of delayed rewards, and suicide attempts in late-life depression. Psychol Med 2012;42(6):1203–15.
48. Hwang JP, Lee TW, Tsai SJ, et al. Cortical and subcortical abnormalities in late-onset depression with history of suicide attempts investigated with MRI and voxel-based morphometry. J Geriatr Psychiatry Neurol 2010;23(3):171–84.
49. Cyprien F, Courtet P, Malafosse A, et al. Suicidal behavior is associated with reduced corpus callosum area. Biol Psychiatry 2011;70(4):320–6.
50. Dombrovski AY, Szanto K, Clark L, Reynolds CF, Siegle GJ. Reward signals, attempted suicide, and impulsivity in late-life depression. JAMA Psychiatry 2013;70(10):1020–30.
51. Caplan R, Siddarth P, Levitt J, Gurbani S, Shields WD, Sankar R. Suicidality and brain volumes in pediatric epilepsy. Epilepsy Behav 2010;18(3):286–90.

52. Ehrlich S, Noam GG, Lyoo IK, Kwon BJ, Clark MA, Renshaw PF. Subanalysis of the location of white matter hyperintensities and their association with suicidality in children and youth. Ann N Y Acad Sci 2003;1008(1):265–8.
53. Ehrlich S, Noam GG, Lyoo IK, Kwon BJ, Clark MA, Renshaw PF. White matter hyperintensities and their associations with suicidality in psychiatrically hospitalized children and adolescents. J Am Acad Child Adolesc Psychiatry 2004;43(6):770–6.
54. Goodman M, Hazlett EA, Avedon JB, Siever DR, Chu KW, New AS. Anterior cingulate volume reduction in adolescents with borderline personality disorder and co-morbid major depression. J Psychiatr Res 2011;45(6):803–7.
55. Pan LA, Hassel S, Segreti AM, Nau SA, Brent DA, Phillips ML. Differential patterns of activity and functional connectivity in emotion processing neural circuitry to angry and happy faces in adolescents with and without suicide attempt. Psychol Med 2013; 43(10):2129–42.
56. Pan LA, Batezati-Alves SC, Almeida JR, et al. Dissociable patterns of neural activity during response inhibition in depressed adolescents with and without suicidal behavior. J Am Acad Child Adolesc Psychiatry 2011;50(6):602–11.
57. Pan L, Segreti A, Almeida J, et al. Preserved hippocampal function during learning in the context of risk in adolescent suicide attempt. Psychiatry Res 2013;211(2):112–8.

Suicide Risk Screening and Assessment

Designing Instruments with Dissemination in Mind

Edwin D. Boudreaux, PhD, Lisa M. Horowitz, PhD, MPH

This paper summarizes recommendations made regarding the National Action Alliance for Suicide Prevention Research Prioritization Task Force's Aspirational Goal 2, to "determine the degree of suicide risk (e.g., imminent, near-term, long-term) among individuals in diverse populations and in diverse settings through feasible and effective screening and assessment approaches." We recommend that researchers shift to using "design for dissemination" principles to maximize both the goodness of fit and validity of screening and assessment measures for a given setting. Three specific recommendations to guide research efforts are made to achieve this shift: (1) the parameters related to each setting, including the logistics, scope of practice, infrastructure, and decision making required, should be identified and used to choose or design screening and assessment instruments that have a good fit; (2) to the greatest feasible extent, technology should be used to support screening and assessment; and (3) researchers should study the best methods for translating validated instruments into routine clinical practice. We discuss the potential barriers to implementing these recommendations and illustrate the paradigm shift within the emergency department setting.

(Am J Prev Med 2014;47(3S2):S163–S169)

Introduction

The National Action Alliance for Suicide Prevention (Action Alliance) Research Prioritization Task Force's (RPTF's) Aspirational Goal 2 (AG2) seeks to outline a research pathway that will lead to the development of validated procedures that can "determine the degree of suicide risk (e.g., imminent, near-term, long-term) among individuals in diverse populations and in diverse settings through feasible and effective screening and assessment approaches" (p. 24).[1]

This paper reviews the specific assertions that underlie AG2, proposes a paradigm shift for screener and assessment development and research, and outlines three specific recommendations to actualize the new paradigm. AG2 is meant to apply to all settings, and although our recommendations can apply to schools, detention settings, and the armed forces, this paper focuses on adult patients in healthcare settings.

From the Department of Emergency Medicine, Department of Psychiatry, and Department of Quantitative Health Sciences (Boudreaux), University of Massachusetts Medical School, Worcester, Massachusetts; and the Intramural Research Program (Horowitz), National institute of Mental Health, NIH, Bethesda, Maryland

Address correspondence to: Edwin D. Boudreaux, PhD, Department of Emergency Medicine, LA-189, 55 Lake Avenue North, Worcester MA 01655. E-mail: edwin.boudreaux@umassmed.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.005

Aspirational Goal 2 Assertions

AG2 can be broken down into several key assertions briefly reviewed below, which will be expanded upon in relation to our specific recommendations in the sections that follow. In addition, some components, such as the definition and measurement of imminent risk, are discussed in detail by other papers appearing in this supplement.

Suicide risk can be operationalized along a timeline of imminent, near-term, and long-term risk. Although a coherent system that operationalizes these terms does not yet exist, and is a key component of the pathway that the Action Alliance is attempting to elucidate, most suicidologists acknowledge that suicide risk is a varying trait that is not stable over time. As embodied in the American Psychiatric Association's suicide assessment and treatment guidelines,[2] suicide risk can be formulated as an interaction between relatively stable risk factors or predisposing characteristics, protective factors, and acute precipitants.

This conceptualization of suicide risk promotes the logical conclusion that an individual should be screened and assessed in reference to a specific risk horizon. All or most settings must attend to imminent risk, because it is critical for deploying suicide prevention efforts that require immediate action. However, some settings also have the capacity to focus on assessing and managing long-term risk, which will strongly influence the

screening and assessment instruments' composition, as well as clinical decision making guided by these instruments and the research methods used to study them.

Individuals in diverse populations and settings may require different approaches. Approaches that work for adults in primary care may not be the same as approaches that work for children in educational settings. Each population and setting must be evaluated individually and a good fit approach should be built with stakeholder involvement.

Screening and assessment are different. Screening is performed to detect whether any actionable risk is present, or put differently, to screen out those with negligible risk. As such, it requires easy administration by front-line staff, should be highly sensitive, and should have a strong ability to confidently rule out patients with no appreciable risk (i.e., low false negatives).[3,4] Assessment, in contrast, is a more in-depth evaluation performed to further quantify the severity of risk to guide further clinical action. Assessments should have strong specificity and be able to identify individuals who are at true risk and need immediate or increased resources and support. Ideally, screening and assessment should work in a coordinated fashion, with screening sensitively detecting any clinically actionable risk and assessment specifying risk on a severity continuum.

The approaches used to screen and assess suicide risk must balance feasibility and effectiveness. In many settings, tension exists between feasibility—or what is most efficiently performed by providers—and effectiveness—or what is most valid in identifying and quantifying risk. For example, the most feasible path may be to screen only patients with frank psychiatric symptoms, which contrasts with what may be the most valid and effective path for identifying risk among the population, such as universal screening.

A Paradigm Shift

The prevailing paradigm guiding suicide risk research has been characterized by mental health specialists creating multi-item instruments and testing them under research conditions to determine if they predict future suicidal behavior. These instruments are often created independent of the specific clinical decisions they will be guiding and without full consideration of the parameters that would be relevant to whether the instrument could be applied under routine "real-world" conditions. Often, the AG2 assertions are not sufficiently considered.

A classic example is the Beck Scale for Suicide Ideation (BSSI).[5] Although this scale is a good fit for mental health settings, where multi-item self-reported paper-and-pencil instruments are commonplace, it can be a poor fit for other settings. For example, most clinicians in adult general medical settings, such as primary care practices, are ill equipped to administer, score, and interpret such instruments. In contrast, as a general rule of thumb, the behavioral health screeners that have fared best in general medical settings are ultra-short and easily memorized.

This efficiency principle has recently been acknowledged by an expert panel convened by the NIH.[6] The ten behavioral health screeners they recommend being integrated into electronic health record systems (EHRs), including those assessing tobacco, alcohol, depression, and other behavioral health domains, consist of no more than three items for each domain. The end result of the prevailing paradigm of suicide risk research is that we are no closer to having a validated, practical screening and assessment approach across most settings, and suicidal individuals continue to be undetected by "front-line" personnel, such as physicians, nurses, teachers, counselors, and detention facility staff.

For example, studies across a range of settings, from schools to emergency departments (EDs) to primary care, indicate that suicide risk screening is simply not being done in any systematic, universal fashion.[3] In addition, because there is a dearth of published, validated screeners, it is likely that suicide screening, when it does occur, is performed in an idiosyncratic, non-standardized manner using questions with unproven reliability or validity.

We propose a new paradigm to guide suicide risk screening and assessment research across diverse settings and populations. Namely, screening and assessment approaches should be selected or designed with dissemination in mind. This means that the screener and assessment should be selected or developed from the ground floor to be tailored to the individual needs of the setting or population with which they are to be used. This shift parallels the work of others who have emphasized that target population characteristics, provider characteristics, and setting demands are important when designing and deploying interventions.[7]

Researchers should actively consider key design parameters inherent to each setting and population at every step of development, from item construction to prospective validation to studying translation into routine use. This paradigm shift should help the field to break out of answering the question "Does instrument 'A' predict suicide attempts at some point in the future?" and reconnect with complex, real-world decision making that is more nuanced than this bivariate perspective.

The goals of standardizing the screening process and developing screening approaches with ecological validity may appear at odds with one another; however, both goals are achievable. Once an ecologically valid approach is developed and validated for a given setting, it can be translated to individual locations where it becomes a standardized protocol. This translation may require local adaptations aimed at improving standardization of the process by addressing local barriers.

This entire translation cycle of developing approaches that are ecologically valid, adapting them to standardized local protocols, and studying the impact of these adaptations can inform recommendations for blending standardization and adaptation at the local level. Below, we review three specific recommendations that will help to operationalize this paradigm shift and guide future research endeavors.

Recommendations

The parameters related to each individual setting, including the logistics, scope of practice, infrastructure, and decision making required, should be identified and used to choose or design screening and assessment instruments that have a good fit. The ultimate purpose of screening for and assessing suicide risk in any setting is to detect when people are at any non-zero risk and then gauge the degree of risk present to guide decision making; however, settings differ dramatically in the kinds of decisions that must be guided by this process, the resources available to manage positive screens, and the protocols that must be followed. Researchers need to carefully consider these factors when designing suicide risk instruments for each setting.

As mentioned earlier, screening and assessment are not the same, and the instruments and protocols employed should be considered as separate but interrelated processes. To use an analogy from the depression literature, the Patient Health Questionnaire (PHQ)-2,[8] a two-item screener for depression, has a weak 38% positive predictive value for diagnosing major depressive disorder; nevertheless, it remains one of the most widely used quick screening instruments for depression in medical settings because it is useful for identifying when further action, such as additional assessment, is warranted.

As introduced earlier, a very important consideration is the risk timeline most pertinent to the setting under consideration. Although it is optimal from a public health perspective to detect and manage lifetime risk, many settings will be focused on detecting and managing imminent or short-term risk. For example, the primary care setting is generally focused on long-term care; the screener and assessment in this setting should not only identify those at imminent risk who need urgent intervention, such as transport to an ED, but also identify those at long-term risk who need more chronic interventions, such as continued monitoring, more frequent visits, and psychotropic medication.

Critical features of the screening and assessment measures will be impacted by such a tailored risk horizon approach, including the nature of the questions asked, the length of the screening or assessment, who is responsible for the screening and assessment, how often the questions are asked, and the kinds of actions that will be taken if the individual screens positive.

Each setting and population will have practical logistics that are important in determining good fit. Researchers should consider these early in the design process. Instruments should be designed for the setting instead of expecting the setting to adapt to the instrument. For example, in many medical settings, providers have limited time to interact with an individual patient and do not have "props" like paper-based forms to help them remember the questions. Consequently, the questions used for primary suicide risk screening in these settings will have to be simple, quickly administered, easily memorized, and use a yes/no response format if they are to be applied with fidelity.

In addition, some frontline personnel may be reluctant to screen for suicide risk because they are uncertain of how to handle positive screens. This "Pandora's box" phenomenon is exacerbated by the lack of evidence-based interventions readily available for most settings that do not specialize in mental health treatment. This reluctance can be minimized by establishing clear protocols for further assessing and managing suicide risk for the specific setting, making sure all staff members are trained, and providing supports or props to help navigate the next actions to take once actionable suicide risk is detected.

Recently, researchers have decried the lack of suicide risk instrument validation across settings and populations.[9,10] Newly designed instruments will need to be rigorously validated. The shift in focus on aligning screening and assessment with decision making appropriate for the setting has important implications for the validation process. When establishing the operating characteristics of an instrument, the criterion reference against which a screener will be validated should be different from the reference against which a full risk assessment is validated.

More specifically, the criterion reference for screening does not need to be suicidal behavior; rather, it can be clinical judgment that actionable risk is present, that is, enough risk is present that some minimal clinical action is necessary, such as additional assessment or referral to mental health care. In contrast, the criterion reference for the risk assessment should be suicidal behavior or other

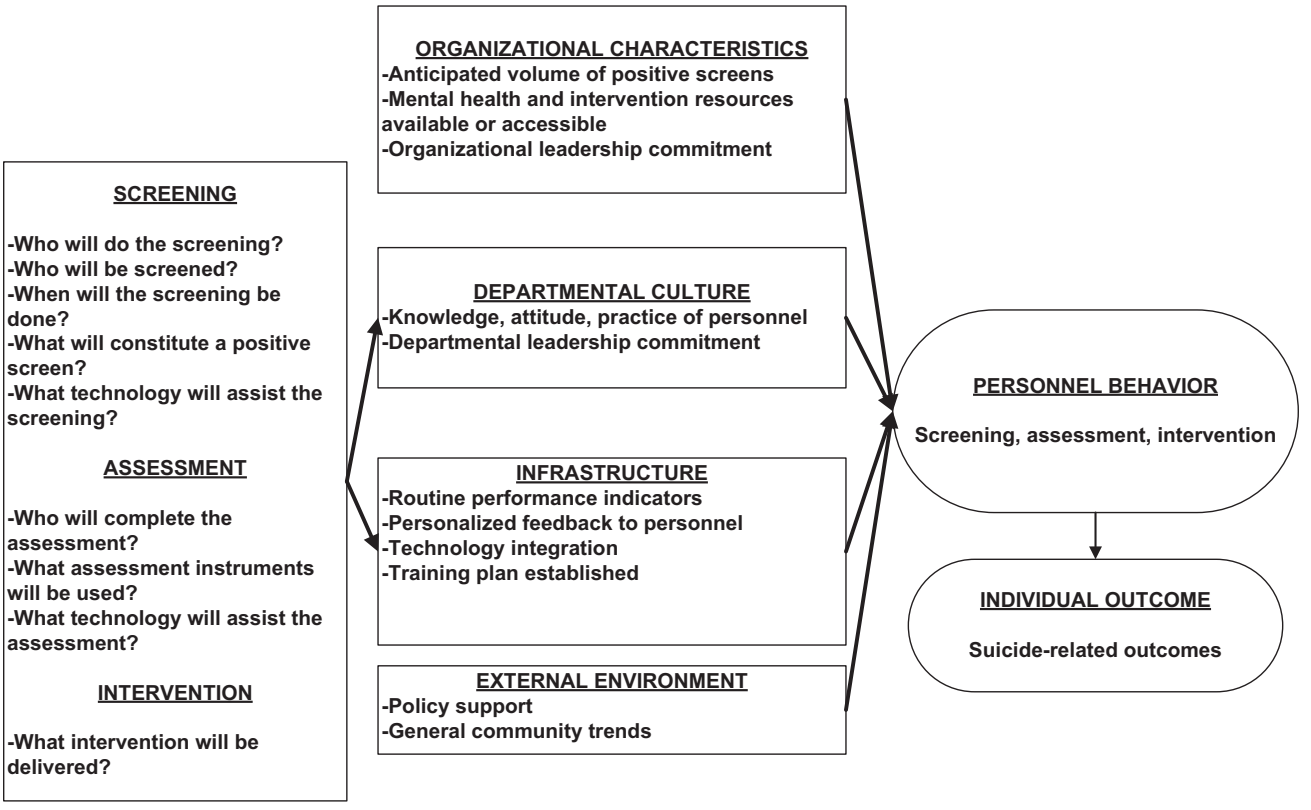

Figure 1. PRISM model template for screening, assessment, and intervention
PRISM, Practical, Robust Implementation and Sustainability Model

important outcomes, such as all-cause death, inpatient admissions, ED visits, or clinical worsening.

To the greatest extent feasible, technology should be used to support screening and assessment. Technology is rapidly revolutionizing health care, and it could be used to help foster the implementation of suicide screening and assessment. Current efforts to design and study instruments should consider the downstream changes that will enable screening and assessment strategies that are simply infeasible now to be disseminated once the technology becomes more readily available. Below, we briefly review several avenues in which technology has the ability to improve suicide risk screening and assessment, and should be the focus of future studies.

EHRs have been publicized as an important tool in improving screening, patient safety, and adherence to clinical guidelines. The existing literature on whether EHRs can accomplish these goals is admittedly mixed; however, the field remains in its early development. We have just begun to establish principles for effective use of EHRs to improve care and establish methods for studying their short- and long-term impacts.

EHRs can be programmed to prompt suicide risk screening, provide guidance for further risk assessment, and facilitate clinical interventions such as discharging patients with outpatient suicide prevention resources. Also, EHRs can be designed to "pre-screen" and alert providers when particularly high-risk individuals are seen, like those with a documented psychiatric disorder or a history of past attempts.

For example, an automated system has recently been developed to predict the development of post-traumatic stress disorder (PTSD) among hospitalized injury survivors using a ten-item algorithm embedded in an EHR.[11] The screener included items reflecting a variety of ICD-9 psychiatric diagnoses, clinical factors such as positive blood alcohol screening, and demographics, and it achieved a sensitivity of 0.71 and specificity of 0.66.

As described previously, the NIH's Patient Reported Outcomes expert panel has made recommendations on a battery of screeners assessing behavioral and mental health outcomes to be integrated into EHRs.[6] Suicide was not included in this because of the lack of evidence-based screeners; however, should such screeners be validated, they could be added to this battery. In addition to helping improve patient care, this would promote standardization in assessment and improve our ability to harmonize data on suicide from diverse healthcare settings.

Patient-facing computing, or readily accessible computer hardware, is not currently commonplace in most

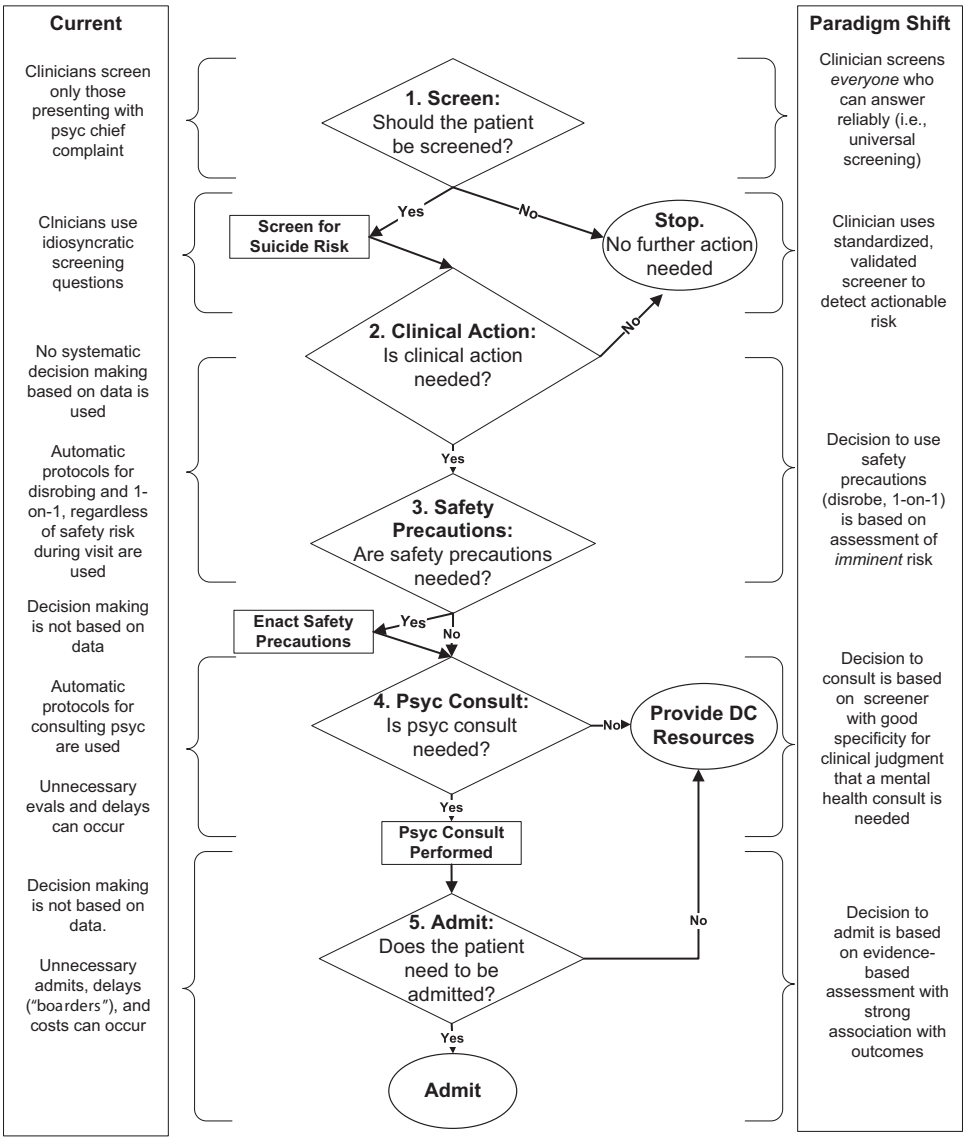

Figure 2. Clinical decision making and suicide risk in the emergency department
DC, Discharge; Psyc, Psychiatry

medical settings, but it is gaining traction. As technology transforms all settings, the probability that medical settings will increase patient-facing computing is highly likely. Computerizing screening and assessment for suicide risk may improve standardization, efficiency, reliability, and validity. In particular, computer adaptive testing and modern psychometric approaches can lead to greater accuracy with the fewest questions necessary, thus maximizing efficiency of both screening and assessment.

Finally, the field of mobile health, in which patients can provide clinical information and receive interventions through mobile phone platforms, is rapidly expanding. This technology may allow for the monitoring of suicidal ideation in an ongoing, longitudinal fashion, rather than simply at discrete points of contact with a healthcare provider. This may be particularly useful for patients in behavioral health settings, those at particularly high risk, and adolescents and young adults who have readily adopted these technologies.

Researchers should study the best methods for translating validated instruments into routine clinical practice. Although following the first two recommendations should help researchers to build validated instruments with a good fit for the setting, it is critical to study how to best translate them in routine practice. Fidelity, or the degree to which an individual adheres to the risk screening and assessment protocols, can be quite different when comparing routine integration into real-world settings against highly standardized research protocols. Consequently, implementation studies are needed to examine the optimal methods for translating these

Patient Safety Screener-5[14] (adults)
Introductory script (sample; modify to fit setting): Now I'm going to ask you some questions that we ask everyone. It is part of our policy and it helps us to make sure we are not missing anything important.
Over the past 2 weeks . . .
1. . . . have you felt down, depressed, or hopeless? ☐ Yes ☐ No
2. . . . have you felt little interest or pleasure in doing things? ☐ Yes ☐ No
3. . . . have you wished you were dead or wished you could go to sleep and not wake up? ☐ Yes ☐ No
4. . . . have you had thoughts of killing yourself? ☐ Yes ☐ No
In your lifetime. . .
5. . . . have you ever attempted to kill yourself? ☐ Yes ☐ No
6. . . . When did this happen? ☐ Today ☐ Within the last 30 days (but not today) ☐ Between 1 and 6 months ago ☐ More than 6 months ago
*Positive screen: yes on #4 or #5.
Ask Suicide-Screening Questionnaire (ASQ)[15] (children)
1. In the past few weeks, have you wished you were dead? ☐ Yes ☐ No ☐ No response
2. In the past few weeks, have you felt that you or your family would be better off if you were dead? ☐ Yes ☐ No ☐ No response
3. In the past week, have you been having thoughts about killing yourself? ☐ Yes ☐ No ☐ No response
4. Have you ever tried to kill yourself? ☐ Yes ☐ No ☐ No response
5. If yes, how? When?
* Positive screen: a positive response to questions 1, 2, 3, or 4.

Figure 3. Examples of frontline screeners

instruments into regular community use in a manner that maintains strong fidelity.

There are many implementation science theories to help guide these examinations.[12] A recent model that has been proposed is the Practical, Robust Implementation and Sustainability Model (PRISM).[13] It integrates several implementation science theories to more fully address the components and shareholders involved in program implementation. The model has four major domains: the intervention or program of focus; the recipients of the intervention or program (usually organizations, clinicians or frontline staff, and patients or students); related infrastructure; and the external environment. Figure 1 depicts a generic PRISM model applied to suicide risk screening, assessment, and intervention.

Illustrative Example: the Emergency Department

In this section, the ED setting is used to illustrate how the paradigm shift and associated recommendations can be put into action. In this setting, a screener should foster the early clinical decisions outlined in Figure 2 that center around detecting and managing imminent risk. A good ED screener should (1) detect when clinically actionable risk is present; (2) identify when an individual requires immediate safety precautions; and (3) identify when a mental health consult is required. Following screening, the risk assessment completed by a mental health professional should then guide the decision to admit the patient to the hospital or provide other services. In this manner, the screening and assessment work hand in hand with clearly defined goals keyed to the decision making each is designed to support.

Instruments such as the BSSI are too complicated or detailed to use as primary screeners without props, so they would be inappropriate for most ED settings. However, other efforts have been closer to the mark, like the Patient Safety Screener–5[14] for adults and the Ask Suicide-Screening Questions[15] for youth, which were developed specifically for use in the ED setting and optimized to be as brief and simple as possible (Figure 3).

The screening process in the ED setting could be enhanced through the use of computerized screeners. Most EDs do not currently have the capacity for patient-facing technology, such as a touch-screen computer that can be used in the treatment area and complies with infection control standards. However, considering the growing technologic revolution that is overcoming health care, it will likely happen within the next 10–20 years, and one can imagine having patients complete computerized assessments while they wait for care. In such an application, safeguards would have to be initiated to ensure patient safety and that patients who screen positive for suicide on the computerized assessment are not accidentally discharged without further evaluation.

Conclusions

The road forward for research on screening and assessing suicide risk within diverse settings will need to navigate a path between two important considerations that are often at odds with one another: The field has to build an evidence base to support clinical decision making based on suicide risk screening and assessments, while developing a better understanding of the practical considerations that influence clinical practice (i.e., feasibility). For research to progress, we must promote the creation and adoption of an evidence-based risk assessment practice with adequate considerations to practical implications important to clinicians, patients, families, and healthcare administrators.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
2. Jacobs DG, Baldessarini RJ, Conwell Y, et al. Practice guideline for the assessment and treatment of patients with suicidal behaviors. psychiatryonline.org/content.aspx?bookid=28&sectionid=1673332.
3. Horowitz L, Ballard E, Paoa M. Suicide screening in schools, primary care and emergency departments. Curr Opin Pediatr 2009;21(5):62–7.
4. Substance Abuse and Mental Health Services Administration. Preventing suicide: a toolkit for high schools. Rockville MD: Center for Mental Health Services, Substance Abuse and Mental Health Services Administration, 2012. HHS Publication No. SMA-12-4669.
5. Beck AT, Steer RA. Manual for the Beck Scale for Suicide Ideation. San Antonio TX: Pearson, 1991.
6. Glasgow RE, Kaplan RM, Ockene JK, Fisher EB, Emmons KM. Patient-reported measures of psychosocial issues and health behavior should be added to electronic health records. Health Aff 2012;31(3):497–504.
7. Schoenwald SK, Hoagwood K. Effectiveness, transportability, and dissemination of interventions: what matters when? Psychiatr Serv 2001;52(9):1190–7.
8. Kroenke K, Spitzer RL, Williams JB. The Patient Health Questionnaire–2: validity of a two-item depression screener. Med Care 2003;41(11):1284–92.
9. Haney EM, O'Neil ME, Carson S, et al. Suicide risk factors and risk assessment tools: a systematic review. VA-ESP Project #05-255. Portland OR: Veterans Health Administration, Department of Veterans Affairs, 2012.
10. National Institute for Health and Clinical Excellence. Self harm: longer term management. NICE clinical guideline—CG133. London. National Institute for Health and Clinical Excellence, 2011.
11. Russo J, Katon W, Zatzick D. The development of a population-based automated screening procedure for PTSD in acutely injured hospitalized trauma survivors. Gen Hosp Psychiatry 2013;35(5):485–91.
12. Tabak RG, Khoong EC, Chambers DA, Brownson RC. Bridging research and practice: models for dissemination and implementation research. Am J Prev Med 2012;43(3):337–50.
13. Feldstein AC, Glasgow RE. A practical, robust implementation and sustainability model (PRISM) for integrating research findings into practice. Jt Comm J Qual Patient Saf 2008;34(4):228–43.
14. Allen MH, Abar BW, McCormick M, et al. Screening for suicidal ideation and attempts among emergency department medical patients: instrument and results from the Psychiatric Emergency Research Collaboration (PERC-02). Suicide Life Threat Behav 2013;43(3):313–23.
15. Horowitz LM, Bridge JA, Teach SJ, et al. Ask Suicide-Screening Questions (ASQ): A brief instrument for the pediatric emergency department. Arch Pediatr Adolesc Med 2012;166(12):1170–6.

Screening Youth for Suicide Risk in Medical Settings

Time to Ask Questions

Lisa M. Horowitz, PhD, MPH, Jeffrey A. Bridge, PhD, Maryland Pao, MD, Edwin D. Boudreaux, PhD

This paper focuses on the National Action Alliance for Suicide Prevention's Research Prioritization Task Force's Aspirational Goal 2 (screening for suicide risk) as it pertains specifically to children, adolescents, and young adults. Two assumptions are forwarded: (1) strategies for screening youth for suicide risk need to be tailored developmentally; and (2) we must use instruments that were created and tested specifically for suicide risk detection and developed specifically for youth. Recommendations for shifting the current paradigm include universal suicide screening for youth in medical settings with validated instruments.

(Am J Prev Med 2014;47(3S2):S170–S175) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

Suicide remains a leading cause of death for youth worldwide.[1] Screening for risk of suicide and suicidal behavior is an important and necessary first step toward suicide prevention in young people. Implementing effective screening programs involves targeting high-risk populations in favorable settings.[2] Medical settings have been designated as key venues to screen for suicide risk and are therefore the focus of this article.

The National Action Alliance for Suicide Prevention (Action Alliance) developed 12 Aspirational Goals as a way of structuring a suicide prevention research agenda aimed at decreasing suicides in the U.S. by 40% over the next decade. Aspirational Goal 2 pertains to screening for suicide risk: "to determine the degree of suicide risk among individuals in diverse populations and in diverse settings through feasible and effective screening and assessment approaches."[3]

As an adjunct to a separate article in this supplement that proposes a paradigm shift for suicide screening instrument development and research aligned with this Aspirational Goal,[4] this paper focuses on suicide screening as it pertains specifically to children, adolescents, and young adults. The aims of this paper are to describe how youth suicide prevention strategies need to be considered independently of adult suicide prevention strategies, underscore the need for universal screening with validated suicide screening instruments for youths in all medical settings, and describe paradigm shifts that would need to occur to achieve reductions in youth suicide/suicidal behavior.

From the Intramural Research Program (Horowitz, Pao), National Institute of Mental Health, NIH, Bethesda, Maryland; Center for Innovation in Pediatric Practice (Bridge), The Research Institute at Nationwide Children's Hospital and The Ohio State University College of Medicine, Columbus, Ohio; and the Department of Emergency Medicine, Department of Psychiatry, and Department of Quantitative Health Sciences (Boudreaux), University of Massachusetts Medical School, Worcester, Massachusetts

Address correspondence to: Lisa M. Horowitz, PhD, MPH, National Institute of Mental Health, Clinical Research Center, Building 10, Room 6-5362, Bethesda MD 20892. E-mail: horowitzl@mail.nih.gov.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.002

Assumptions of Screening for Suicide Risk

Assumption 1: Strategies for Screening Youth for Suicide Risk Need to be Tailored Developmentally

In the field of pediatrics, there is a well-known maxim: "Children are not just small adults." This tenet is applicable to suicide prevention strategies. As with many types of public health threats, a one-size-fits-all approach will not be effective. Suicide risk changes at each developmental stage of a young person's life, increasing with age throughout adolescence and early adulthood.[5] Although death by suicide does occur in children under 12 years,[6] suicide and suicidal behavior are rare prior to puberty, in part because mood disorders, for example, are less common in younger children. Risk of suicide increases in the late teen years, coinciding with increased risk of mood disorder onset. Nevertheless, half of all mental illness onset begins in childhood, making it a critical period of time to intervene.[7]

Developmental trajectories are the main characteristics that set children apart from adults (Figure 1), considering factors such as variable physical growth; differences in cognition (ability to think abstractly); language (ability to communicate needs); and social competence (ability to make friends). These streams of development are all happening at different times and rates in children and adolescents. Converging upon these trajectories are critical risk factors such as mental illness, family history of mental illness, and history of suicidal ideation or behavior. In addition, other psychiatric comorbid conditions, such as substance abuse, may help promote the transition from suicidal ideation to behavior.

Some psychological traits can increase risk, such as impulsive aggression in which a child may have a tendency to react aggressively to frustrating situations or have other maladaptive coping strategies. Environmental factors such as psychosocial stressors, poverty, and "non-intact" families may contribute to hopelessness. Many youth have acute stressors that include interpersonal conflict, loss, and problems with school.[8] These factors can all increase a young person's risk for suicide. Ideally, protective factors such as strong relationships with adults, academic success, or religious beliefs can modify these risk factors and reduce risk for suicidal behaviors—but even these are not always sufficiently protective.

According to the most recent CDC data, 15.8% of all high school students in the U.S. have seriously considered suicide.[9] Some existential questioning is expected in adolescence; however, when these thoughts become more frequent or expand into plans to end one's life, they become clinically significant. Manifestations along the continuum of suicide, from thoughts to behavior, are important because they can all be predictive of death by suicide. The hope is that screening and early detection can have an impact and thwart the progression from ideation to behavior.

Another important difference when evaluating and treating youth as compared to adults is that most youth are accompanied by parents or guardians when they visit a medical setting. This has implications for the first assumption noted above, as these adult caregivers can provide useful collateral information that assists with suicide risk assessment. In addition, having a parent/guardian aware of elevated suicide risk in their child affords them the opportunity to help with means restriction and other important safeguards that can aid in prevention of suicide. Currently, however, there is no empirical evidence about whether including parental questions in a suicide screening tool is more effective than only screening the child, nor are there clinical guidelines for how to proceed if parents and youth disagree in their answers.

Assumption 2: We Must Use Instruments that Were Developed and Tested Specifically for Suicide Risk Detection and Developed Specifically for Youth

This section emphasizes the importance of using instruments that have been validated to detect the condition of interest—suicide risk in youth. Sometimes, suicide risk detection strategies are created for the general public and are then utilized for children and adolescents, even if

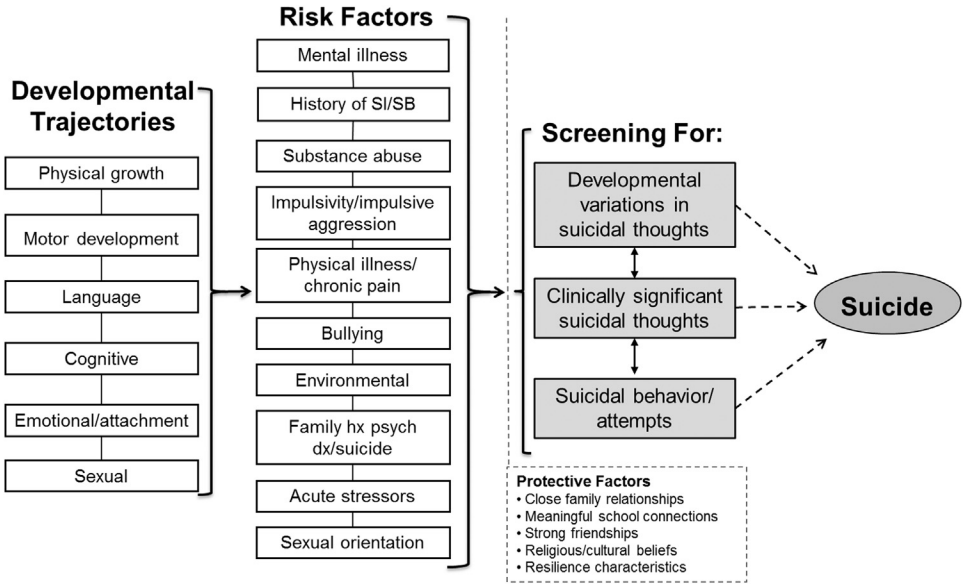

Figure 1. Developmental considerations in youth suicide
SI, suicidal ideation; SB, suicidal behavior; hx, history of; dx, diagnosis

age-specific validity has not been proven. Given all the variables mentioned above, adult instruments may not always be appropriate for screening youth for suicide risk.

The current paradigm is that screening occurs in a non-standardized manner with patients who appear at high risk to non–mental health clinicians, who may or may not be knowledgeable about the risk factors. Screening items and suicide screening practices differ across and within hospitals depending on knowledge and training of staff, which varies greatly. The current national practice for suicide screening in most hospitals has not been assessed. For example, when the Joint Commission issued Patient Safety Goal 15A in 2007 requiring all behavioral health patients to be screened for suicide,[10] nurses were asked to screen patients, but were not given validated instruments for making such inquiries. This would be akin to asking a nurse to guess a patient's body temperature without giving them a thermometer.

Nurses reported a wide range of screening questions, from indirect questions such as *Are you safe?* and *How will I know when you're angry?* to very specific questions such as *Have you had any thoughts of wanting to harm yourself or others?* (L. Horowitz, National Institute of Mental Health, and J. Bridge, The Research Institute at Nationwide Children's Hospital and The Ohio State University College of Medicine, personal communication, 2013). A national survey on what is being asked and how to standardize the questions would be useful.

A proposed paradigm shift is to implement validated tools and training staff to use clinical practice guidelines developed for managing positive screens safely. Screening would not be limited to patients with a known psychiatric history; rather, it would occur universally in certain settings. However, specific guidelines will need to be established for setting up screening parameters for who should administer the screening instrument, when during the visit the patient should be screened, and, most importantly, how positive screens will be managed.

If universal screening is to be implemented, the initial screening tool will have to be brief, highly sensitive, highly specific, and validated on the targeted population for the condition under evaluation. Several measures have been used to screen patients for suicide risk in various medical settings: for specific use in the pediatric emergency department (ED) population, the Risk of Suicide Questionnaire (RSQ)[11] and the Ask Suicide-Screening Questions (ASQ);[12] and in primary care (PC) clinics, the Behavioral Health Screen (BHS),[13] the Columbia Suicide Severity Rating Scale (CSSRS),[14] and others.[2,15] Validation studies should test for sensitivity, specificity and negative and positive predictive values. Prospective predictive validity of completed suicide and suicidal behavior has yet to be established on the tools mentioned above, and is greatly needed.

Because depression and suicide are frequently linked, clinicians often use depression screens as suicide risk detection instruments. Yet, depression screens are not necessarily designed to be sensitive or specific enough instruments for recognizing suicidal thoughts and behaviors, especially in medical patients.[16]

A widely used valid and reliable depression screening instrument, the Patient Health Questionnaire (PHQ-9),[17] provides an illustrative example. The ninth item on the PHQ-9 asks the patient how often he or she is *bothered by the thought that you would be better off dead, or of hurting yourself in some way* and is widely used clinically and in research studies to screen for suicide risk. This item simultaneously and indistinguishably measures both passive thoughts of death and suicide ideation, both symptoms of depression. Because the question contains an "or," it has been found to be overly sensitive in that it detects patients who have passive thoughts of death or thoughts of hurting themselves.

In patients with serious medical illnesses, thoughts of death are common and may be categorically unrelated to suicide. Recent studies examining the use of Item 9 to assess for suicide risk in medically ill patients suggest that this question provides ambiguous, non-specific, and difficult-to-interpret information that may overburden already strained mental health resources.[18] In addition, inquiring about hurting and killing oneself, especially for adolescents, may identify two different problems. In settings where mental health resources are limited, asking youth as directly as possible about suicide may be critical for more accurate detection.

Recommendations

The public health import of utilizing universal screening in medical settings as a way to identify youth at risk for suicide and suicidal behavior is immense. Screening positive on validated instruments may not only be predictive of future suicidal behavior but also be a proxy for other serious mental health concerns that require further mental health attention and follow-up. For example, it may not be feasible to screen for every sociobehavioral risk factor in a busy ED setting.

However, once a young person screens positive for suicide risk and receives a mental health evaluation, they can be further assessed for serious mental illness, substance abuse, homicidal ideation, and history of physical and sexual abuse. The proposed paradigm shift is that an effective suicide screening instrument not only will detect imminent risk but can also identify youth with significant emotional distress warranting further mental health

attention, which if otherwise ignored can lead to serious personal and societal consequences (e.g., school absenteeism, antisocial behavior, school dropout, and increased use of healthcare services).

Any setting in which a healthcare provider delivers medical care, such as PC clinics, EDs, inpatient medical units, and school-based clinics, may be ideal venues to identify youth at elevated risk. More than 80% of youths visit their PC doctor each year, making the PC clinic well situated to identify young people at risk. Wintersteen[19] showed that there was a 4-fold increase in detection of suicidal ideation by pediatricians when screening tools were used in outpatient clinics (base rate=0.8%, screening tools=3.6%). The study, however, emphasized that these data translated into one additional youth per week requiring further mental health follow-up, which did not overwhelm the pediatric care clinics.

Similar results have been found in pediatric emergency care settings. For those who are not connected to a PC clinic, estimated to be about 1.5 million youth, the ED is their sole contact with the healthcare system,[20] creating not only an opportunity but a responsibility to screen for suicide risk. A recent Canadian study revealed that 80% of youth who died by suicide visited a PC provider, an ED, or had an inpatient medical hospitalization within 3 months prior to their death.[21] The obvious clinical challenge is that these individuals do not walk into their doctor's office and say, "I want to kill myself"; rather, they frequently present with somatic complaints (e.g., headaches, stomachaches), and may not talk about their suicidal thoughts unless asked directly.

Pediatric ED studies show that screening for suicide risk can reveal previously undetected thoughts of suicide in youth presenting with medical/surgical chief complaints.[18] Moreover, screening was found to be acceptable to clinicians, parents, and youth and was found to be non-disruptive to ED workflow. Several studies reveal that young patients embrace the notion of being screened for suicide risk in medical settings.[22,a]

Larkin and Beautrais[23] describe the ED as an important nexus for suicide-related endophenotypes (e.g., alcohol and substance abuse, pain syndromes, medical comorbidities). These high-risk groups include young people who may be disenfranchised, may have dropped out of school, are not employed, or are in the foster care system. These young people are often isolated and do not have a connection with someone who can recognize that they need help. An ED visit can provide this opportunity.

A major barrier to screening for suicide risk is the concern about how to safely manage patients who screen positive. What does a positive screen on a validated instrument that was created to detect suicide risk actually mean? Screening positive means a patient has a symptom that requires further evaluation. To use a medical analogy, this is akin to a pediatric patient who is found to have high blood pressure during an ED visit. They are not immediately administered an anti-hypertensive medication; rather, a further assessment ensues to determine what is causing the high blood pressure and what may happen to the patient if the hypertension persists.

Screening positive on a suicide risk screen is similar; something is amiss and further evaluation is necessary. A patient who screens positive is in need of a psychiatric evaluation by a trained mental health professional who can examine related symptoms, judge risk of self-harm, and, if necessary, guide the primary physician in appropriate disposition decisions and link the patient with mental health treatment if needed. It does not necessarily mean a constant observer is necessary or that the child needs to be hospitalized on an inpatient psychiatric unit, although these are potential outcomes.

Not inquiring about suicide risk would be akin to not measuring blood pressure because the system did not want to find out the child had hypertension. In addition, taking into account developmental needs, a child-sized blood pressure cuff would be needed to measure blood pressure properly. The patient has the symptom whether or not a healthcare provider asks about it. But if we do not ask, chances are the patient will not tell us, and they may not get the help they need.

Important research pathways will include validating screening instruments with targeted populations in the specific healthcare settings in which they will be used. This effort would require conducting universal screening and developing clinical practice guidelines tailored for youth to manage positive screens safely and effectively in each setting, with long-term follow-up for youth who screen positive and negative to determine the validity and full impact of screening.

Critical stakeholders in the screening process will need to be identified, such as hospital administrators, whose commitment to implementing effective screening programs and providing mental health resources for positive screens will be essential. Importantly, we will need nurse and physician champions to help with changing clinical practice to include screening and reduce stigma associated with patients who screen positive. We will need to educate families about what positive screens imply, the need for mental health follow-up services for the patient, and guidance sessions for the parents.

Screening for suicide risk can become part of core performance improvement measures for hospitals and clinics by adding screening to hospital scorecards and Healthcare Effectiveness Data and Information Set

[a]Contact corresponding author for additional references.

(HEDIS) measures. Currently, more than 90% of American health insurance plans use HEDIS as a tool to measure performance on critical dimensions of healthcare delivery.[24] The current metrics include "adolescent well-visits" or "anti-depressant medication management," and "cervical cancer screening in adolescent females," but suicide screening is notably absent

Barriers to universal screening include strapped mental health resources and limited patient care time. Other roadblocks include myths of iatrogenic risk. Many, including healthcare providers, still believe that we may be putting ideas of suicide into a youth's mind if we ask them directly about suicide; however, there have been several studies that refute this myth.[25,a] Another barrier is the lack of mental health resources available in medical settings to manage positive screens, especially providers trained in child/adolescent mental health. Linkage rates to mental health providers have been low with people who have screened positive, partly due to few resources, but also because the stigma of having mental health concerns still plagues patients and prevents them from initiating conversations about their mental suffering and seeking help.

Opponents of universal screening may argue that suicide is a low–base rate event, especially in young people, so we cannot develop instruments that accurately predict suicide. Although it is true that we do not currently have tools that predict which youths will kill themselves, we do have tools that can detect suicidal ideation, which should not be minimized in young people. Nock et al.[26] found that approximately one third of youth with suicidal ideation go on to develop a suicide plan in adolescence, and about 60% of those with a plan will attempt suicide. The hope is that intervening early, during ideation, will lead to prevention.

Conclusions

Youth suicide prevention strategies will need to be designed with developmental considerations in mind. It is time for all youth in medical settings to be screened for suicide risk, just as they are routinely screened for hypertension, fever, and falls risk. We cannot rely solely on depression screens or non-validated instruments to identify young people at risk for suicide. We as researchers need to create and test developmentally sound tools for healthcare providers to use.

Demonstration projects in pediatric medical settings with these instruments will highlight strengths and uncover future challenges to overcome. Importantly, screening can only take us so far. We must turn our research efforts toward developing more effective interventions. Lastly, we must hold ourselves, as clinicians and researchers, accountable for lowering the youth suicide rate within the next decade. Every healthcare provider can have an impact.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

Dr. Boudreaux receives consulting payment and owns stock options in Polaris Health Directions, a private company that creates and markets mental health assessment and intervention software. This paper does not endorse any specific programs or products that Dr. Boudreaux has developed.

No financial disclosures were reported by the other authors of this paper.

References

1. Bridge JA, Goldstein TR, Brent DA. Adolescent suicide and suicidal behavior. J Child Psychol Psychiatry 2006;47(3–4):372–94.
2. Peña JB, Caine ED. Screening as an approach for adolescent suicide prevention. Suicide Life Threat Behav 2006;36(6):614–36.
3. Pearson J, Claassen C, Booth CL. Introduction to the Suicide Prevention Research Prioritization Task Force special supplement: the topic experts. Am J Prev Med 2014;47(3S2):S102–S105.
4. Boudreaux ED, Horowitz L. Suicide risk screening and assessment: designing instruments with dissemination in mind. Am J Prev Med 2014.
5. Gould MS, Greenberg T, Velting DM, Shaffer D. Youth suicide risk and preventive interventions: a review of the past 10 years. J Am Acad Child Adolesc Psychiatry 2003;42(4):386–405.
6. Tishler CL, Reiss NS, Rhodes AR. Suicidal behavior in children younger than twelve: a diagnostic challenge for emergency department personnel. Acad Emerg Med 2007;14(9):810–8.
7. Kessler RC, Berglund P, Demler O, et al. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005;62(6):593.
8. Karch DL, Logan J, McDaniel DD, Floyd CF, Vagi KJ. Precipitating circumstances of suicide among youth aged 10–17 years by sex: data from the national violent death reporting system, 16 states, 2005–2008. J Adolesc Health 2013;53(1S):S51–S53.
9. CDC National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). cdc.gov/injury/wisqars/index.html.
10. Joint Commission on Accreditation of Healthcare Organizations Patient Suicide: complying with National Patient Safety Goal 15A. Jt Comm Perspect Patient Safety 2008;8:7–8, 11.
11. Horowitz LM, Wang PS, Koocher GP, et al. Detecting suicide risk in a pediatric emergency department: development of a brief screening tool. Pediatrics 2001;107(5):1133–7.
12. Horowitz LM, Bridge JA, Teach SJ, et al. Ask Suicide-Screening Questions (ASQ): a brief instrument for the pediatric emergency department. Arch Pediatr Adolesc Med 2012;166(12):1170–6.
13. Diamond G, Levy S, Bevans KB, et al. Development, validation, and utility of Internet-based, behavioral health screen for adolescents. Pediatrics 2010;126(1):163–70.
14. Posner K, Brown GK, Stanley B, et al. The Columbia-Suicide Severity Rating Scale: initial validity and internal consistency findings from

three multisite studies with adolescents and adults. Am J Psychiatry 2011;168(12):1266–77.
15. Goldston D. Assessment of suicidal behaviors and risk among children and adolescents. Bethesda MD: National Institute of Mental Health, 2000. Contract No. 263-MD-909995.
16. Recklitis CJ, Lockwood RA, Rothwell MA, Diller LR. Suicidal ideation and attempts in adult survivors of childhood cancer. J Clin Oncol 2006;24(24):3852–7.
17. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 2001;16(9):606–13.
18. Walker J, Hansen CH, Hodges L, et al. Screening for suicidality in cancer patients using item 9 of the nine-item patient health questionnaire; does the item score predict who requires further assessment? Gen Hosp Psychiatry 2010;32(2):218–20.
19. Wintersteen MB. Standardized screening for suicidal adolescents in primary care. Pediatrics 2010;125(5):938–44.
20. Wilson KM, Klein JD. Adolescents who use the emergency department as their usual source of care. Arch Pediatr Adolesc Med 2000;154(4):361–5.
21. Rhodes AE, Khan S, Boyle MH, et al. Sex differences in suicides among children and youth: the potential impact of help-seeking behaviour. Can J Psychiatry 2013;58(5):274–82.
22. Ballard ED, Bosk A, Snyder D, et al. Patients' opinions about suicide screening in a pediatric emergency department. Pediatr Emerg Care 2012;28(1):34–8.
23. Larkin GL, Beautrais AL. Emergency departments are underutilized sites for suicide prevention. Crisis 2010;31(1):1–6.
24. Health Indicators Warehouse. Healthcare Effectiveness Data and Information Set (HEDIS). healthindicators.gov/Resources/DataSources/HEDIS_56/Profile.
25. Gould MS, Marrocco FA, Kleinman M, et al. Evaluating iatrogenic risk of youth suicide screening programs: a randomized controlled trial. JAMA 2005;293(13):1635–43.
26. Nock MK, Green JG, Hwang I, et al. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents results from the National Comorbidity Survey Replication Adolescent Supplement. JAMA Psychiatry 2013;70(3):300–10.

Improving the Short-Term Prediction of Suicidal Behavior

Catherine R. Glenn, PhD, Matthew K. Nock, PhD

Aspirational Goal 3 of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force is to predict who is at risk for attempting suicide in the near future. Despite decades of research devoted to the study of risk and protective factors for suicide and suicidal behavior, surprisingly little is known about the short-term prediction of these behaviors. In this paper, we propose several questions that, if answered, could improve the identification of short-term, or imminent, risk for suicidal behavior. First, what factors predict the transition from suicidal thoughts to attempts? Second, what factors are particularly strong predictors of making this transition over the next hours, days, or weeks? Third, what are the most important objective markers of short-term risk for suicidal behavior? And fourth, what method of combining information about risk and protective factors yields the best prediction? We propose that the next generation of research on the assessment and prediction of suicidal behavior should shift, from cross-sectional studies of bivariate risk and protective factors, to prospective studies aimed at identifying multivariate, short-term prediction indices, examining methods of synthesizing this information, and testing the ability to predict and prevent suicidal events.

(Am J Prev Med 2014;47(3S2):S176–S180) © 2014 Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

Suicide is a leading cause of death worldwide.[1–3] In order to ultimately prevent suicide, we need to be able to predict who is at greatest suicide risk so targeted interventions can be employed. Over the past few decades, impressive gains have been made in identifying lifetime, or long-term, risk and protective factors for suicide deaths and suicide attempts (i.e., nonfatal suicidal behavior).[4–9]

However, one of the most important jobs of clinicians is to determine who is at short-term, or imminent, risk for suicide. This decision is extremely difficult because alarmingly little is known about the short-term risk factors for suicide. Not surprisingly, Aspirational Goal 3 of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force is to improve prediction of short-term, or imminent, suicide risk.

The purpose of this paper is to highlight gaps in our knowledge about the short-term prediction of suicide and to suggest the types of breakthroughs needed to fill these gaps. Suicide death is challenging to study because it is a low base rate event. Nonfatal suicidal behavior (e.g., suicide attempt) is much more common, often leads to serious harm in itself, and is currently the most robust risk factor for suicide death.[5,8,10] Therefore, as a key first step we outline the research needed to improve the prediction of suicidal behavior, which, given its frequency, increases the statistical power of prediction studies.

What We Know

Most of what is known about the prediction of suicidal behavior comes from epidemiologic studies of lifetime and 12-month suicide ideation and attempts.

Approximately 9.2% of adults have seriously considered suicide, 3.1% have formulated a suicide plan, and 2.7% have attempted suicide in their lifetime.[6] In regard to 12-month prevalence, approximately 2% of adults report past-year suicide ideation, 0.6% report suicide plans, and 0.3% report a suicide attempt.[8]

Suicide ideation and attempts are relatively rare in childhood, but rates increase dramatically during adolescence and remain high throughout adulthood.[3,11] Of particular importance for short-term prediction, approximately one third of individuals with suicidal thoughts will transition to make a suicide plan, and one third of those with suicidal thoughts will make a suicide

From the Department of Psychology, Harvard University, Cambridge, Massachusetts

Address correspondence to: Catherine R. Glenn, PhD, Department of Psychology, Harvard University, William James Hall, 1280, 33 Kirkland Street, Cambridge MA 02138. E-mail: catherienglenn@fas.harvard.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.004

attempt in their lifetime.[6] More than 60% of individuals who progress from thinking about suicide to attempting suicide will do so within the first year after the onset of suicide ideation,[6,9,11] suggesting that the year after the first onset of suicide ideation is a particularly high-risk time. However, few variables have been identified that predict which individuals with suicide ideation go on to make a suicide attempt. Therefore, the field knows much less about who is likely to act on their suicidal thoughts, and, for those at risk, when they are likely to take suicidal action.

Moreover, very little research has focused on the persistence of suicide ideation and attempts. In one of the only studies to do so, Kessler and colleagues,[3] using the WHO World Mental Health (WMH) Surveys data, found that for most individuals with suicidal thoughts and behaviors (51% of suicide ideators, 59% of planners, and 70% of attempters), the behavior will not persist for more than 1 year. For the remaining percentage of individuals, however, suicidal thoughts and behaviors can be chronic and even lifelong.

A range of lifetime and 12-month risk factors for suicide ideation and attempts have been identified, including sociodemographic factors, stressful life events, family history of psychopathology, presence and accumulation of mental disorders, and past suicidal thoughts and behaviors.[2,5] However, there is still much to learn about how these factors confer risk for future suicidal behavior. For instance, although past suicidal behavior is one of the most robust risk factors for future suicidal behavior,[5,8,10] 60% of previous attempters will not make another suicide attempt in their lifetime,[3] and many people who die by suicide have no previous history of suicidal behavior.[12] Moreover, it is unclear whether these long-term variables hold any value for the short-term prediction of suicidal behavior. Time-invariant factors, like gender, clearly do not. In contrast, time-varying factors, such as the presence of multi-morbidity, may be predictive of short-term risk. However, we are unaware of any existing studies with this temporal resolution.

Breakthroughs Needed

Below, we present four key questions that highlight the gaps in our current knowledge of short-term predictors of suicidal behavior, and suggest breakthroughs needed to advance existing research.

1. What Factors Predict the Transition from Suicidal Thoughts to Attempts?

Although suicide ideation is a well-documented risk factor for suicidal behavior, the majority of those with suicidal thoughts do *not* go on to make a suicide plan or attempt. Therefore, it is vital to improve prediction of which individuals are likely to act on their suicidal thoughts. Unfortunately, most identified risk factors, such as major depression, predict suicide ideation but not attempts among those thinking about suicide.[3,13] Data from the WHO WMH Surveys indicate that whereas known risk factors account for 62.4% and 80.3% of the variance in predicting suicide ideation and attempts, respectively, these same risk factors account for only 7.1% of the variance predicting suicide attempts among ideators.[3]

Recent research has started to identify some risk factors that do differentiate suicide attempters from suicide ideators, including younger age; low income or unemployment; history of childhood adversities[8,10]; disorders characterized by agitation, impulsiveness, and aggression[8,13]; parental history of panic and antisocial behavior[8,14]; and history of sexual violence.[15] However, much more progress is needed in this direction.

2. What Factors Predict This Transition Over the Next Hours, Days, or Weeks?

Previously identified long-term risk factors have unknown abilities for predicting the transition from suicidal thoughts to actions over the short term, and research suggests there may be important differences between the risk conferred by short- and long-term variables. For instance, Fawcett et al.[16] found that hopelessness and suicide ideation predicted suicide over the longer term (2–10 years), whereas anxiety, insomnia, and anhedonia predicted suicide death over the next 12 months. Although long-term risk factors may indicate who is more likely to engage in suicidal behavior in their lifetime, distinct short-term risk factors are necessary for indicating when individuals are likely to act on their suicidal thoughts.[16,17] Research on short-term risk has been hampered by three key methodological limitations.

First, though the field generally agrees on the overall distinction between chronic and acute risk factors, there is no consensus definition for what constitutes short-term, or imminent, risk (i.e., subsequent hours, days, or weeks). Second, most studies measuring suicide risk factors use a long assessment window (i.e., lifetime or past year). Studies that have examined more short-term risk factors indicate that suicidal behavior is often closely preceded by acute substance use,[18] interpersonal negative life events,[17] and extreme anxiety, agitation, or other negative affective states.[12] However, because most previous studies used small, selective samples without a comparison group, it is unclear how these results will generalize to other populations, or how unique these risk factors are to suicide, as compared to psychiatric crises

more broadly. A third limitation is the reliance on retrospective self-reports, which, though a valuable source of information, can be limited by bias and unreliability (e.g., forgetting). What are needed now, in addition to such studies, are prospective examinations of short-term (i.e., over the next hours, days, and weeks) predictors of suicidal behavior.

3. What Are the Most Important Objective Markers of Short-Term Risk?

The current state of the art in acute suicide risk assessment is to ask individuals questions such as: *Do you have any plan or intent to kill yourself?* Research has therefore been limited by an almost exclusive reliance on self-reported likelihood of future engagement in suicidal behavior, which may be biased for a variety of reasons (e.g., motivation to conceal suicide plans and intentions).[12,19] Given the limitations of self-report methods, the field needs new and objective ways of measuring suicide risk (i.e., assessment not biased by opinion or interpretation).

Importantly, measures and tests that objectively assess suicide risk are currently being developed, including (1) behavioral measures of implicit suicidal cognition[20]; (2) neurocognitive measures of difficulties in attention, working memory, and executive functioning[21]; and (3) biological tests of dysfunction in the serotonergic system and hypothalamic–pituitary–adrenal axis.[4] Though promising, these tests are not currently used in practice to assess risk, and it is not yet clear if and how they might be combined with existing risk factors to improve the accuracy of resulting predictions.

4. What Method of Combining Information About Risk and Protective Factors Yields the Best Prediction?

There is currently no empirically supported method for incorporating these variables in a way that informs our determination of an individual's risk for future suicidal behavior (i.e., low, moderate, high, or imminent risk). In the absence of a tool for synthesizing this information, clinical judgment or intuition is currently used, rather than science, to combine details about risk factors—a problematic method given the superiority of actuarial over clinical methods for predicting human behavior.[22]

To address this gap, more research is needed to identify a set of risk factors that maximize prediction sensitivity (i.e., to accurately identify suicides) and specificity (i.e., to accurately identify non-suicides). The development of such prediction is complicated by the low base rate of suicide death.[23] It is unlikely that a single risk factor will effectively predict suicide with both high sensitivity and high specificity. Therefore, research needs to move from bivariate to multivariate prediction models examining combinations of multiple risk factors in the same large sample.

Notably, several recent studies have tested different methods of combining suicide risk factors with some initial success.[8,10,24] These risk indices included known sociodemographic and psychiatric risk factors and were able to accurately classify a substantial portion of individuals (areas under the curve [AUCs] ranged from .74 to .88). This means that a randomly selected suicide attempter could be distinguished from a randomly selected suicide ideator with 74%–88% accuracy.[8,10] Of note, risk indices were moderated by factors such as attempt planning, suggesting that risk factors may vary among suicidal subgroups. Although promising, these risk indices included lifetime and 12-month risk factors, which provide less information about short-term risk, and are not currently used in naturalistic settings. Future research is needed that incorporates short-term factors into these risk indices, examines how risk indices vary across subgroups, and translates these tools into a form that is easily accessible and interpretable in clinical practice.

Short-Term Research Objectives

Following directly from the limitations and needed breakthroughs described above, the suggested short-term research objectives are to identify (1) factors that predict the transition from ideation to attempts; (2) risk factors more closely temporally linked to engagement in suicidal behavior; (3) objective risk markers; and (4) scientifically informed methods for combining risk factors. There are many avenues to pursue in order to make these advances. We propose two possibilities for illustrative purposes below.

Large Representative Samples

For this line of research, it would be ideal to follow large, representative, and demographically diverse samples (i.e., $\geq$10,000 individuals, consistent with sample sizes used in national[9] and cross-national epidemiologic research)[3] over a number of years while assessing a large number of risk factors yearly, or more frequently (e.g., via email/smartphone). Data from these large-scale samples could be used to examine prospective predictors of the transition from suicide ideation to suicide attempts or completions (e.g., among those without a history of prior attempts), as well as to inform the development of risk indices and algorithms for predicting suicidal behavior, including moderators of multivariate risk index models.

Small High-Risk Samples

A second set of studies could more intensively monitor small samples (e.g., ≥ 100 individuals, consistent with studies using real-time monitoring techniques)[25,26] at high risk for suicide (e.g., previous suicide attempts) to identify acute risk factors more closely linked to suicidal behavior. High-risk studies could focus on frequent monitoring of state-related risk factors (e.g., agitation, suicide planning, recent negative life events) on a weekly, or ideally daily, basis using real-time monitoring.[26] This type of research could improve understanding of specific triggers for suicidal behavior and, moreover, could help identify acute risk factors that predict suicide attempts among ideators. In addition, small samples are ideal for testing the efficacy of existing objective tools, as well as developing novel objective measures.

Long-Term Research Objectives

The ultimate goal of this research is to use information about short-term risk to help prevent suicide. To this end, after short-term risk factors are identified, the first long-term objective is to develop tools for clinical practice that can more accurately identify who is at risk, as well as when and where they are at risk for engaging in suicidal behavior. It will be important for these tools to integrate information about known long-term and short-term risk factors, as well as both subjective and objective measures in a way that is useful in clinical settings. Ideally, these tools could be used to inform decisions about appropriate treatment (e.g., indicating when hospitalization is warranted).

A second long-term objective is to design intervention and prevention strategies that target and manipulate known risk factors to examine whether they are causally related to suicidal behavior and can ultimately help decrease the likelihood of future suicidal behavior. For example, studies using objective tools may suggest that interventions aimed at improving specific aspects of memory, attention, or executive functioning could help decrease suicide risk.

Conclusions

Although advances have been made in the long-term prediction of suicidal behavior, there are significant gaps in our knowledge about the short-term prediction of suicide risk. We suggest four key targets for future research that could help improve short-term prediction. Preliminary steps have been made in some of these areas, but a great deal of work is needed to more accurately predict these dangerous behaviors and ultimately help prevent suicide.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The research was supported, in part, by a grant from the National Institute of Mental Health (F32 MH097354) awarded to Catherine R. Glenn.

No financial disclosures were reported by the authors of this paper.

References

1. WHO. Prevention of suicide: guidelines for the formulation and implementation of national strategies. Geneva: WHO, 1996.
2. Nock MK, Borges G, Bromet EJ, Cha CB, Kessler RC, Lee S. Suicide and suicidal behavior. Epidemiol Rev 2008;30(1):133–54.
3. Nock MK, Borges G, Ono Y. Suicide: global perspectives from the WHO World Mental Health surveys. New York: Cambridge University Press, 2012.
4. Mann JJ, Currier D, Stanley B, Oquendo MA, Amsel LV, Ellis SP. Can biological tests assist prediction of suicide in mood disorders? Int J Neuropsychopharmacol 2006;9(4):465–74.
5. Joiner TE, Conwell Y, Fitzpatrick KK, et al. Four studies on how past and current suicidality relate even when "everything but the kitchen sink" is covaried. J Abnorm Psychol 2005;114(2):291–303.
6. Nock MK, Borges G, Bromet EJ, et al. Cross-national prevalence and risk factors for suicidal ideation, plans and attempts. Br J Psychiatry 2008;192(2):98–105.
7. Cassells C, Paterson B, Dowding D, Morrison R. Long- and short-term risk factors in the prediction of inpatient suicide: a review of the literature. Crisis 2005;26(2):53–63.
8. Borges G, Nock MK, Abad JM, et al. Twelve month prevalence of and risk factors for suicide attempts in the WHO World Mental Health surveys. J Clin Psychiatry 2010;71(12):1617–28.
9. Kessler RC, Borges G, Walters EE. Prevalence of and risk factors for lifetime suicide attempts in the National Comorbidity Survey. Arch Gen Psychiatry 1999;56(7):617–26.
10. Borges G, Angst J, Nock MK, Ruscio AM, Walters EE, Kessler RC. A risk index for 12-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;36(12):1747–57.
11. Nock MK, Green JG, Hwang I, et al. Prevalence, correlates and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent Supplement. JAMA Psychiatry 2013;70(3):300–10.
12. Busch KA, Fawcett J, Jacobs DG. Clinical correlates of inpatient suicide. J Clin Psychiatry 2003;64(1):14–9.
13. Nock MK, Hwang I, Sampson NA, Kessler RC. Mental disorders, comorbidity and suicidal behavior: results from the National Comorbidity Survey Replication. Mol Psychiatry 2010;15(8):868–76.
14. Gureje O, Oladeji B, Hwang I, et al. Parental psychopathology and the risk of suicidal behavior in their offspring: results from the World Mental Health surveys. Mol Psychiatry 2011;16(12):1221–33.
15. Stein DJ, Chiu WT, Hwang I, et al. Cross-national analysis of the associations between traumatic events and suicidal behavior: findings from the WHO World Mental Health surveys. PLoS One 2010;5(5):e10574.
16. Fawcett J, Scheftner WA, Fogg L, et al. Time-related predictors of suicide in major affective disorder. Am J Psychiatry 1990;147(9):1189–94.

17. Bagge CL, Glenn CR, Lee H-J. Quantifying the impact of recent negative life events on suicide attempts. J Abnorm Psychol 2013;122(2):359–68.
18. Chiles JA, Strosahl K, Cowden L, Graham R, Linehan M. The 24 hours before hospitalization: factors related to suicide attempting. Suicide Life Threat Behav 1986;16(3):335–42.
19. Qin P, Nordentoft M. Suicide risk in relation to psychiatric hospitalization. Arch Gen Psychiatry 2005;62(4):427–32.
20. Nock MK, Park JM, Finn CT, Deliberto TL, Dour HJ, Banaji MR. Measuring the suicidal mind: implicit cognition predicts suicidal behavior. Psychol Sci 2010;21(4):511–7.
21. Keilp JG, Gorlyn M, Russell M, et al. Neuropsychological function and suicidal behavior: attention control, memory and executive dysfunction in suicide attempt. Psychol Med 2013;43(3):539–51.
22. Dawes RM, Faust D, Meehl PE. Clinical versus actuarial judgment. Science 1989;243(4899):1668–74.
23. Pokorny AD. Prediction of suicide in psychiatric patients: report of a prospective study. Arch Gen Psychiatry 1983;40(3):249–57.
24. Mann JJ, Ellis SP, Waternaux CM, et al. Classification trees distinguish suicide attempters in major psychiatric disorders: a model of clinical decision making. J Clin Psychiatry 2008;69(1):23–31.
25. Nock MK, Prinstein MJ, Sterba SK. Revealing the form and function of self-injurious thoughts and behaviors: a real-time ecological assessment study among adolescents and young adults. J Abnorm Psychol 2009;118(4):816–27.
26. Muehlenkamp JJ, Engel SG, Wadeson A, et al. Emotional states preceding and following acts of non-suicidal self-injury in bulimia nervosa patients. Behav Res Ther 2009;47(1):83–7.

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.

(Am J Prev Med 2014;47(3S2):S181–S185)

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.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.003

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.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of

Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The views represented are those of the authors and do not necessarily represent the views of the NIH, the Universities of North Texas or New Mexico, or the USDHHS. Dr. Claassen's work on this manuscript was partially funded under contract number HHSN271201000152M with the National Institute of Mental Health.

No financial disclosures were reported by any of the authors of this paper.

References

1. Office of Applied Studies. Results from the 2008 National Survey on Drug Use and Health: National Findings. oas.samhsa.gov.
2. Crosby AE, Ortega L, Melanson C. Self-directed violence surveillance: uniform definitions and recommended data elements, version 1.0. Atlanta GA: CDC, 2011. www.cdc.gov/violenceprevention/pdf/Self-Directed-Violence-a.pdf.
3. Werth JL. U.S. involuntary mental health commitment statutes: requirements for persons perceived to be a potential harm to self. Suicide Life Threat Behav 2001;31(3):348–57.
4. Bryan C, Rudd M. Advances in the assessment of suicide risk. J Clin Psychol 2006;62(2):185–200.
5. Simon R. Imminent suicide: the illusion of short-term prediction. Suicide Life Threat Behav 2006;36(3):296–301.
6. Bouch J, Marshall JJ. Suicide risk: structured professional judgment. Adv Psychiatr Treat 2005;11:84–91.
7. McMinn T, Goat G, Wiener P, et al. User's guides to the medical literature XXII: how to use articles about clinical decision rules. JAMA 2000;284(1):79–84.
8. Reilly B, Evans A. Translating clinical research into clinical practice: impact of using prediction rules to make decisions. Ann Intern Med 2006;144(3):201–9.
9. Yang M, Wong S, Coed J. The efficacy of violence prevention: a meta-analytic comparison of nine risk assessment tools. Psychol Bull 2010;136(5):740–67.
10. Littman R, Murphy T, Schneidman E, Farberow N, Tabachnik N. Investigations of equivocal suicides. JAMA 1963;184:924–9.
11. Pokorny A. Prediction of suicide in psychiatric patients. Arch Gen Psychiatry 1984;40(3):249–57.
12. Goldstein R, Black D, Nasrallah A, Winokur G. The prediction of suicide: sensitivity, specificity, and predictive value of a multivariate model applied to suicide among 1906 patients with affective disorders. Arch Gen Psychiatry 1991;48(5):418–22.
13. Goldney R. Prediction of suicide and attempted suicide. In: Hawton K, van Heringen K, eds. The international handbook of suicide and attempted suicide. New York: Wiley, 2000.
14. Brown SL, St. Amand MD, Zamble E. The dynamic prediction of criminal recidivism: a three-wave prospective study. Law Hum Behav 2009;33(1):25–45.
15. Dolan M, Fullam R. The validity of the Violence Risk Scale Second Edition (VRS-2) in a British forensic inpatient sample. J Forens Psychiatry Psychol 2007;18(3):381–93.
16. Andrews DA, Bonta J. Level of service inventory—revised. Toronto: Multi-Health Systems, 1995.
17. Fawcett J. Clinical prediction of suicide in patients with major affective disorders: a controlled prospective study. Am J Psychiatry 1987;144(1):35–40.
18. Fawcett J. Predictors of early suicide: identification and appropriate intervention. J Clin Psychiatry 1988;49(1S):7S–8S.
19. Fawcett J. Time-related predictors of suicide in major affective disorder. Am J Psychiatry 1990;147(9):1189–94.
20. Mann JJ. Neurobiology of suicidal behavior. Nat Rev Neurosci 2003;10:819–28.
21. Rudd M. Cognitive therapy for suicidality: an integrative, comprehensive, and practical approach to conceptualization. J Contemp Psychother 2004;34(1):59–72.
22. Joiner T. Why people die of suicide. Cambridge MA: Harvard University Press, 2005.
23. Schotte DE, Cools J, Payvar S. Problem-solving deficits in suicidal patients: trait vulnerability or state phenomenon? J Consult Clin Psychol 1990;58(5):562–4.
24. Hendin H, Al Jurdi R, Houck P, Hughes S, Turner J. Role of intense affects in predicting short-term risk for suicidal behavior: a prospective study. J Nerv Ment Dis 2010;198(3):220–5.
25. Nock M, Banaji M. Prediction of suicide ideation and attempts among adolescents using a brief performance-based test. J Consult Clin Psychol 2007;75(5):707–15.
26. Klerman GL. Clinical epidemiology of suicide. J Clin Psychiatry 1987;48(12):33–8.
27. Kessler RC, Borges G, Walters EE. Prevalence of and risk factors for lifetime suicide attempts in the National Comorbidity Survey. Arch Gen Psychiatry 1999;56(7):617–26.
28. Mann J, Waternaux C, Haas G, Malone KM. Toward a clinical model of suicidal behavior in psychiatric patients. Am J Psychiatry 1999;156(2):181–9.
29. Fairweather A, Anstey K, Rodgers B, Butterworth P. Factors distinguishing suicide attempters from suicide ideators in a community sample: social issues and physical health problems. Psychol Med 2006;36(9):1235–45.
30. Joiner T, Brown J, Wingate L. The psychology and neurobiology of suicidal behavior. Annu Rev Clin Psychol 2004;56:287–314.
31. Administration for Children and Families of the USDHHS. Protective Factors Framework 2013. childwelfare.gov/can/factors/protective_factors.cfm.
32. Masten AS. Ordinary magic: lessons from research on resilience in human development. Edu Can 2009;49(3):28–32.
33. Berman A, Silverman M. Suicide risk assessment and risk formulation Part II: suicide risk formulation and the determination of levels of risk. Suicide Life Threat Behav 2013 Nov 29. http://dx.doi.org/10.1111/sltb.12067.
34. King G, Zeng L. Logistic regression in rare events data. Polit Anal 2001;9(2):137–63.
35. Donnenberg A, Donnenberg V. Rare-events analysis in flow cytometry. Lab Res Methods 2007;27(3):627–52.
36. Frei C, Schar C. Detection probability of trends in rare events: theory and application to heavy precipitation in the Alpine region. J Clim Change 2001;14(7):1568–85.
37. Lam K-Y, Ramamritham K. RTMonitor: real-time data monitoring using mobile agent technologies. Proceedings of the 28th VLDB Conference; 2002 Aug 20–23; Hong Kong, China. VLDB, Inc., 2002. vldb.org/archives/website/2002/VLDB2002-proceedings/index.html.
38. Thurmond V, Hicks R, Gleason T, et al. Advancing integrated research in psychological health and traumatic brain injury: common data elements. Arch Phys Med Rehabil 2010;91(11):1632–6.
39. Hatcher S, Sharon C, Coggan C. Beyond randomized controlled trials in attempted suicide research. Suicide Life Threat Behav 2009;39(4):396–407.
40. Defense Advanced Research Project Agency. The Durkheim Project 2013. durkheimproject.org/.
41. American Foundation for Suicide Prevention. Assessment and risk studies. Washington DC. afsp.org/research/our-researchers/psychosocial-studies/assessment-and-risk-studies.

Evidence-Based Psychotherapies for Suicide Prevention

Future Directions

Gregory K. Brown, PhD, Shari Jager-Hyman, PhD

Psychotherapeutic interventions targeting suicidal thoughts and behaviors are essential for reducing suicide attempts and deaths by suicide. To determine whether specific psychotherapies are efficacious in preventing suicide and suicide-related behaviors, it is necessary to rigorously evaluate therapies using RCTs. To date, a number of RCTs have demonstrated efficacy for several interventions focused on preventing suicide attempts and reducing suicidal ideation. Although these studies have contributed greatly to the understanding of treatment for suicidal thoughts and behaviors, the extant literature is hampered by a number of gaps and methodologic limitations. Thus, further research employing increased methodologic rigor is needed to improve psychotherapeutic suicide prevention efforts. The aims of this paper are to briefly review the state of the science for psychotherapeutic interventions for suicide prevention, discuss gaps and methodologic limitations of the extant literature, and suggest next steps for improving future studies.

(Am J Prev Med 2014;47(3S2):S186–S194)

Introduction

The development and implementation of effective interventions are imperative for reducing rates of suicide and related behaviors. In response to the ongoing need for effective treatments aimed at preventing suicide and self-directed violence, the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF)[1] has proposed the following Aspirational Goal focused on psychotherapeutic interventions: "…develop widely available, more effective and efficient psychosocial interventions targeted at individuals, families, and community levels."

The current paper has three main aims in discussing this Aspirational Goal. First, with a focus on RCTs, the state of the science for evidence-based psychotherapy interventions for suicidal ideation and behavior is reviewed. Second, limitations of the current research and suggestions for future research are discussed. Finally, a step-by-step pathway for evaluating psychotherapy interventions for suicide prevention is proposed.

From the Perelman School of Medicine of the University of Pennsylvania, Philadelphia, Pennsylvania

Address correspondence to: Gregory K. Brown, PhD, Department of Psychiatry, University of Pennsylvania, 3535 Market Street, Room 2032, Philadelphia PA 19104-3309. E-mail: gregbrow@mail.med.upenn.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.008

State of the Science of Evidence-Based Treatments for Suicide Prevention

Several RCTs[2–5] have demonstrated promising results in reducing suicide attempts and self-directed violence. A comprehensive review of the literature is beyond the scope of this paper; however, reviews[2–5] were used to identify studies to include in this brief review. A selection of studies yielding positive effects will be highlighted and presented in Table 1. Briefly, cognitive therapy for suicide prevention (CT-SP)[6]; cognitive–behavioral therapy (CBT)[7]; dialectical behavior therapy (DBT)[8]; problem-solving therapy (PST)[9]; mentalization-based treatment (MBT)[10]; and psychodynamic interpersonal therapy (PIT)[11] have all evidenced positive effects for preventing suicide attempts or self-directed violence in adults.

More specifically, recent suicide attempters who received CT-SP were 50% less likely to reattempt than participants who received enhanced usual care (EUC) with tracking and referrals.[6] CBT plus treatment as usual (TAU) also reduced self-harming behaviors relative to TAU alone.[7] For individuals with borderline personality disorder (BPD), DBT demonstrated a greater reduction in suicide attempts relative to community treatment by experts.[8] However, DBT was not statistically more effective than a manualized general psychiatric management condition, consisting of case management, dynamically informed psychotherapy, and medication management.[12]

Also focused on BPD, MBT, a psychoanalytically oriented partial hospitalization program, was more

Table 1. Summary of select RCTs

Authors	Sample	Study intervention	Control condition	Outcome variables	Follow-up intervals	Main findings
Bateman and Fonagy (1999)[10]	Adults with BPD referred to psychiatric unit	Partial hospitalization (n=19)	Standard psychiatric care (n=19)	Suicide attempts	3, 6, 9, 12, 15, 18 months	Patients who received the study intervention experienced a significant reduction in attempts from admission to 18 months (Kendall's W=0.59, $\chi^2(3)=33.5$, $p<0.001$)
Blum et al. (2008)[13]	Adults with BPD	STEPPS plus TAU (n=65)	TAU (n=59)	Suicide attempts	1, 3, 6, 9, 12 months	No differences in time to first suicide attempt between STEPPS + TAU and TAU groups; $\chi^2(1)<0.1$, p=0.994
Brown et al. (2005)[6]	Adults recruited from ED following a suicide attempt	CT (n=60)	EUC (n=60)	Suicidal ideation, suicide attempts	1, 3, 6, 12, 18 months	At 6 months, using the Kaplan–Meier method, estimated reattempt-free probability: CT group=0.86 (95% CI=074, 0.93); usual care =0.68 (95% CI=0.54, 0.79) At 18 months, estimated reattempt-free probability: CT=0.76 (95% CI=0.62, 0.85); usual care=0.58 (95% CI=0.44, 0.70) Patients in the CT condition had a significantly lower reattempt rate (Wald χ^2=3.9, p=0.049) and were 50% less likely to reattempt than the usual care group (hazard ratio=0.51, 95% CI=0.26, 0.997) There were no significant group differences in suicidal ideation
Bruce et al. (2004)[21]	Depressed older adults recruited from primary care	Structured, team-based intervention including citalopram + psychotherapy (n=320)	TAU (n=278)	Suicidal ideation	4, 8, 12 months	Rates of suicidal ideation declined faster for the intervention group (12.9% decline from baseline) than the TAU group (3.0% decline from baseline; p=0.01 for all depressed patients, p=0.006 for patients with MDD)
Comtois et al. (2011)[17]	Adults evaluated for suicide attempt or imminent risk but judged safe for discharge	CAMS (n=16)	E-CAU (n=16)	Suicide attempts, suicidal ideation	2, 4, 6, 12 months	Participants who received CAMS made fewer suicide attempts than those who received E-CAU at 2-, 4-, and 6-month follow-ups[a] Suicidal ideation improved significantly for CAMS patients, reaching 89% reduction at 12 months, RR=0.11, 95% CI=0.04, 0.30; at 12 months, E-CAU patients reported significantly worse suicidal ideation than CAMS patients (RR=4.81, 95% CI=1.61, 14.33)

(continued on next page)

Table 1. Summary of select RCTs *(continued)*

Authors	Sample	Study intervention	Control condition	Outcome variables	Follow-up intervals	Main findings
Davidson et al. (2006)[14]	Adults with BPD and an episode of DSH within the past 12 months	CBT + TAU (n=53)	TAU (n=49)	Suicidal acts	6, 12, 18, 24 months	After 24 months, there was a greater reduction in number of suicidal acts in the intervention group compared to the TAU group (mean difference= −0.91, p=0.020)
Diamond et al. (2010)[19]	Adolescents identified as suicidal by screening during primary care or ED visits	ABFT (n=35)	EUC (n=31)	Suicidal ideation	6, 12, 24 weeks	At the 12-week assessment, patients receiving ABFT demonstrated a significantly greater rate of improvement in suicidal ideation than patients receiving EUC, $F(1, 64)=12.60$, $p=0.001$ ABFT had a significant effect on clinical recovery (SIQ-JR ≤ 13) of suicidal ideation at all time points; at 6 weeks, 69.7% of ABFT patients and 40.7% of EUC patients reported suicidal ideation in the normative range, OR=3.35, 95% CI=1.15, 9.73, $\chi^2(1)=5.07$, $p=0.02$; at 12 weeks, 87.1% of ABFT patients and 51.7% of EUC patients reported ideation in the normative range, OR=6.30, 95% CI=1.76, 22.61, $\chi^2(1)=8.93$, $p=0.003$; at 24 weeks, 70% of ABFT patients and 34.6% of EUC patients reported ideation in the normative range, OR=4.41, 95% CI=1.43, 13.56, $\chi^2(1)=7.01$, $p=0.008$
Guthrie et al. (2001)[11]	Adults presenting to ED after self-poisoning	Psychodynamic interpersonal therapy delivered in home (n=58)	TAU (n=61)	Suicidal ideation	1, 6 months	At the 6-month follow-up assessment, patients receiving the study intervention reported lower levels of suicidal ideation compared to those receiving TAU (differences between means= −4.9, 95% CI= −8.2, −1.6, p=0.005)
Hatcher et al. (2011)[9]	Adults presenting to a hospital after self-harm	PST (n=522)	Usual care (n=572)	Self-harm	3, 12 months	Fewer patients receiving PST reported repeat episodes of self-harm at the 12-month assessment than those receiving usual care (RR=0.39, 95% CI=0.07, 0.60, p=0.03)
Huey et al. (2004)[16]	Youth following ED visit for suicide attempt, ideation, or planning	MST[b]	Standard treatment[b]	Suicidal ideation, suicide attempts	4, 16 months	MST was significantly more effective than standard treatment at reducing suicide attempts over 16 months, t(linear)=2.61, $p<0.01$, t (quadratic)=3.60, $p<0.001$ There were no significant group differences for suicidal ideation

(continued on next page)

Table 1. Summary of select RCTs *(continued)*

Authors	Sample	Study intervention	Control condition	Outcome variables	Follow-up intervals	Main findings
Linehan et al. (2006)[8]	Women with BPD with ≥2 episodes of self-harm in the past 5 years, including ≥1 within the past 8 weeks	DBT (*n*=52)	Community treatment by experts (*n*=49)	Suicidal ideation, suicide attempts	4, 8, 12, 16, 20, 24 months	Fewer patients receiving DBT had suicide attempts than those receiving treatment by experts (23.1% vs 46%, hazard ratio=2.66, *p*=0.005, NNT=4.24, 95% CI=2.40, 18.07); the mean proportions of suicide attempters per treatment group per period were 6.2% (95% CI=3.1%, 11.7%) and 12.2% (95% CI=7.1%, 20.3%) for the DBT and control groups, respectively Fewer patients receiving DBT than community treatment by experts had non-ambivalent suicide attempts (5.8% vs 13.3%, *p*=0.18, Fisher's exact test and NNT=13.3, 95% CI=5.28, 25.41) There were no significant group differences for suicidal ideation
McMain et al. (2009)[12]	Adults with BPD with ≥2 suicidal or non-suicidal self-injurious episodes in the past 5 years, ≥1 episode in the past 3 months	DBT (*n*=90)	General psychiatric management (*n*=90)	Frequency and severity of suicidal episodes	4, 8, 12 months	There were no significant group differences for suicidal episodes
Slee et al. (2008)[7]	Adults who recently engaged in deliberate self-poisoning or self-injury	CBT + TAU (*n*=40)	TAU (*n*=42)	Self-harm, suicidal cognition	3, 6, 9 months	At 9 months, patients who received CBT + TAU had significantly greater reductions in self-harm than those who received TAU alone ($p<0.05$) CBT +TAU patients had significantly decreased suicidal cognitions as compared to TAU patients at the 3- ($p<0.05$), 6- ($p<0.05$), and 9-month ($p<0.01$) assessments
Stewart et al. (2009)[18]	Adults in treatment following a suicide attempt	CBT (*n*=11), PST (*n*=12)	TAU (*n*=9)	Suicidal ideation, suicide attempts	4 weeks (PST), 7 weeks (CBT), 2 months (TAU)	CBT was the most effective treatment for reducing suicide attempts; patients receiving CBT made no attempts during the study, whereas patients receiving PST and TAU made an average of 0.33 attempts and 0.22 attempts, respectively Suicidal ideation decreased with both CBT ($z=-2.32$, $p<0.05$, $r=0.49$) and PST ($z=-2.39$, $p<0.05$, $r=0.49$); decreases in suicidal ideation were greater for the PST than TAU group ($U=26.5$, $p\leq0.05$, $r=0.49$)

(continued on next page)

Table 1. Summary of select RCTs *(continued)*

Authors	Sample	Study intervention	Control condition	Outcome variables	Follow-up intervals	Main findings
Unützer et al. (2006)[20]	Older adults with MDD or dysthymia	IMPACT intervention (n=906)	Usual care (n=895)	Suicidal ideation	6, 12, 18, 24 months	Fewer patients receiving the IMPACT intervention than usual care reported thoughts of suicide at 6 (OR=0.54, 95% CI=0.37, 0.78, p=0.001), 12 (OR=0.54, 95% CI=0.40, 0.73, $p<0.001$), 18 (OR=0.52, 95% CI=0.36, 0.75, $p<0.001$), and 24 (OR=0.65, 95% CI=0.46, 0.91, $p<0.01$) months Fewer patients receiving the IMPACT intervention reported thoughts of death or dying at 6 (OR=0.62, 95% CI=0.49, 0.78, $p<0.001$), 12 (OR=0.44, 95% CI= 0.35, 0.56, $p<0.001$), 18 (OR=0.62, 95% CI=0.49, 0.79, $p<0.001$), and 24 (OR=0.72, 95% CI=0.57, 0.92, p=0.01) months
Wood et al. (2001)[15]	Adolescents referred to mental health services after deliberate self-harm	Group therapy (n=32)	Routine care (n=31)	Repetition of self-harm, suicidal thinking	6 weeks, 7 months	Participants who received group therapy were less likely to repeat self-harm than those who received routine care (OR=6.3, 65% CI=1.4, 28.7) There were no significant group differences regarding suicidal thinking

Note: Only outcomes related to suicide ideation and attempts are reported.
[a]No statistical analyses were performed for these results.
[b]Study did not indicate the number of participants per condition.
ABFT, attachment-based family therapy; BPD, borderline personality disorder; CAMS, collaborative assessment and management of suicidality; CBT, cognitive–behavioral therapy; CT, cognitive therapy; DBT, dialectical behavior therapy; DSH, deliberate self-harm; E-CAU, enhanced care as usual; ED, emergency department; EUC, enhanced usual care; IMPACT, Improving Mood: Promoting Access to Collaborative Treatment; MDD, major depressive disorder; MST, multisystemic therapy; NNT, number needed to treat; PST, problem-solving therapy; RR, risk ratio; SIQ-JR, Suicide Ideation Questionnaire–Junior; STEPPS, systems training for emotional predictability and problem solving; TAU, treatment as usual

effective than general psychiatric services in reducing suicidal and self-mutilatory acts.[10] Similarly, relative to TAU alone, PST plus usual care resulted in a decrease in repeat hospitalizations for self-harm in individuals with a history of previous self-harm.[9] Finally, four home-based sessions of interpersonal therapy were more effective than TAU in reducing suicidal ideation and repeated self-harm in individuals who self-poisoned.[11]

Although a number of suicide-prevention interventions have evidenced efficacy, other interventions, including systems training for emotional predictability and problem solving[13] and CBT for Cluster B personality disorders,[14] have not been supported empirically. For a comprehensive review of negative findings, please see previous reviews.[2–5]

Fewer studies[15,16] have demonstrated efficacy for psychotherapy interventions in reducing self-directed violence in adolescents. Wood and colleagues[15] found that adolescents who received developmental group therapy (consisting of components of CBT, DBT, and psychodynamic group therapy) plus TAU were less likely to engage in repeated deliberate self-harm on two or more occasions than those who received TAU alone. Finally, multisystemic therapy, an intensive family-based treatment, reduced the frequency of suicide attempts compared to treatment received during inpatient hospitalization.[16]

In addition to psychosocial interventions designed to prevent suicide attempts, several psychotherapy treatments directly target suicidal ideation. Specifically, collaborative assessment and management of suicidality (CAMS),[17] CBT,[18] PST,[18] and PIT[11] have resulted in the reduction of suicidal ideation in adults. CAMS, a therapeutic framework focused on identifying causes of suicidal ideation and treatment goals for reducing suicidal ideation, was associated with significantly greater and sustained reduction of suicidal ideation at 12 months post-treatment compared to TAU.[17] Similarly, both PST and CBT resulted in greater reduction of suicidal ideation than TAU.[16] Attachment-based family

therapy, which focuses on strengthening the parent–adolescent attachment bond, has also demonstrated promise in reducing suicidal ideation in suicidal adolescents relative to EUC.[19]

Finally, to our knowledge, two studies have demonstrated efficacy in reducing suicidal ideation in depressed older adults in primary care settings.[20,21] The Improving Mood: Promoting Access to Collaborative Treatment study determined that a collaborative, team-based approach to treating depression resulted in a greater reduction of suicidal ideation than usual care. The Prevention of Suicide in Primary Care Elderly: Collaborative Trial intervention, consisting of a clinical algorithm for treating geriatric depression in primary care settings and care management, was more effective in reducing suicidal ideation than EUC.

Limitations of the Current State of the Science

Although the aforementioned RCTs represent important first steps in gaining a deeper understanding of effective suicide prevention strategies, several gaps and methodologic concerns limit conclusions that can be drawn from these studies. Several significant gaps in the literature should be noted. First, given the paucity of RCTs powered to detect deaths by suicide, it is unknown whether death by suicide (rather than suicide attempts) can be prevented by psychotherapy. Moreover, it is unclear as to whether the reduction of suicide attempts or ideation via psychotherapy actually reduces deaths by suicide.

Second, many studies focused on suicide prevention exclude patients at imminent risk for suicide, making it impossible to determine whether interventions that are efficacious for lower-risk patients are also efficacious for those at highest risk.[22] Third, there are limited psychotherapy RCTs focused on preventing suicide attempts for many at-risk populations, including older adults; Veterans or military service members; lesbian, gay, bisexual, transgender, queer, and two-spirit (LGBTQ2) populations; Native Americans and other minority groups; and survivors of suicide or suicide attempts. It is unclear whether the results of existing RCTs generalize to these populations.

Additionally, the majority of psychotherapy interventions for suicidal thoughts and behaviors have been conducted in outpatient settings, and very few RCTs have been conducted in acute care settings, such as emergency departments, inpatient units, and crisis hotlines. The development of interventions for these settings is particularly important given that many high-risk patients only present to acute care services and never receive additional psychosocial treatment. The dearth of knowledge about effective treatments for inpatient settings is especially alarming given that the current standard of care is to admit high-risk patients to inpatient units. This suggests that patients who are at high risk for suicide may not receive appropriate evidence-based treatments to prevent suicide.

A final gap in the extant research examining the efficacy of psychotherapy interventions for suicide prevention is the failure to replicate studies in which treatments have been found to be efficacious. It is especially critical that replication trials be conducted by independent researchers, as in some cases replication studies conducted outside of the original research groups have failed to demonstrate the same beneficial effects.[12]

A variety of methodologic limitations of the existing research hamper the ability to draw firm conclusions regarding the effectiveness and generalizability of various suicide prevention efforts (limitations have been published elsewhere[1–4]). First, a lack of consensus regarding terms and operationalized definitions used to describe suicide, attempts, ideation, and other related behaviors limits the ability to generalize across studies and replicate findings. Researchers also often neglect to use reliable and validated measures of suicidal ideation and behaviors, making it difficult to understand the specific behaviors measured and targeted by the interventions in question.

In addition, many previously published RCTs do not provide detailed psychotherapy manuals. The absence of treatment manuals creates significant challenges for dissemination and implementation efforts in the community and precludes appropriate replication studies. Furthermore, researchers often neglect to include measures assessing the integrity of the study intervention. It is important to assess the extent to which study therapists adhere to the theory and practice of the intervention of interest.

An additional common methodologic problem is that studies are underpowered to adequately detect treatment effects, causing potentially efficacious treatments to yield negative results owing to lack of power rather than lack of efficacy. Moreover, very few studies include descriptions of power analyses, making it difficult to determine the reasons for failing to find positive effects. Other studies conduct power analyses based on unlikely or biased estimates of effects, leading to inadequate estimates of sample sizes. Conservative estimates are necessary to ensure that samples are powered sufficiently to detect effects.

Given that RCTs are generally longitudinal, attrition is common and results in an additional methodologic issue of handling missing data. This is particularly problematic when dropout rates differ across treatment conditions, which may result in biased results.[7] As recommended in the CONSORT guidelines for reporting RCT results, intention-to-treat analysis is a helpful statistical approach to handling missing data to minimize bias.[23]

Other methodologic limitations encountered in the extant literature include potential threats to external validity by choosing highly selective samples[11]; failure to use blind investigators, assessors, or patients or specify whether blinding was implemented; potential measurement bias (e.g., using differential measurement intervals and methods for assessing primary outcomes in intervention and control groups[10]); failure to identify, measure, and control for potential non-study co-interventions (e.g., pharmacotherapy); and analyses capitalizing on differences in baseline characteristics.[16]

It is also advised that researchers focus on a priori analyses and refrain from making firm conclusions on the basis of unplanned, underpowered subgroup analyses. Finally, stratified randomization is an important tool in preventing Type I errors and imbalance between treatment groups, particularly for smaller trials in which known factors influence treatment responsiveness.

Next Steps and Breakthroughs Needed

Although the existing RCTs have created an important jumping-off point for evaluating future psychotherapeutic interventions for suicide attempts and ideation, much work remains. The adoption of the following recommendations may lead to increased methodologic rigor with which suicide research is conducted, and in turn, the development and dissemination of treatments that reduce suicidal ideation, suicide attempts, and ultimately, suicide.

Given that the current lack of consensus of terms and definitions leads to difficulty in interpreting results and aggregating findings across studies, an important short-term goal is to adopt an agreed-upon nomenclature for all studies addressing suicide-relevant thoughts and behaviors, such as the self-directed violence nomenclature proposed by the CDC's National Center for Injury Prevention and Control.[24] It is then essential to employ valid and reliable measures to assess these constructs.

The Columbia Suicide Severity Rating Scale (C-SSRS[25]) is one such measure endorsed by the U.S. Food and Drug Administration for use in pharmaceutical trials. It would also be beneficial to use an agreed-upon measure for psychotherapy trials. Furthermore, to achieve continuity across studies, it would be helpful for all studies to use the same endpoints in reporting outcomes, thereby increasing the ease with which results can be aggregated across studies via meta-analyses.

There is also a need for methods to address ambiguous suicide behavior that may not neatly fit into a specific category of suicidal thoughts or behaviors. One potential solution to this problem is to form suicide adjudication boards to review ambiguous behaviors and reach a consensus regarding appropriate classification.[26]

An additional short-term goal is to develop interventions designed for high-risk populations, including older adults, Veterans or military service members, LGBTQ2 individuals, minority groups, and survivors of suicide or suicide attempts as indicated by empirical research. There is also a need for methods to screen and treat high-risk individuals in acute care settings, including emergency departments, crisis hotlines, and inpatient units.

As previously mentioned, many studies assessing the efficacy of treatments for suicide prevention are underpowered. Although preliminary studies to determine acceptability and feasibility of specific interventions are necessary, large-scale RCTs that are adequately powered to detect treatment effects are also imperative. This is true for studies assessing treatments focused on reducing suicidal thoughts, suicide attempts, and other self-directed violence, as well as those designed to evaluate treatments for the prevention of deaths by suicide.

Because suicide is a low base rate behavior, very large samples are required to conduct adequately powered trials. Multi-site collaborations allow the collection of data from large samples while reducing financial and organizational burden on any one site. In addition, the use of standardized outcome measures and data sharing may facilitate meta-analytic approaches and circumvent problems associated with inadequately powered studies.

Further development and dissemination of treatments specifically targeting suicidal ideation are also necessary, particularly for populations such as older men who have the highest rates of suicide of any age group.[27] Despite their increased rate of deaths by suicide, older adults are less likely to make suicide attempts than individuals in any other age group.[28] Suicidal ideation may thus serve as the only warning sign of future suicides in older adults, making it especially important to specifically target suicidal ideation in this population. As frequent attempts are less common in this population, treatments focused on preventing attempts may be less appropriate.

Because suicidal ideation is a dimensional construct that waxes and wanes over time, RCTs should include appropriate measures for tracking fluctuations in suicidal ideation. The use of ecological momentary assessment, for example, would provide much-needed insight into the fluctuation of suicidal ideation and inform the development of timely interventions that specifically target changes in suicidal ideation.

Very little is known about whether positive effects of psychotherapies for suicide prevention extend beyond laboratory settings. In addition to efficacy trials, effectiveness trials are also needed to assess whether specific treatments work in real-world settings. Moreover, in order to increase external validity of psychotherapy trials,

it is important that inclusion and exclusion criteria result in samples that reflect patients as they present in the real world (e.g., the exclusion of potential participants who do not misuse substances may result in a biased sample of suicide attempters[10]).

There is a need to better develop mechanisms to ensure that the individuals at risk of suicide have access to treatments that work. In designing interventions, researchers should consider ways to increase the feasibility and ease with which treatments can be disseminated and adapted to various settings. For example, future psychotherapies that can be implemented in rural settings using telehealth technologies are needed.

In addition, researchers are encouraged to clearly communicate the specific treatment components necessary to successfully implement interventions in nonlaboratory settings. Another potential approach to increasing the availability of evidence-based treatments is to develop innovative electronic health interventions (e.g., smartphone applications, texting, web-based interventions, or chat rooms) as either widely available stand-alone interventions or adjunctive treatments to face-to-face interventions. Finally, further research is needed to determine the cost-effectiveness and cost utility of psychotherapy studies for suicide prevention.

As researchers continue to find support for treatments that reduce suicidal thoughts and behaviors, it is necessary to identify potential mechanisms of actions that account for therapeutic change. Thus, in addition to asking whether a treatment works, it is essential to ask why a treatment works. This can be achieved by including measures assessing constructs underlying treatment effects, such as improvements in hopelessness or emotion regulation. Identifying mechanisms of action will allow for the development of more efficient, targeted treatments and may provide insight into which treatments work best for whom.

In addition to identifying treatments that are effective in reducing suicide ideation and behaviors, it is also important to understand which treatments have not garnered support in psychotherapy trials. Systematic trial registration is one method for reducing the "file-drawer effect" in which negative findings are not presented to the public.

Given the gaps and methodologic flaws in the literature focused on psychotherapy interventions for suicide prevention, additional research is needed to determine the efficacy of existing and future treatments. Thus, we propose a general step-by-step research pathway for conducting future RCTs with high-risk patients for examining the efficacy of new psychotherapy treatments (Figure 1).

The first step of this paradigm is to identify high-risk subjects by using agreed-upon nomenclature (e.g., CDC nomenclature) as well as validated and reliable assessment measures. These high-risk patients can be recruited from a variety of settings including emergency departments, inpatient units, mental health outpatient clinics, and primary care. Following recruitment and initial assessment to determine eligibility, it is recommended that patients be randomly assigned to either (1) the co-active intervention condition, which may include medication, treatment as usual, a comparative therapy, or follow-up services, or (2) the same co-active intervention plus a suicide-specific study intervention condition.

Alternatively, depending on the question of interest, it may be more appropriate to omit the co-active intervention for participants who are randomized to the suicide-specific study intervention condition. In order to gain an understanding of the pathways by which

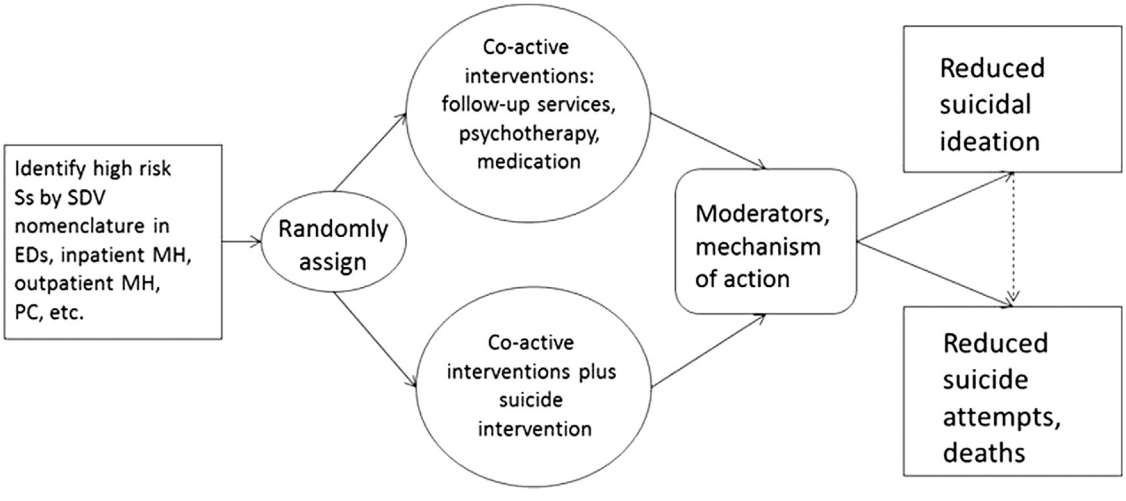

Figure 1. Proposed step-by-step research pathway for conducting RCTs
ED, emergency department; MH, mental health; PC, primary care; SDV, self-directed violence; Ss, subjects

treatment affects the outcome of interest (i.e., suicidal ideation, suicide attempts, or suicides), it is imperative to examine moderators of the study treatment and potential mechanisms of actions. Elucidating the moderators and mechanisms at play will inform the development of more efficient and targeted future interventions. This paradigm will also allow for increased understanding of the relation between reductions in suicidal ideation and reductions in suicide attempts or deaths by suicide.

Conclusions

Despite important advances in the development and evaluation of psychotherapeutic treatments for suicide prevention, additional research is needed to improve the current state of the science. A focus on filling the gaps in the literature and increasing methodologic rigor with which RCTs of suicide-prevention psychotherapies are conducted will lead to increasingly effective treatments for reducing suicidal ideation, attempts, and deaths.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. USDHHS Office of the Surgeon General and National Action Alliance for Suicide Prevention. 2012 National Strategy for Suicide Prevention: Goals and Objectives for Action. Washington, DC: HHS, September 2012. http://www.surgeongeneral.gov/library/reports/national-strategy-suicide-prevention/full-report.pdf.
2. O'Neil M, Peterson K, Low A, et al. Suicide prevention interventions and referral/follow-up services: a systematic review. Washington, DC: Department of Veterans Affairs, 2012.
3. Mann J, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
4. National Institute for Health and Clinical Excellence. Self-harm: longer-term management. (Clinical Guideline CG133). guidance.nice.org.uk/CG133.
5. O'Connor E, Gaynes BN, Burda BU, et al. Screening for and treatment of suicide risk relevant to primary care: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med 2013;158(10):741–54.
6. Brown GK, Ten Have T, Henriques GR, et al. Cognitive therapy for the prevention of suicide attempts: a randomized controlled trial. JAMA 2005;294(5):563–70.
7. Slee N, Garnefski N, van der Leeden R, et al. Cognitive-behavioural intervention for self-harm: randomized controlled trial. Br J Psychiatry 2008;192(3):202–11.
8. Linehan MM, Comtois KA, Murray AM, et al. Two-year randomized controlled trial and follow-up of dialectical behavior therapy vs therapy by experts for suicidal behaviors and borderline personality disorder. Arch Gen Psychiatry 2006;63(7):757–66.
9. Hatcher S, Sharon C, Parag V, Collins N. Problem-solving therapy for people who present to hospital with self-harm: Zelen randomised controlled trial. Br J Psychiatry 2011;199(4):310–6.
10. Bateman A, Fonagy P. Effectiveness of partial hospitalization in the treatment of borderline personality disorder: a randomized controlled trial. Am J Psychiatry 1999;156(10):1563–9.
11. Guthrie E, Kapur N, Mackway-Jones K, et al. Randomised controlled trial of brief psychological intervention after deliberate self-poisoning. BMJ 2001;323(7305):135–8.
12. McMain SF, Links PS, Gnam WH, et al. A randomized trial of dialectical behavior therapy versus general psychiatric management for borderline personality disorder. Am J Psychiatry 2009;166(12):136–74.
13. Blum N, St John D, Pfohl B, et al. Systems training for emotional predictability and problem solving (STEPPS) for outpatients with borderline personality disorder: a randomized controlled trial and 1-year follow-up. Am J Psychiatry 2008;165(4):468–78.
14. Davidson K, Norrie J, Tyrer P, et al. The effectiveness of cognitive behavior therapy for borderline personality disorder: results from the Borderline Personality Disorder Study of Cognitive Therapy (BOSCOT) trial. J Pers Disord 2006;20(5):450–65.
15. Wood A, Trainor G, Rothwell J, et al. Randomized trial of a group therapy for repeated deliberate self-harm in adolescents. J Am Acad Child Adolesc Psychiatry 2001;40(11):1246–53.
16. Huey S, Henggeler S, Rowland M, et al. Multisystemic therapy effects on attempted suicide by youths presenting psychiatric emergencies. J Am Acad Child Adolesc Psychiatry 2004;43(2):183–90.
17. Comtois K, Jones D, O'Connor S, et al. Collaborative assessment and management of suicidality (CAMS): feasibility trial for next-day appointment services. Depress Anxiety 2011;28(11):963–72.
18. Stewart C, Quinn A, Plever S, Emmerson B. Comparing cognitive behavior therapy, problem solving therapy, and treatment as usual in a high-risk population. Suicide Life Threat Behav 2009;39(5):538–47.
19. Diamond G, Wintersteen M, Brown GK, et al. Attachment-based family therapy for adolescents with suicidal ideation: a randomized controlled trial. J Am Acad Child Adolesc Psychiatry 2010;49(2):122–31.
20. Unützer J, Tang L, Oishi S, et al. Reducing suicidal ideation in depressed older primary care patients. J Am Geriatr Soc 2006;54(10):1550–6.
21. Bruce M, Ten Have T, Reynolds Cr, et al. Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA 2004;291(9):1081–91.
22. Pearson J, Stanley B, King C, Fisher C. Intervention research with persons at high risk for suicidality: safety and ethical considerations. J Clin Psychiatry 2001;62(25S):S17–S26.
23. Moher D, Schulz KF, Altman DG, CONSORT Group. Consolidated standards of reporting trials. Ann Intern Med 2001;134(8):657–62.
24. Crosby AE, Ortega L, Melanson C. Self-directed violence surveillance: uniform definitions and recommended data elements, version 1.0. Atlanta GA: CDC, 2011. www.cdc.gov/violenceprevention/pdf/Self-Directed-Violence-a.pdf.
25. Posner K, Brown GK, Stanley B, et al. The Columbia-Suicide Severity Rating Scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. Am J Psychiatry 2011;168(12):1266–77.
26. Meltzer HY, Alphs L, Green AI, et al. Clozapine treatment for suicidality in schizophrenia: International Suicide Prevention Trial (InterSePT). Arch Gen Psychiatry 2003;60(1):82–91.
27. Hoyert S, Smith B, Murphy S, Kochanek M. Deaths: final data for 1999. Natl Vital Stat Rep 2001;49(8):1–113.
28. CDC, National Center for Injury and Prevention Control. Web-Based Injury Statistics Query and Reporting System (WISQARS). webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html.

Existing and Novel Biological Therapeutics in Suicide Prevention

Joshua J. Griffiths, MD, Carlos A. Zarate Jr., MD, J. J. Rasimas, MD, PhD

We summarize outcomes for several pharmacologic and neurostimulatory approaches that have been considered potential treatments to reduce suicide risk, namely, by reducing suicide deaths, attempts, and ideation in various clinical populations. Available treatments include clozapine, lithium, antidepressants, antipsychotics, electroconvulsive therapy, and transcranial magnetic stimulation. The novel repurposing of ketamine as a potential suicide risk–mitigating agent in the acute setting is also discussed. Research pathways to better understand and treat suicidal ideation and behavior from a neurobiological perspective are proposed in light of this foundation of information and the limitations and challenges inherent in suicide research. Such pathways include trials of fast-acting medications, registry approaches to identify appropriate patients for trials, identification of biomarkers, neuropsychological vulnerabilities, and endophenotypes through the study of known suicide risk–mitigating agents in hope of determining mechanisms of pathophysiology and the action of protective biological interventions.

(Am J Prev Med 2014;47(3S2):S195–S203)

Introduction

According to the WHO, suicide ranks among the top three causes of death worldwide for those aged 15–44 years.[1] In 2009, deaths from suicide surpassed deaths from motor vehicle crashes in the U.S.[2] According to the CDC, the overall rate of suicide for both male and female Americans has shown a slow but gradual increase since 2000.[3] Since the 1950s, suicide rates have not decreased, despite the fact that more than six decades of research have produced scores of medications and other interventions for diseases of the brain.

Aspirational Goal 5 of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force petitions the medical community to "find better ways to use existing biological treatments and discover improved new ones to prevent suicide."

Historically, the biologic treatment of suicide attempts and suicidal ideation has been approached with a focus on treating underlying DSM diagnoses associated with suicide (e.g., major depression, substance abuse, bipolar disorder, schizophrenia), with less emphasis placed on addressing suicide risk directly. The logic behind this approach is that of those who die by suicide, an estimated 60%–90% have some form of mental illness.[4,5] However, more treatments for mental disorders in general have not decreased suicide rates, and risk factors for suicide have been found to cross diagnostic categories.[6]

Furthermore, despite multitudes of efficacy trials for biological agents designed around DSM diagnoses, there are very few adequately powered RCTs examining the efficacy of biological treatments in preventing suicide deaths, attempts, and ideation as independent outcomes, according to several recent systematic literature reviews.[7,8] Patients with suicidal ideation and prior suicide attempts have traditionally been excluded from studies of biological treatments for DSM diagnoses on both scientific and ethical grounds. Most evidence for biological intervention in suicide prevention comes from post hoc analyses.[9] There is even debate as to whether drugs developed to treat certain DSM diagnoses, such as selective serotonin reuptake inhibitors, may actually increase the risk of suicide acutely in certain groups of patients (e.g., youth).[10]

Thus, future research should seek to understand suicide as a phenomenon not entirely dependent on a particular mental disorder but as a separate construct that is a final common endpoint of many forms and paths of human suffering. The DSM-5 takes a step in this direction. Even though it continues to reference suicide

From the Department of Psychiatry (Griffiths), University of Colorado, Denver, Colorado; Experimental Therapeutics and Pathophysiology Branch (Zarate, Rasimas), Intramural Research Program, National Institute of Mental Health, NIH, Bethesda, Maryland; and Departments of Psychiatry and Emergency Medicine (Rasimas), Penn State College of Medicine, Hershey, Pennsylvania

Address correspondence to: Joseph J. Rasimas, MD, PhD, Psychiatry & Emergency Medicine, University of Minnesota & Penn State College of Medicine, Staff Psychiatrist & Medical Toxicologist, HealthPartners/Regions Hospital, 640 Jackson Street, Mailstop 12002A, Saint Paul MN 55101. E-mail: joseph.j.rasimas@healthpartners.com.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.06.012

as a symptom of its major disorders listed in section 2, it contains two new diagnoses—non-suicidal self-injury and suicidal behavior disorder—in section 3 for disorders requiring further research. These diagnoses refer to suicide and suicidal behavior independent of any major mental disorder classification.[11]

On the basis of the current limited state of clinical science, we provide an overview and present credible evidence for biological interventions that may be protective against suicidal ideation, suicide attempts, and ultimately suicide deaths. It is important to note that the three are not synonymous, despite the former often being used as proxy for the latter two because its study entails fewer ethical and practical concerns. It is still unclear whether reductions in suicidal ideation and suicide attempts will directly result in reduction of suicide deaths. Additionally, different forms of psychotherapy and other promising psychosocial interventions have roles in prevention of suicide,[12] but they are beyond the scope of this paper and are not discussed here.

Data exist for the use of lithium and clozapine for prophylaxis against suicide attempts in select populations. Additionally, some weaker evidence for antipsychotics, antidepressants, and neurostimulatory interventions such as transcranial magnetic stimulation (TMS) and electroconvulsive therapy (ECT) are presented. The potential role of novel fast-acting anti-depressants such as ketamine as agents for further study in the mitigation of suicide risk is then discussed. Finally, a closer look is taken at the challenges facing suicide research and suggestions made as to how these challenges might be overcome with an eye toward suicide risk–mitigating medical interventions.

Clozapine

Clozapine is an atypical antipsychotic medication used primarily to treat patients with schizophrenia after other more conventional medications have failed. It acts on multiple neurotransmitter systems, including dopamine, acetylcholine, serotonin, histamine, epinephrine/norepinephrine, gamma aminobutyric acid, and glutamate. This wide array of actions is largely responsible for the drug's broad, and potentially dangerous, side effect profile. However, clozapine is relevant to the discussion of suicide prevention as it is the only medication with a specific U.S. Food and Drug Administration (FDA) indication for "reducing the risk of recurrent suicidal behavior"—namely, "in patients with schizophrenia or schizoaffective disorder who are judged to be at risk of re-experiencing suicidal behavior."

Though it is used relatively infrequently in the general psychiatric population because of its side effect profile and the need to have frequent monitoring of white blood cells for agranulocytosis,[13,14] clozapine remains an important treatment given evidence for its efficacy in select circumstances. The indication for the use of clozapine to decrease suicide risk in patients with schizophrenia is based on the InterSept trial, a large, multicenter, international RCT with 2-year follow-up and a total of 980 patients with schizophrenia and schizoaffective disorder.

In this trial, olanzapine (a more commonly prescribed atypical antipsychotic) was compared to clozapine. The clozapine group showed a significant reduction in suicide attempts compared to the olanzapine group (hazard ratio of suicide attempt or hospitalizations to prevent suicide attempt of 0.76, 95% CI=0.58, 0.97). However, the data are modest owing to the relative rarity of suicide even within such a large sample—there was no statistically significant difference between the two groups in suicide deaths (five in the clozapine group versus three in the olanzapine group).[15]

The mechanism for this decrease in suicide attempts is unclear, as it might be related to the closer follow-up of clozapine patients given the required biweekly blood counts to monitor for agranulocytosis, a rare (about 1%) but dangerous reaction unique to clozapine among antipsychotic medications. Another possible mechanism is better symptomatic control of the psychotic illnesses for which patients take the drug.

Considering clozapine's unique and complex pharmacology, however, it may bear some anti-suicidal mechanism that involves simultaneous modulation of multiple neurotransmitters (i.e., dopamine, norepinephrine, and serotonin)[16]; hormones (e.g., pregnenolone, cortisol)[17]; or intracellular systems (e.g., cyclic adenosine monophosphate–dependent modulation of *N*-methyl-D-aspartate [NMDA] receptor expression, brain-derived neurotrophic factor upregulation, and regulation of the arachidonic acid cascade)[18,19]—mechanisms independent of that which provides psychotic symptom relief. This possibility demands further study.

Despite being the first drug to demonstrate a reduction in suicidal behavior in a large RCT, clozapine's proven efficacy is limited to a very select subgroup of patients with increased suicidal risk, and its burdensome and potentially dangerous side effect profile limits the possibility for broader clinical applications. This notwithstanding, the drug's various modes of action may be potential targets for future therapeutics for suicide reduction in other groups of patients, as the pharmacologic mechanisms mentioned above are implicated in successful treatment of many DSM diagnoses, not merely schizophrenia and schizoaffective disorder. Additionally, the InterSept trial itself may be used as a model for future studies to evaluate the effectiveness of biological interventions in preventing suicide attempts and deaths.

Lithium

Lithium is one of the oldest and most widely used medications in the modern era of psychiatry. Its efficacy in the treatment of bipolar disorder, although still not mechanistically well understood, is unquestioned in the psychiatric community. There is also a reliable body of evidence to support its use as an augmenting agent to traditional antidepressants in the treatment of unipolar depression.[20] Its role in preventing suicide in patients with affective disorder is not as well established, though a significant body of evidence for this claim exists. It is hypothesized that rather than decreasing suicidal ideation, lithium mitigates suicide "secondarily," by diminishing impulsivity in many who attempt suicide.[21] Lithium impacts inositol cycling and has some neuroprotective potential, but it also displays a low therapeutic index.

Adverse effects and issues of dosing adherence represent significant barriers to its effectiveness and widespread use, particularly in patients at risk for suicide, as its toxicity profile often deters physicians from prescribing. Problems such as thyroid dysfunction, kidney dysfunction, cardiac arrhythmia, neurologic symptoms, as well as the risk of serious neurotoxicity, delirium, and convulsions when overdosed, make the decision to use lithium a serious one.

Unlike clozapine and the InterSept trial, no large randomized placebo-controlled study examining the effect of lithium on suicide has been published. However, many smaller RCTs comparing lithium to a variety of other drugs (antidepressants and anticonvulsant mood stabilizers) and placebo have been conducted. Some such studies are detailed in Table 1. Many of these trials include data regarding suicide deaths and suicide attempts.

Most notable among these was a study conducted by Oquendo et al.[23] comparing lithium to valproate in 98 patients with either bipolar disorder I, II, or not otherwise specified. This study had many unique strengths including relatively large sample size, extensive follow-up (2.5 years), and examination of both suicidal ideation and behavior. Additionally it included only patients with prior suicide attempts who would thus be expected to have a greater risk for suicidal behavior. It further stratified these patients by proximity of attempt (<1 year versus >1 year). The weaknesses of the study were its high attrition rate (approximately 50%) and its lack of placebo control. An intent-to-treat analysis showed no significant difference between lithium and valproate groups mostly owing to insufficient statistical power. However, this study is relevant not only because of its results but also its unique design.

Another slightly larger RCT of lithium versus placebo was conducted by Lauterbach[26] in 2008 in 167 depressed patients. This study included patients at higher risk for suicide, enrolling only those with a recent suicide attempt (<3 months). However, this study also suffered from a high attrition rate (only 31% retained at the 13-month follow-up). Post hoc analysis indicated that all recorded suicide deaths occurred in the placebo group. This study should be interpreted with caution but does provide some evidence for the use of lithium to address the risk of suicide in other forms of affective illness, not just bipolar disorder.

A meta-analysis of the pooled data from smaller trials was conducted in 2005 by Cipriani and colleagues.[31] In the combined lithium group, there were 2 suicide deaths out of a total of 503 subjects, and in the combined placebo/comparator drug group, there were 11 suicide deaths among 611 subjects (OR=0.26, 95% CI=0.09, 0.77). The analysis also showed a decrease in all suicidal behavior (8 events among 670 subjects in the lithium groups vs 18 of 781 in the placebo/comparator drug groups, OR=0.21, 95% CI=0.08, 0.51). Finally, all-cause mortality was examined and found to be lower in the lithium group than the comparator/placebo group (9/696 vs 22/788, OR=0.42, 95% CI=0.21, 0.87), suggesting that the effect of lithium may be beneficial in preventing death despite the threat of toxicity.

An update to this analysis was published in 2013 and included data from 48 RCTs with a total of 6,674 subjects.[32] Examined outcomes were once again suicide deaths, suicidal behavior (renamed "deliberate self-harm"), and all-cause mortality. Again, lithium was more effective than placebo and comparator drugs in preventing suicide deaths (OR=0.13, 95% CI=0.03, 0.66), but unlike the 2005 analysis, it did not show a significant difference in reduction of deliberate self-harm (OR=0.60, 95% CI=0.27, 1.32). All-cause mortality was, again, found to be decreased (OR=0.38, 95% CI=0.15, 0.95). Given the pooled sample size and the size of the effect on suicide mortality, the findings of Cipriani et al give fairly compelling evidence for the use of lithium in preventing suicide deaths.

A meta-analysis of 45 mostly open-label, naturalistic studies conducted by Baldessarini and colleagues[33] in 2006 communicated a similar message; they found a suicide death or suicide attempt event prevalence of 0.435% per year on lithium, compared with 2.63% per year off lithium, a near seven-fold decrease in risk for the pooled drug treated group.[34] Other similarly conducted meta-analyses have yielded concordant results.[35,36] The case for lithium as a suicide prevention agent in patients with bipolar disorder who are at risk for suicide is a relatively strong one, based on limited RCTs and cohort studies. However, the magnitude of this protective effect, the generalizability of this effect to other mental

Table 1. Summary of randomized medication trials evaluating suicidal ideation/behavior as a primary outcome

Study	Diagnosis	History of suicide attempt	Design/sample	Primary measures	Results
Grunebaum et al. (2012)[22]	MDD	Yes	DB, RCT, N=74, paroxetine (max 50 mg/day) versus bupropion (max 450 mg/day), 16 weeks	Suicidal attempt classification by weekly consensus; suicidal events by Columbia Suicide History Form; SSI	Depressed patients with greater baseline SI treated with paroxetine compared to bupropion appeared to experience greater acute improvement in suicidal ideation, after adjusting for global depression
Oquendo et al. (2011)[23]	BD	Yes	DB, RCT, N=98, lithium versus valproate, 2.5 years	Time to suicide completion; time to suicide attempt; time to suicide event; SSI	Intent-to-treat analysis showed no differences between treatment groups in time to suicide attempt or to suicide event
Khan et al. (2011)[24]	MDD	No	DB, RCT, N=80, parallel group; citalopram (20 mg/day) + placebo versus citalopram + lithium (300 mg/day), 4 weeks	At screening and trial end: suicidal thoughts/behaviors; S-STS; MADRS; CSSRS	No significant differences in primary outcome measures at 4 weeks; post hoc analysis showed patients assigned to citalopram + lithium had significantly higher S-STS remission rates
Rucci et al. (2011)[25]	MDD	No	Two-site, RCT, N=29, allocated to IPT or SSRI, 4 months	SI; Suicidality items from HDRS and QIDS	Time to suicidal ideation was significantly longer in patients allocated to SSRI compared to those allocated to IPT, even after controlling for treatment augmentation, benzodiazepine use, and comorbid anxiety disorders
Lauterbach et al. (2008)[26]	Affective spectrum disorders	Yes	DB, RCT, N=167, recent suicide attempts (<3 months), treatment with lithium or placebo, 12 months	Suicide attempt; SSI	Survival analysis showed no significant difference of suicidal acts between lithium and placebo; post hoc analysis revealed that all suicide deaths had occurred in the placebo group, with significant difference in incidence rate
Reeves et al. (2008)[27]	MDD	No	DB, RCT, placebo-controlled, N=24, antidepressant + risperidone (0.25–2 mg/day) versus antidepressant + placebo, 8 weeks	Severity of suicidality; SSI	Risperidone significantly reduced SI in MDD patients; overall effect of risperidone superior to placebo; the onset of effect was within 2 weeks of treatment and sustained for the 8-week course
Lauterbach et al. (2005)[28]	Absence of MDD or BD	Yes	DB, RCT, N=70, placebo-controlled multi-center trial evaluating proposed suicide preventive effects of lithium in patients with suicidal behavior	Number of suicide attempts or suicide deaths; SIS; Medical Damage Scale; Risk-Rescue Scale; SSI	SUPLI study terminated because number of enrolled individuals after 5 years was still below necessary estimated sample size

(continued on next page)

Table 1. Summary of randomized medication trials evaluating suicidal ideation/behavior as a primary outcome *(continued)*

Study	Diagnosis	History of suicide attempt	Design/sample	Primary measures	Results
Meltzer et al. (2003)[16]	Schizophrenia/ schizoaffective disorder	Yes	Multicenter, RCT, N=980, international, clozapine versus olanzapine, 2 years	Suicide attempts/ completion; hospitalizations to prevent suicide; rating of "much worsening of suicidality" from baseline; CGI-SS	Clozapine therapy was superior to olanzapine therapy in preventing suicide attempts in patients with schizophrenia and schizoaffective disorder at high risk for suicide
Verkes et al. (1998)[29]	No DSM diagnosis	Yes	DB, RCT, N=91, paroxetine (40 mg/ day) versus placebo in patients who recently attempted suicide for at least a second time, 1year	suicide attempt; self-rating scales for depressive symptoms, anger; Axis II diagnoses	With adjustment for the number of previous suicide attempts, paroxetine showed significant efficacy in the prevention of recurrent suicidal behavior

Adapted from Mathews et al.[30]
BD, bipolar disorder; CGI-SS, Clinical Global Impression of Suicide Severity; C-SSRS, Columbia Suicide Severity Rating Scale; DB, double blind; HDRS, Hamilton Rating Scale for Depression; IPT, interpersonal therapy; MADRS, Montgomery–Åsberg Depression Rating Scale; MDD, major depressive disorder; QIDS, Quick Inventory of Depressive Symptomatology; SI, suicidal ideation; SIS, Suicide Intent Scale; SSI, scale for suicide ideation; SSRI, selective serotonin reuptake inhibitor; S-STS, Sheehan-Suicidality Tracking Scale; SUPLI, Suicide Prevention by Lithium—the Lithium Intervention Study

disorders, and the risk–benefit profile of its widespread use primarily as a suicide risk–mitigating agent are all topics for further debate and study.

Antidepressants, Antipsychotics, and Neurostimulatory Techniques

There are a variety of other agents used to treat psychiatric disorders related to suicide. Antipsychotics, antidepressants, and neurostimulatory therapies, such as TMS and ECT, have all been proposed as possible biological treatments for the prevention of suicide and suicidal behavior. Perhaps with the exception of the newer and less-studied TMS, these therapeutic agents are widely accepted in the psychiatric community as treatments for discrete DSM-diagnosed mental disorders.

Additionally, untreated mental illness, particularly depression, has been shown in epidemiologic studies to be a significant risk factor for suicide attempts and deaths.[37,38] Therefore, much of the current rationale for the use of these agents in decreasing suicide risk is based on this indirect yet widely accepted logic. The symptomatic relief these agents provide is generally supported by literature that is beyond the scope of this paper. Nevertheless, direct evidence for the efficacy of these agents in suicide prevention is not as compelling as that for lithium and clozapine. Second-generation antipsychotics are widely prescribed, yet the class effect of these medications on suicide—aside from the protective effect of clozapine—has yet to be explored in much detail.

One study[27] of note in patients with major depressive disorder examined augmentation strategies by comparing the effect of antidepressant plus risperidone to antidepressant plus placebo on suicidal ideation. It used the scale of suicidal ideation as well as other "suicidality" measures as outcomes. For the risperidone group, a significant effect on suicidal ideation was seen at 2 weeks that continued until the end of follow-up at 8 weeks. This study, however, suffered from a short follow-up (8 weeks) and low statistical power (N=24), and it examined suicidal ideation only without any data on suicidal behavior.

A post hoc analysis[39] of pooled secondary outcomes data from two 6-week studies with a total of 737 patients where augmentation of antidepressants with aripiprazole was examined showed no difference in "suicide-related adverse events," although it did show significant decreases in suicidal ideation with aripiprazole augmentation on both the Montgomery–Åsberg Depression Rating Scale and the Inventory of Depressive Symptomatology. A retrospective database study has suggested that better medication compliance with antipsychotics is associated with a decreased risk of suicide.[40]

Several RCTs have been conducted in recent years examining effectiveness of antidepressants in reducing suicidal ideation and behavior. One trial[22] compared bupropion to paroxetine and evaluated suicide attempts, deaths, and ideation; it showed greater improvement in suicidal ideation for paroxetine over bupropion in patients with more severe baseline suicidal ideation. Another[29] compared paroxetine to placebo with 91 participants who

had all attempted suicide for at least the second time within the last year. With adjustment for the number of previous suicide attempts, paroxetine showed significant efficacy in the prevention of recurrent suicidal behavior. Both studies were relatively unique in that they included subjects at significant risk for suicide with active suicidal ideation.

Augmentation of the antidepressant citalopram with lithium has also been examined in a study[24] of 80 patients for 4 weeks. Although there was no difference in primary outcomes (suicidal thoughts and behaviors) at the 4-week point, a post hoc analysis showed that patients assigned to citalopram plus lithium had significantly higher Sheehan-Suicidality Tracking Scale remission rates—in these studies and several others summarized in Table 1. The observational studies also show a link between prescription rates of antidepressants and a decrease in the incidence of suicide, but the results of meta-analyses have been mixed.[41]

There is some evidence that the additional prescription of antidepressants or antipsychotics to an existing prescription of an anticonvulsant may actually increase the risk of suicide attempt in patients with bipolar disorder.[42] Additionally, for therapeutic efficacy, these interventions may take weeks to months to find the optimal blend of compounds and doses. During such times of trial and titration, a patient may remain at significant risk for suicide.

ECT is an intervention for which its role in suicide prevention is not based on any robust, formalized study, but rather relies on a long clinical history of successful use in the treatment of depression associated with suicidal thoughts and behaviors. Despite expert consensus that ECT is effective, it has a limited role in the general prevention of suicide given its cost, limited availability, and procedural logistics with associated stigma. Each treatment requires several hours for administration of anesthesia and recovery in a monitored medical setting, and it is generally given 3 times per week for 2–4 weeks, making it a very involved process for patients, clinicians, and family members. Unlike the pharmacotherapies discussed above, convulsive treatments can work rather quickly to reduce suicidal ideation, but their long-term impact is not as clear, and the potential for cognitive side effects can be limiting.

TMS is a newer neurostimulatory technique that is less invasive than ECT and does not require sedation. It utilizes alternating magnetic fields to induce neuronal firing in targeted brain regions. In a recent trial[43] that included some patients with a history of suicide attempt, TMS was shown to have an effect on depressive symptoms, including suicidal ideation, comparable to that of a 6-week course of standard antidepressant medications. One weakness of the study was it did not take into account the proximity of attempts to the treatment. Direct evaluation of this novel therapy with regard to suicide has not been conducted.

Ketamine or Ketamine-Like Compounds

Ketamine is an anesthetic agent that works on the glutamatergic system by specifically antagonizing NMDA receptors. Ketamine has been used and FDA approved as a general anesthetic agent since the 1970s, but it does sometimes precipitate transient psychotomimetic reactions, and these central nervous system (CNS) effects are related to its recreational use and abuse.

Until recently, its use had been largely limited to pediatric and veterinary populations, but utility for emergency procedures and management of chronic pain syndromes has been demonstrated. And in the past 10 years, evidence has emerged that ketamine has rapid-acting antidepressant properties, even at lower, subanesthetic doses. This effect is seen as early as 40 minutes after IV infusion and typically lasts 3–7 days, with some patients experiencing improved mood beyond 7 days.[44–46] The effect is thought to be mediated by molecular cascades that promote synaptic plasticity and dendritic spine maturation in key brain regions.[47]

Ketamine is generally well tolerated at low doses, with the most common side effects being transient and limited to the infusion period (generally 40–60 minutes), including transient increases in blood pressure and heart rate, mild dissociative symptoms such as dizziness, derealization, and depersonalization, and transient neurologic symptoms such as aphasia, diplopia, nystagmus, and paresthesias. These side effects only rarely are severe enough to lead to termination of infusion. One challenge of using ketamine as an antidepressant, though, is its potential for abuse and associated classification as a controlled substance. Efforts are being made to explore the efficacy of ketamine-like agents that act on the same brain systems but have a more favorable side-effect profile and lower addictive potential (e.g., GLYX-13 and AZD6765).[48,49]

Although no studies directly examining the effect of ketamine on suicide attempts and deaths have been completed, there is a significant body of evidence for its rapid effect on mood in patients with suicidal ideation. There have been several RCTs conducted in the last decade demonstrating the rapid antidepressant effect of ketamine in both bipolar and unipolar depression, even that refractory to other treatments.[44,45] Suicidal tendencies and thoughts that are conceptualized as part of these depressive conditions appear to remit just as rapidly as the overall syndrome.[50]

This may give a rapid-acting agent such as ketamine an advantage in the acute management of suicide risk

over traditional antidepressants with effects that may be more enduring with consistent daily dosing but take much longer to develop. There may be mechanistic grounds for this rapid effect, as new research connects inflammatory markers of depression with physiologic glutamate agonism in suicidal patients,[51] a clinical state that ketamine's NMDA antagonism rapidly reverses with potentially protective effects.

Because of the prolonged period between the initiation of treatment and the onset of action of most currently available antidepressant medications (often 2 weeks or more), there is little that can be done in the setting of acute and serious suicidal ideation aside from close monitoring or hospitalization. This could make ketamine and other potential rapid-acting antidepressant medications uniquely suited for acute biological intervention in suicide prevention. One open-label study in the emergency setting showed significant reductions of suicidal ideation on a standardized depression rating scale just 40 minutes after IV bolus administration of low-dose ketamine.[52] NMDA agents certainly warrant further investigation as part of strategies intended to reduce suicide deaths.

Conclusions and Future Research

Direct study of patients at high risk for suicide with particular attention to the acute precipitants and related opportunities for intervention will always be challenging. In such vulnerable populations who suffer rare but lethal events, it is particularly difficult to test single interventions the way that we expect in high-quality biomedical studies. To simultaneously monitor and ensure safety while controlling for therapeutic variables apart from a purported suicide risk–mitigating treatment itself is complicated, based upon what we know about the impact of psychosocial care, relatedness, and even the passage of time in a monitored environment.

Studies of suicidal ideation, though much easier to conduct from an ethical and logistic perspective, may not translate well to the more relevant outcomes of suicidal behavior and mortality. Sufficiently large, practical, multi-site studies using patient registries are needed so that larger-scale data can be gathered to assess treatment effects and track long-term outcomes. Many in the field are now advocating greater standardization of methodology and outcomes measures (e.g., suicidal ideation versus suicidal behavior versus suicidal mortality) to improve the shelf life and compatibility of data collected in smaller studies.[53]

For compounds that already appear to be beneficial, pharmacologic study coupled with neurobiological techniques such as functional neuroimaging, CNS spectroscopy, polysomnography, and genetic analysis may reveal what is vulnerable about patients and, correspondingly, what is protective about drugs like lithium and clozapine. Many psychological vulnerabilities place individuals at risk for suicide, including hopelessness, poor self-esteem, impulsivity, deficient problem-solving skills, disadvantageous decision making,[54] poor reality testing, and cognitive rigidity.

Yet, the neurobiological mechanisms of these vulnerabilities and their related constructs remain unexplicated; thus, it is difficult to discern how proposed biological agents could act to mitigate them at a neurophysiological level. Study of the nature of the neurobiological principles involved in suicidal vulnerability and resilience may lead to the tailoring of therapeutics to specific patient needs.

More sophisticated characterization of suicidal individuals should also be useful in its own right. Identifying DSM diagnostic entities and testing treatments designed to address them has not reduced rates of suicide. It is time for a shift in thinking about what a patient at risk for suicide is and what a suicide risk–mitigating drug would do. There are a number of different reasons why different types of individuals end their own lives. Assembling typologies of individuals based upon different factors of history, phenomenology, behavior, and advanced neurobiology together is likely to reveal certain therapies (both established and novel) that are helpful to different individuals.

Such research could reveal endophenotypes of suicidal individuals with new biological targets as well. Typological categorization of patients and of suicide risk itself would also serve as the foundation for detailed assessment of new therapies. One clinical reality supporting this mode of categorization is the tremendous comorbidity of psychiatric disorders and symptoms in those who attempt suicide. Diagnostic comorbidity has been shown to be one of the greatest predictors of suicide, though this finding has not yet put medical science closer to realistic prevention strategies.[55]

More sophisticated interventions should emerge from studies designed to understand suicide at the interface of biology with other factors—many of which are environmental—that impact risk. One recent study using an integrative approach to assess multiple variables demonstrated gender differences in suicide attempters related to a history of suffering abuse and markers of function (cortisol, dehydroepiandrosterone sulphate, and serotonin) in different neurobiological systems.[56] The findings of the study did not point to a simple chemical lesion or common CNS locus of self-destruction, but instead reflect the complex reality of factors that must be considered when targeting physiology for prevention.

Lastly, any assessments and innovations must account for the impact of time. Just as its passage is the ultimate arbiter of mortality for everyone, time also greatly impacts

the experience of and response to suicidal individuals. Some biological interventions may modulate traits, whereas others may be state-specific in their suicide risk–mitigating effects. Patients spend much more of their lives in non-clinical settings where trait-based treatments may be more effective, but many more variables and risk factors are at play at those times, making the systematic study and effective implementation of such treatments challenging. On the other hand, clinic- and hospital-based treatments of acute states, although more easily studied and systematized, may not provide lasting effects in the prevention of suicide.

Additionally, optimism about any intervention must be tempered by the realities of access and delivery. Though the prospect of discovering a rapidly acting biological agent to mitigate acute suicide risk may seem ideal for practice in the acute setting, one must also account for the daily existence that patients face outside the context of care—one that often still places them at high chronic risk for suicide.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

Dr. Zarate is listed as a coinventor on a patent application for the use of ketamine and its metabolites in major depression. Dr. Zarate has assigned his rights in the patent to the U.S. government but will share a percentage of any royalties that may be received by the government.

No financial disclosures were reported by the other authors of this paper.

References

1. WHO. SUPRE information leaflet. Geneva: WHO, 2002. www.who.int/entity/mental_health/management/en/SUPRE_flyer1.pdf.
2. Rockett IR, Regier MD, Kapusta ND, et al. Leading causes of unintentional and intentional injury mortality: U.S., 2000–2009. Am J Public Health 2012;102(11):e84–e92.
3. CDC. Trends in suicide rates among persons ages 10 years and older, by sex, U.S., 1991–2009. Atlanta GA: CDC, 2014. cdc.gov/violenceprevention/suicide/statistics/trends01.html.
4. Cavanagh JT, Carson AJ, Sharpe M, Lawrie SM. Psychological autopsy studies of suicide: a systematic review. Psychol Med 2003;33(3):395–405.
5. Milner A, Sveticic J, De Leo D. Suicide in the absence of mental disorder? A review of psychological autopsy studies across countries. Int J Soc Psychiatry 2013;59(6):545–54.
6. Mann JJ, Waternaux C, Haas GL, Malone KM. Toward a clinical model of suicidal behavior in psychiatric patients. Am J Psychiatry 1999;156(2):181–9.
7. O'Neil ME, Peterson K, Low A, et al. Suicide prevention interventions and referral/follow-up services: a systematic review. Washington DC: Department of Veterans Affairs, Health Services Research and Development Service, 2012. VA-ESP Project #05-225. www.hsrd.research.va.gov/publications/esp/suicide-interventions.pdf.
8. O'Connor E, Gaynes B, Burda BU, et al. Screening for suicide risk in primary care: a systematic evidence review for the U.S. Preventive Services Task Force. ncbi.nlm.nih.gov/books/NBK137737/.
9. NICE. Self-harm: the NICE guideline on longer-term management. nccmh.org.uk/guidelines_selfharm_ltm.html.
10. Zimmerman M, Mattia JI, Posternak MA. Are subjects in pharmacological treatment trials of depression representative of patients in routine clinical practice? Am J Psychiatry 2002;159(3):469–73.
11. Whittington CJ, Kendall T, Fonagy P, Cottrell D, Cotgrove A, Boddington E. Selective serotonin reuptake inhibitors in childhood depression: systematic review of published versus unpublished data. Lancet 2004;363(9418):1341–5.
12. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Washington DC: APA, 2013.
13. van der Feltz-Cornelis CM, Sarchiapone M, Postuvan V, et al. Best practice elements of multilevel suicide prevention strategies. Crisis 2011;32(6):319–33.
14. Nielsen J, Dahm M, Lublin H, Taylor D. Psychiatrists' attitude towards and knowledge of clozapine treatment. J Psychopharmacol 2010;24(7):965–71.
15. Pharmacy Times. Top 200 drugs of 2011. Plainsboro NJ: Pharmacy Times, 2012. www.pharmacytimes.com/_media/_pdf/Top_200_Drugs_2011_Total_Rx.pdf.
16. Meltzer HY, Alphs L, Green AI, et al. Clozapine treatment for suicidality in schizophrenia: International Suicide Prevention Trial (InterSePT). Arch Gen Psychiatry 2003;60(1):82–91.
17. Meltzer HY, Anand R, Alphs L. Reducing suicide risk in schizophrenia: focus on the role of clozapine. CNS Drugs 2000;14(5):355–65.
18. Marx CE, Shampine LJ, Duncan GE, et al. Clozapine markedly elevates pregnenolone in rat hippocampus, cerebral cortex, and serum: candidate mechanism for superior efficacy? Pharmacol Biochem Behav 2006;84(4):598–608.
19. Leveque JC, Macías W, Rajadhyaksha A, et al. Intracellular modulation of NMDA receptor function by antipsychotic drugs. J Neurosci 2000;20(11):4011–20.
20. Kim HW, Cheon Y, Modi HR, Rapoport SI, Rao JS. Effects of chronic clozapine administration on markers of arachidonic acid cascade and synaptic integrity in rat brain. Psychopharmacology 2012;222(4):663–74.
21. Lam RW, Kennedy SH, Grigoriadis S, et al. Canadian Network for Mood and Anxiety Treatments (CANMAT) clinical guidelines for the management of major depressive disorder in adults. III. Pharmacotherapy. J Affect Disord 2009;117(S1):S26–S43.
22. Grunebaum MF, Ellis SP, Duan N, Burke AK, Oquendo MA, John Mann J. Pilot randomized clinical trial of an SSRI vs bupropion: effects on suicidal behavior, ideation, and mood in major depression. Neuropsychopharmacology 2012;37(3):697–706.
23. Oquendo MA, Galfalvy HC, Currier D, et al. Treatment of suicide attempters with bipolar disorder: a randomized clinical trial comparing lithium and valproate in the prevention of suicidal behavior. Am J Psychiatry 2011;168(10):1050–6.
24. Khan A, Khan SR, Hobus J, et al. Differential pattern of response in mood symptoms and suicide risk measures in severely ill depressed patients assigned to citalopram with placebo or citalopram combined with lithium: role of lithium levels. J Psychiatr Res 2011;45(11):1489–96.
25. Rucci P, Frank E, Scocco P, et al. Treatment emergent suicidal ideation during 4 months of acute management of unipolar major depression with SSRI pharmacotherapy or interpersonal psychotherapy in a randomized clinical trial. Depress Anxiety 2011;28(4):303–9.
26. Lauterbach E, Felber W, Muller-Oerlinghausen B, et al. Adjunctive lithium treatment in the prevention of suicidal behaviour in depressive disorders: a randomised, placebo-controlled, 1-year trial. Acta Psychiatr Scand 2008;118(6):469–79.

27. Reeves H, Batra S, May RS, Zhang R, Dahl DC, Li X. Efficacy of risperidone augmentation to antidepressants in the management of suicidality in major depressive disorder: a randomized, double-blind, placebo-controlled pilot study. J Clin Psychiatry 2008;69(8):1228.
28. Lauterbach E, Ahrens B, Felber W, et al. Suicide prevention by lithium SUPLI—challenges of a multi-center prospective study. Arch Suicide Res 2005;9(1):27–34.
29. Verkes RJ, Van der Mast RC, Hengeveld MW, Tuyl JP, Zwinderman AH, Van Kempen GM. Reduction by paroxetine of suicidal behavior in patients with repeated suicide attempts but not major depression. Am J Psychiatry 1998;155(4):543–7.
30. Mathews DC, Richards EM, Niciu MJ, Ionescu DF, Rasimas JJ, Zarate CA. Neurobiological aspects of suicide and suicide attempts in bipolar disorder. Transl Neurosci 2013: In press.
31. Cipriani A, Pretty H, Hawton K, Geddes JR. Lithium in the prevention of suicidal behavior and all-cause mortality in patients with mood disorders: a systematic review of randomized trials. Am J Psychiatry 2005;162(10):1805–19.
32. Cipriani A, Hawton K, Stockton S, Geddes JR. Lithium in the prevention of suicide in mood disorders: updated systematic review and meta-analysis. BMJ 2013;346:f3646.
33. Baldessarini RJ, Tondo L, Davis P, Pompili M, Goodwin FK, Hennen J. Decreased risk of suicides and attempts during long-term lithium treatment: a meta-analytic review. Bipolar Disorders 2006;8(5 Pt 2): 625–39.
34. Müller-Oerlinghausen B, Ahrens B, Felber W. The suicide-preventive and mortality reducing effect of lithium. Lithium in neuropsychiatry: the comprehensive guide. Oxfordshire: Informa Healthcare, 2006.
35. Guzzetta F, Tondo L, Centorrino F, Baldessarini RJ. Lithium treatment reduces suicide risk in recurrent major depressive disorder. J Clin Psychiatry 2007;68(3):380–3.
36. Muller-Oerlinghausen B. Arguments for the specificity of the anti-suicidal effect of lithium. Eur Arch Psychiatry Clin Neurosci 2001; 251(2S):S1172–S1175.
37. Isacsson G, Holmgren A, Ösby U, Ahlner J. Decrease in suicide among the individuals treated with antidepressants: a controlled study of antidepressants in suicide, Sweden 1995–2005. Acta Psychiatrica Scandinavica 2009;120(1):37–44.
38. Isacsson G, Bergman U, Rich CL. Epidemiological data suggest antidepressants reduce suicide risk among depressives. J Affect Disorders 1996;41(1):1–8.
39. Weisler RH, Khan A, Trivedi MH, et al. Analysis of suicidality in pooled data from 2 double-blind, placebo-controlled aripiprazole adjunctive therapy trials in major depressive disorder. J Clin Psychiatry 2011;72(4):548–55.
40. Ward A, Ishak K, Proskorovsky I, Caro J. Compliance with refilling prescriptions for atypical antipsychotic agents and its association with the risks for hospitalization, suicide, and death in patients with schizophrenia in Quebec and Saskatchewan: a retrospective database study. Clin Ther 2006;28(11):1912–21.
41. Saunders KE, Hawton K. The role of psychopharmacology in suicide prevention. Epidemiol Psychiatr Soc 2009;18(3):172–8.
42. Yerevanian BI, Koek RJ, Mintz J. Bipolar pharmacotherapy and suicidal behavior: part 3: impact of antipsychotics. J Affect Disorders 2007;103(1–3):23–8.
43. Ferrucci R, Bortolomasi M, Vergari, et al. Transcranial direct current stimulation in severe, drug-resistant major depression. J Affect Disord 2009;118(1-3):215–9.
44. Zarate CA, Singh JB, Carlson PJ, et al. A randomized trial of an *N*-methyl-D-aspartate antagonist in treatment-resistant major depression. Arch Gen Psychiatry 2006;63(8):856–64.
45. Zarate CA Jr, Brutsche NE, Ibrahim L, et al. Replication of ketamine's antidepressant efficacy in bipolar depression: a randomized controlled add-on trial. Biol Psychiatry 2012;71(11):939–46.
46. Berman RM, Cappiello A, Anand A, et al. Antidepressant effects of ketamine in depressed patients. Biol Psychiatry 2000;47(4):351–4.
47. Kavalali ET, Monteggia LM. Synaptic mechanisms underlying rapid antidepressant action of ketamine. Am J Psychiatry 2012;169(11):1150–6.
48. Burgdorf J, Zhang XL, Nicholson KL, et al. GLYX-13, a NMDA receptor glycine-site functional partial agonist, induces antidepressant-like effects without ketamine-like side effects. Neuropsychopharmacology 2013;38(5):729–42.
49. Zarate CA Jr., Mathews D, Ibrahim L, et al. A randomized trial of a low-trapping nonselective *N*-methyl-D-aspartate channel blocker in major depression. Biol Psychiatry 2012;S0006-3223(12):941–9.
50. DiazGranados N, Ibrahim LA, Brutsche NE, et al. Rapid resolution of suicidal ideation after a single infusion of an *N*-methyl-D-aspartate antagonist in patients with treatment-resistant major depressive disorder. J Clin Psychiatry 2010;71(12):1605–11.
51. Erhardt S, Lim CK, Linderholm KR, et al. Connecting inflammation with glutamate agonism in suicidality. Neuropsychopharmacology 2013;38(5):743–52.
52. Larkin GL, Beautrais AL. A preliminary naturalistic study of low-dose ketamine for depression and suicide ideation in the emergency department. Int J Neuropsychopharmacol 2011;14(8):1127–31.
53. Insel TR, Morris SE, Heinssen RK. Standardization, integration, and sharing-leveraging research investments. Biol Psychiatry 2011;70(1):5–6.
54. Richard-Devantoy S, Berlim MT, Jollant F. A meta-analysis of neuropsychological markers of vulnerability to suicidal behavior in mood disorders. Psychol Med 2013;44(8):1663–73.
55. Nock MK, Hwang I, Sampson NA, Kessler RC. Mental disorders, comorbidity and suicidal behavior: results from the National Comorbidity Survey Replication. Mol Psychiatr 2009;15(8):868–76.
56. Chatzittofis A, Nordström P, Hellström C, Arver S, Åsberg M, Jokinen JCSF. 5-HIAA, cortisol and DHEAS levels in suicide attempters. Eur Neuropsychopharmacol 2013;23(10):1280–7.

Alcohol and Suicidal Behavior

What Is Known and What Can Be Done

Kenneth R. Conner, PsyD, MPH, Courtney L. Bagge, PhD, David B. Goldston, PhD, Mark A. Ilgen, PhD

Research on associations between substances of abuse and suicidal behaviors is a large, complex area. Herein, alcohol, the most commonly abused intoxicant worldwide, is examined with a focus on two topics: (1) acute use of alcohol (AUA) shortly prior to suicidal behavior; and (2) more chronic alcohol use disorder (AUD) and suicidal behavior. First, a brief summary of what is known about AUA, AUD, and suicidal behavior is provided. Next, we draw on preliminary evidence, practical considerations, and our own experience to offer recommendations for intervention research that may lower risk associated with AUA and AUD. The literature on AUD and suicidal behavior is more developed, thus we discuss separately research designed to: (1) prevent individuals with AUD with suicidal ideation from engaging in suicidal behavior; and (2) prevent individuals with AUD who have made a suicide attempt from reattempting. Our focus is on clinical intervention strategies for individuals at risk for suicidal behavior that use alcohol or have developed AUD. We also focus on applied research that may directly lead to practical prevention efforts. Although clinical interventions are important components of a comprehensive suicide prevention strategy, they should be complemented with primary prevention efforts.

(Am J Prev Med 2014;47(3S2):S204–S208) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

Acute use of alcohol (AUA) and alcohol use disorder (AUD) are correlated but distinct constructs. For example, AUA is a potent risk factor for suicidal behavior after adjusting for drinking pattern or AUD,[1] and many acts of suicide among individuals with a history of AUD occur outside periods of acute intoxication.[2,3]

An empirical review of published studies reported that a median of 37% of suicides and 40% of suicide attempts are preceded by AUA.[4] The reviewed reports were primarily uncontrolled descriptive studies, and only a handful of studies of AUA and suicidal behavior have included a non-suicidal control group[5–7] or used a case-crossover design where cases served as their own controls.[8,9] These controlled reports were limited by the small number of suicidal acts preceded by AUA, with fewer than 50 such cases in each study.

Nonetheless, each controlled study demonstrated that AUA confers increased risk at a statistically significant level, with point estimates in the range of 5–10-fold risk. There are also data indicating that risk for suicidal behavior is increased at high drinking levels[5,6,8] and that use of firearms and hanging, deadly methods of suicide, are associated with high drinking levels,[10] underscoring the importance of alcohol dose in the link between AUA and suicidal behavior.

Psychological autopsy investigations worldwide show that substance use disorders, most often AUD, are the second most common group of mental disorders among suicide decedents and that AUD is a risk factor for suicide.[11] Epidemiologic studies[12] also show that AUD is a risk factor for suicide attempts. Several reports[13–15] have examined risk factors for suicide attempts and suicide among individuals with AUD.

These studies show that, compared to non-suicidal individuals with AUD, those with AUD who attempt or die by suicide are more likely to have (or show greater levels of) depressive disorder, drug use disorder, AUD symptoms or severity, low social support, aggression,

From the Department of Psychiatry (Conner), University of Rochester Medical Center, Rochester; VISN2 Center of Excellence for Suicide Prevention (Conner), Canandaigua VA Medical Center, Canandaigua, New York; Department of Psychiatry and Human Behavior (Bagge), University of Mississippi Medical Center, Jackson, Mississippi; Department of Psychiatry and Behavioral Sciences (Goldston), Duke University School of Medicine, Durham, North Carolina; Veterans Affairs Serious Mental Illness Treatment Resource and Evaluation Center (Ilgen), Department of Veterans Affairs Healthcare System, and Department of Psychiatry (Ilgen), University of Michigan, Ann Arbor, Michigan

Address correspondence to: Kenneth R. Conner, PsyD, MPH, Department of Psychiatry, University of Rochester Medical Center, 300 Crittenden Boulevard, Rochester NY. E-mail: kenneth_conner@urmc.rochester.edu.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.06.007

interpersonal stressful life events, medical illness or complaints, and unemployment or other indications of economic adversity. Among comorbidities, depression is particularly salient and associated with risk in this population, regardless of whether it is caused by AUD or other drug use (i.e., substance-induced depression) or occurs independent of AUD (i.e., primary depression).[16,17]

What Can Be Done to Understand and Lower Risk Associated with AUA

There are a number of breakthroughs that would need to occur to best inform prevention and intervention efforts concerning the association between AUA and suicidal behavior. There is a paucity of data on drinking shortly prior to suicidal behavior beyond estimates of the number of drinks consumed in a general period of time (e.g., within 3 hours of death). Missing are data pertinent to understanding the progression or escalation of suicidal risk during drinking bouts. Research is needed on whether alcohol use (and degree of use) and suicidal ideation (and degree of ideation) covary generally. Such event-based analysis of drinking and suicidal thoughts and behavior would inform theory and prevention efforts targeting alcohol-involved acts of suicide.

It is also necessary to determine the mechanisms by which AUA may increase suicidal thoughts and behavior. These mechanisms may include, but are not limited to, alcohol-related psychological distress, depressed mood and anxiety, aggressiveness, impulsivity, and cognitive constriction.[18,19] AUA may also lead to acute interpersonal conflict and disruption that may serve to increase risk for stress reactive suicidal behavior.[20] Preliminary genetic research suggests that suicidal acts preceded by AUA may be a distinct phenotype of suicidal behavior.[21]

Prior studies of AUA and suicidal behavior have failed to consider that the circumstances and motivations for drinking prior to suicidal behavior may differ in key ways. For example, although seldom considered, alcohol may be used deliberately prior to suicidal behavior in order to remove psychological barriers by increasing courage and numbing fears; anesthetizing the pain of dying[18,19]; or to make death more likely (e.g., "I mixed alcohol with pills"). Although the use of alcohol for the purpose of facilitating suicidal behavior has rarely been examined, a large case series estimated that approximately one quarter of suicide attempters with AUA fit this pattern,[22] suggesting it is common.

We hypothesize that use of alcohol among individuals intending to make a suicide attempt, for the purpose of facilitating the suicidal act, may represent a distinct group typified by greater suicide planning, intent, lethality, and potentially co-occurring depression. Such an idea could be tested using a large sample of suicide attempts preceded by AUA whose motivations for alcohol use (among other variables) were retrospectively assessed shortly after the attempt.

After a finer-grained understanding of the role of AUA and suicidal thoughts and behavior is obtained, treatment development research may proceed to prevent attempts in acutely intoxicated individuals expressing suicidal ideation and to prevent reattempts among individuals with a history of attempt(s) while drinking. This likely will concern two phases, development of research for acute intervention (e.g., crisis-line calls, hospital presentation) and then linkage to integrated interventions that address the specific role of AUA in suicidal risk for a particular patient, and target both behaviors.

Although it is logical to pursue foundational studies at this early stage of research, there is also an urgency to explore what may work in preventing suicidal behavior based on current knowledge. For example, the current zeitgeist in emergency settings is to wait until intoxicated suicidal individuals "sober up" and reassess them for safety, with most being sent home with an outpatient appointment.

Data[23] also suggest that patients hospitalized for suicide risk who are judged to have risk related to alcohol (or drug) intoxication are discharged sooner than patients who are perceived not to have substance-related risk. Individuals who appear to be at increased risk for suicidal behavior while intoxicated provide an opportunity for researchers to explore the feasibility and promise of brief interventions that may be delivered prior to discharge including interventions to increase motivation to live[24] and to develop a safety plan.[25]

The study of AUA and suicidal behavior presents many challenges. Potentially informative naturalistic studies of intoxicated suicidal states, such as during presentations to emergency departments, for example, may not be possible because of prohibitions on obtaining informed consent for research from intoxicated persons. Similarly, for ethical reasons, controlled experiments to examine the role of drinking in suicidal thoughts or other relevant cognitive or affective states may only be able to be conducted in low-risk populations, with unclear generalizability to high-risk patients known to become suicidal while drinking.

The low incidence rate of suicidal behavior in most populations may make it impractical to study drinking immediately prior to suicidal behavior using intensive prospective study designs such as experience sampling where data may be gathered several times per day. Moreover, asking an individual to continue to document their drinking during an unfolding suicidal crisis raises

ethical concerns and would presumably require the investigator to intervene whenever possible, altering the course of the phenomena under study.

Understanding and Lowering Risk Associated with AUD

One approach to prevent individuals with AUD and suicidal ideation from attempting suicide is to focus on treating the AUD, with the expectation that suicide risk will become reduced with successful treatment. Indirect support for this conclusion comes from observational research indicating that non-fatal suicide attempts are approximately half as likely in the year following an episode of treatment for AUD and other drug use disorders than in the year prior to treatment.[26,27]

However, merely targeting the AUD is likely to be insufficient given that AUDs often function as chronic, relapsing conditions that require multiple episodes of care, and many acts of suicide among those with history of AUD occur during major depressive episodes (including those that are alcohol induced) or outside periods of acute intoxication,[2,3] suggesting that suicide-specific interventions are needed to target other factors. The fact that AUD treatment alone may be insufficient to reduce risk is highlighted by recent findings that, in the population of veterans with an established substance use disorder including AUD who died by suicide within a given year, only one third had been treated in substance use disorder treatment in the year prior to death.[28]

There is a clear need to conduct randomized trials of interventions for those with AUDs who are experiencing suicidal ideation. Indeed, it would be a coup to prioritize the inclusion of AUD patients with suicidal ideation, insofar as suicidal thoughts and behavior has so often served as exclusion criteria in clinical trials research.

For practical reasons, these studies should be based in settings that frequently treat those with AUDs who may be experiencing suicidal thoughts, such as AUD treatment programs, emergency departments, inpatient psychiatry units, and detoxification units. With the exception of inpatient psychiatry treatment, these are settings that typically do not involve much, if any, suicide-related assessment or treatment; thus, even minimal increases in the quantity/quality of suicide prevention may represent an improvement in the standard of care.

There is also a need for studies of collaborative care across these settings. Effective interventions in these settings for individuals with AUD who are experiencing suicidal ideation would likely include some combination of education about suicide risk, motivational interviewing or relapse prevention to reduce substance use, and planning for how to respond to a suicide crisis. Extending such research to non-traditional settings, for example, 12-step or peer-led programs, is another important direction that carries the potential for increased social support generally as well as more targeted support designed to prevent suicidal behavior.

Once the efficacy (or combined efficacy–effectiveness) trials are completed and with positive results, the longer-term research agenda may proceed to focus on the difficult task of successful implementation in real-world clinical settings. Studies of implementation of screening in key settings (e.g., AUD treatment programs) and meaningful intervention based on screening results are also needed.

Progress may be accelerated by developing and testing treatments that, based on their characteristics (e.g., simplicity), may be presumed to have the greatest potential for successful implementation. Along these lines, a brief, straightforward suicide prevention training curriculum designed for substance abuse treatment providers led to increases in provider self-efficacy, knowledge, and suicide prevention practice behaviors,[29] suggesting the importance of future research on patient outcomes.

There have been few studies designed to prevent suicide attempts that have focused specifically on individuals with suicidal ideation or behavior plus AUD or other drug use disorders[30] or that have focused on preventing reattempts in groups with very high representation of AUD or other drug use disorders.[31,32] Positive results from these studies indicate the need for continued study of the effectiveness of these interventions. For the purpose of case finding, it may be most practical to recruit participants for studies focused on reduction of the recurrence of suicidal behavior from acute psychiatric units and emergency departments.

Studies of interventions to prevent the recurrence of suicidal behavior that are appropriate for different age and cultural groups are especially needed. Given the fact that many individuals with AUD or other drug use disorders do not seek treatment or do not present for treatment in traditional mental health specialty settings,[33] it will be important to examine the effectiveness of these interventions and their adaptations across multiple settings, including detoxification centers, forensic settings, intensive alcohol and substance abuse treatment programs, community-based health clinics, and crisis hotlines.

Because there are very likely mutually influential interrelationships between drinking and AUD symptoms and suicidal thoughts and behavior,[11,12,34] future development of integrated treatment interventions is essential. Interventions with demonstrated efficacy to prevent suicide reattempts among individuals who predominantly (or exclusively) have alcohol or other drug use disorders[30,31,35] suggest the value of skill development and problem solving; mindfulness, emotion regulation, and

distress tolerance; interpersonal effectiveness and reduction of relational and family difficulties that provide a context for much suicidal behavior; and motivational enhancement and relapse prevention.

It is also essential to continue studying how prevention strategies focused on the reduction of risk factors (e.g., co-occurring depression) and the promotion of protective factors (e.g., positive social support) may reduce the likelihood of AUD and suicidal thoughts and behaviors. Treatment development efforts would be enhanced by the examination of data regarding mechanisms of action, for example, the role of drinking and AUD in depression and interpersonal stressful life events, both of which are potent risk factors for suicidal behavior.

Finally, although AUD and AUA should not be conflated, instances of AUA prior to suicidal behavior may be expected to be prevalent among individuals who engage in problematic alcohol use and particularly those meeting criteria for AUD, a severe drinking population, indicating the critical importance of addressing risk associated with both chronic and acute use of alcohol in individuals with AUD.

Conclusion

Given that AUA and AUD are risk factors for suicidal behavior, it is essential that researchers turn their attention to developing and testing interventions to lower risk associated with AUA and AUD. We have made several recommendations for advancing intervention research in this area, acknowledging that solid preliminary intervention-based data on which to base our recommendations are limited. Nonetheless, there have been some informative intervention studies in high-risk populations on which to draw, particularly as pertains to AUD.

Research of practical interventions that may be applied in real-world clinical settings should have first priority. We also recommend that our clinically oriented intervention research recommendations be complemented with primary prevention strategies, for example, evidence-based strategies to lower the prevalence of AUD in the general population.[36]

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. Borges G, Loera CR. Alcohol and drug use in suicidal behaviour. Curr Opin Psychiatry 2010;23(3):195–204.
2. Simon TR, Swann AC, Powell KE, Potter LB, Kresnow M, O'Carroll PW. Characteristics of impulsive suicide attempts and attempters. Suicide Life Threat Behav 2001;32(1S):S49–S59.
3. Wojnar M, Ilgen MA, Jakubczyk A, Wnorowskaa A, Klimkiewicz A, Brower KJ. Impulsive suicide attempts predict post-treatment relapse in alcohol-dependent patients. Drug Alcohol Depend 2008;97(3):268–75.
4. Cherpitel CJ, Borges GLG, Wilcox HC. Acute alcohol use and suicidal behavior: a review of the literature. Alcohol Clin Exp Res 2004;28(5S):S18S–S128.
5. Borges G, Rosovsky H. Suicide attempts and alcohol consumption in an emergency room sample. J Stud Alcohol 1996;57(5):543–8.
6. Branas CC, Richmond TS, Ten Have TR, Wiebe DJ. Acute alcohol consumption, alcohol outlets, and gun suicide. Subst Use Misuse 2011;46(13):1592–603.
7. Powell KE, Kresnow MJ, Mercy JA, et al. Alcohol consumption and nearly lethal suicide attempts. Suicide Life Threat Behav 2001;32(1S):S30–S41.
8. Bagge CL, Lee HJ, Schumacher J, Gratz K, Krull J, Holloman G. Alcohol as an acute risk factor for suicide attempt: a case-crossover analysis. J Stud Alcohol Drugs 2013;74(4):552–8.
9. Borges G, Cherpitel CJ, Macdonald S, Giesbrecht N, Stockwell T, Wilcox HC. A case-crossover study of acute alcohol use and suicide attempt. J Stud Alcohol 2004;65(6):708–14.
10. Conner KR, Huguet N, Caetano R, et al. Acute use of alcohol and methods of suicide in a U.S. national sample. Am J Public Health 2014;104(1):171–8.
11. Yoshimasu K, Kiyohara C, Miyashita K, The Stress Research Group of the Japanese Society for Hygiene. Suicidal risk factors and completed suicide: meta-analyses based on psychological autopsy studies. Environ Health Prev Med 2008;13(5):243–56.
12. Kessler RC, Borges G, Walters EE. Prevalence of and risk factors for lifetime suicide attempts in the National Comorbidity Survey. Arch Gen Psychiatry 1999;56(9):617–26.
13. Conner KR, Beautrais AL, Conwell Y. Risk factors for suicide and medically serious suicide attempts among alcoholics: analyses of Canterbury suicide project data. J Stud Alcohol 2003;64(4):551–4.
14. Murphy GE, Wetzel RD, Robins E, McEvory L. Multiple risk factors predict suicide in alcoholism. Arch Gen Psychiatry 1992;49(6):459–63.
15. Roy A, Janal MN. Risk factors for suicide attempts among alcohol dependent patients. Arch Suicide Res 2007;11(2):211–7.
16. Preuss UW, Schuckit MA, Smith TL, et al. A comparison of alcohol-induced and independent depression in alcoholics with histories of suicide attempts. J Stud Alcohol 2002;63(4):498–502.
17. Preuss UW, Schuckit MA, Smith TL, et al. Comparison of 3190 alcohol-dependent individuals with and without suicide attempts. Alcohol Clin Exp Res 2002;26(4):471–7.
18. Bagge CL, Sher KJ. Adolescent alcohol involvement and suicide attempts: toward the development of a conceptual framework. Clin Psychol Rev 2008;28(8):1283–96.
19. Hufford MR. Alcohol and suicidal behavior. Clin Psychol Rev 2001;21(5):797–811.
20. Conner KR, McCloskey MS, Duberstein PR. Psychiatric risk factors for suicide in the alcohol dependent patient. Psychiatr Ann 2008;38(11):742–8.
21. Fudalej S, Ilgen M, Fudalej M, et al. Clinical and genetic risk factors for suicide under the influence of alcohol in a Polish sample. Alcohol Alcohol 2009;44(5):437–42.
22. Hawton K, Fagg J, McKeown SP. Alcoholism, alcohol and attempted suicide. Alcohol Alcohol 1989;24(1):3–9.
23. Ries RK, Yuodelis-Flores C, Comtois KA, Roy-Byrne P, Russo JE. Substance-induced suicidal admissions to an acute psychiatric service: characteristics and outcomes. J Subst Abuse Treat 2008;34(1):72–9.

24. Britton PC, Conner KR, Maisto SA. An open trial of motivational interviewing to address suicidal ideation with hospitalized veterans. J Clin Psychol 2012;68(9):961–71.
25. Knox KL, Stanley B, Stanley B, Brenner L, Ghahramanlou-Holloway M, Brown GK. An emergency department-based brief intervention for veterans at risk for suicide (SAFE VET). Am J Public Health 2012;102 (1S):S33–S37.
26. Ilgen MA, Harris AH, Moos RH, Tiet QQ. Predictors of a suicide attempt one year after entry into substance use disorder treatment. Alcohol Clin Exp Res 2007;31(4):635–42.
27. Ilgen MA, Jain A, Lucas E, Moos RH. Substance use-disorder treatment and a decline in attempted suicide during and after treatment. J Stud Alcohol 2007;68(4):503–9.
28. Ilgen MA, Conner KR, Roeder KM, Blow FC, Austin K, Valenstein M. Patterns of treatment utilization before suicide among male veterans with substance use disorders. Am J Public Health 2012;102(1S):S88–S92.
29. Conner KR, Wood J, Pisani AR, Kemp J. Evaluation of a suicide prevention training curriculum for substance abuse treatment providers based on Treatment Improvement Protocol Number 50 (TIP 50). J Subst Abuse Treat 2013;44(1):13–6.
30. Esposito-Smythers C, Spirito A, Kahler CW, Hunt J, Monti P. Treatment of co-occurring substance abuse and suicidality among adolescents: a randomized trial. J Consult Clin Psychol 2011;79(6):728–39.
31. Brown GK, Have TT, Henriques GR, Xie SX, Hollander JE, Beck AT. Cognitive therapy for the prevention of suicide attempts: a randomized controlled trial. JAMA 2005;294(5):563–70.
32. Harned MS, Chapman AL, Dexter-Mazza ET, Murray A, Comtois KA, Linehan MM. Treating co-occurring axis I disorders in recurrently suicidal women with borderline personality disorder: a 2-year randomized trial of dialectical behavior therapy versus community treatment by experts. J Consult Clin Psychol 2008;76(6):1068–75.
33. Cohen E, Feinn R, Arias A, Kranzler HR. Alcohol treatment utilization: findings from the National Epidemiologic Survey on Alcohol and Related Conditions. Drug Alcohol Depend 2007;86(2–3): 214–21.
34. Goldston DB. Conceptual issues in understanding the relationship between suicidal behavior and substance use during adolescence. Drug Alcohol Depend 2004;76(1S):S79–S91.
35. Linehan MM, Comtois KA, Murray AM, et al. Two-year randomized controlled trial and follow-up of dialectical behavior therapy vs therapy by experts for suicidal behaviors and borderline personality disorders. Arch Gen Psychiatry 2006;63(7):757–66.
36. Babor TF, Caetano R. Evidence-based alcohol policy in the Americas: strengths, weaknesses, and future challenges. Rev Panam Salud Publica 2005;18(4–5):327–37.

A Review of Evidence-Based Follow-Up Care for Suicide Prevention

Where Do We Go From Here?

Gregory K. Brown, PhD, Kelly L. Green, PhD

Context: Follow-up services are an important component of a comprehensive, national strategy for suicide prevention. Increasing our knowledge of effective follow-up care has been identified as an Aspirational Goal by The National Action Alliance for Suicide Prevention's Research Prioritization Task Force.

Evidence acquisition: Several recent comprehensive reviews informed the selection of studies included in this brief review. Studies of follow-up services that reported significant effects for the outcomes of death by suicide, suicide attempts, or suicidal ideation were included.

Evidence synthesis: Although there is a paucity of research in this area, promising paradigms that have demonstrated effectiveness in preventing suicide and suicide attempts and reducing suicidal ideation will be discussed. The major limitations of the literature in this area include numerous methodological flaws in the design and analyses of such studies and the lack of replication of studies with positive findings.

Conclusions: This paper identifies several breakthroughs that would be helpful for advancing this area of research and describes a comprehensive research pathway for achieving both short- and long-term research objectives.

(Am J Prev Med 2014;47(3S2):S209–S215)

Introduction

The development and implementation of effective follow-up care for individuals at risk for suicide is important for reducing rates of suicide and related behaviors. In response to the ongoing need for effective treatments aimed at preventing suicide, the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF) developed a comprehensive set of goals.[1]

Specifically, Aspirational Goal 6 aims to "ensure that people who have attempted suicide can get effective interventions to prevent further attempts." Follow-up care is defined as services interventions that aim to both increase access to and engagement in care, as well as to prevent suicide and related behaviors, as opposed to more acute care interventions, such as psychotherapy.

The aims of this article are to (1) briefly review the state of the science for follow-up care; (2) summarize limitations of the current research and needed breakthroughs; and (3) describe both short- and long-term research objectives as well as a step-by-step research pathway to advance the field of providing follow-up care for suicide prevention.

Evidence Acquisition

As a comprehensive review was beyond the scope of this paper, several recent comprehensive systematic reviews[2–5] were used to identify studies to include in this brief review. Those studies with significant findings for the outcomes of death by suicide, suicide attempts, or suicidal ideation were selected for inclusion. There are additional studies[2–5] that have examined the effectiveness of follow-up approaches, primarily on the outcome of suicide attempts or self-injury behavior, that failed to report significant effects and are not included in this brief review. Table 1 provides more detailed descriptions of the intervention and comparison conditions evaluated in each study, as well as the assessed outcomes and results.

Evidence Synthesis

The primary finding noted from these reviews is that only two RCTs have examined the effect of follow-up care on death by suicide. The first study[6] followed patients who had attempted suicide and refused or

From the Perelman School of Medicine of the University of Pennsylvania, Philadelphia, Pennsylvania

Address correspondence to: Gregory K. Brown, PhD, Department of Psychiatry, University of Pennsylvania, 3535 Market Street, Room 2030, Philadelphia PA 19104-3309. E-mail: gregbrow@mail.med.upenn.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.06.006

Table 1. Studies reviewed with condition descriptions, assessed outcomes, and results

Study	RCT	*n*	Follow-up service description	Comparison condition description	Primary outcome(s)	Results
Motto and Bostrom, 2001[6]	Yes	389 Intervention 454 Control	Subjects were sent letters expressing care and concern by research staff (24 letters over 5 years); letters were non-demanding (i.e., subjects were invited to respond if they wished, but this was not required)	Subjects received no additional contact from study staff	Death by suicide	Kaplan–Meier survival probabilities between groups were significantly different for the first 2 years of follow-up (p=0.043); M (SE): Year 1: Treatment, 0.990 (0.005) Control, 0.978 (0.007) Year 2: Treatment, 0.983 (0.006) Control, 0.964 (0.009)
Fleischmann et al., 2008[7]	Yes	922 Intervention 945 Control	Subjects received a brief 1-hour psychoeducational intervention close to discharge and 9 follow-up contacts (either by phone or in-person) over 18 months	Subjects received TAU	Death by suicide	At 18-month follow-up, significantly more subjects died by suicide in the TAU condition than the intervention condition: χ^2=13.83, $p<0.001$
Welu, 1977[8]	Yes	62 Intervention 57 Control	Subjects received treatment within the context of a special outreach program, in which they were contacted by a mental health clinician as soon as possible following discharge, and follow-up contacts included a home visit and weekly or biweekly contact over a 4-month follow-up period	Subjects received TAU	Suicide attempt	At 4-month follow-up, Fisher's exact test indicated that fewer subjects in the intervention condition reported a suicide attempt compared to the TAU condition: p=0.04573
Carter et al., 2005[9] and 2007[10]	Yes	378 Intervention 394 Control	Subjects received 8 postcards expressing care and concern over a 12-month period	Subjects received no postcards	Intentional self-poisoning	At 12-month follow-up, there were no significant differences in the proportion of subjects in each group who repeated self-poisoning; however, the number of repetitions was significantly lower in the intervention group compared to the control group: IRR=0.55, p=0.01, 95% CI=0.35, 0.87 At 24-month follow-up, there was no significant difference in the proportion of subjects who repeated self-poisoning; however, the number of repetitions was significantly lower in the intervention group compared to the control group for women only: IRR=0.49, p=0.004, 95% CI=0.30, 0.80
Hassanian-Moghaddam et al., 2011[11]	Yes	1,150 Intervention 1,150 Control	Subjects received 9 postcards expressing care and concern over a 12-month period.	Subjects received TAU	Suicide attempt, suicidal	At 12-month follow-up, the intervention group demonstrated less suicidal ideation

(continued on next page)

Table 1. Studies reviewed with condition descriptions, assessed outcomes, and results *(continued)*

Study	RCT	*n*	Follow-up service description	Comparison condition description	Primary outcome(s)	Results
					ideation	(RRR=0.31, 95% CI=0.22, 0.38), and lower rate of suicide attempt (RRR=0.42, 95% CI=0.11, 0.63) compared with the control condition Additionally, the number of suicide attempts was also reduced in the intervention condition compared to the control condition (IRR=0.64, 95% CI=0.42, 0.97)
Vaiva et al., 2006[12]	Yes	147 Phone calls after 1 month 145 Phone calls after 3 months 312 Control	Subjects received follow-up phone calls either 1 or 3 months after the suicide attempt from a psychiatrist during which the psychiatrist reviewed the treatment recommended by the ED and suggested a new treatment plan if the original was too difficult for the patient to follow; an urgent appointment was also scheduled at the ED if the patient was considered at high risk for suicide	Subjects received TAU	Suicide attempt	At 13-month follow-up, the number of subjects who attempted suicide was significantly lower over the 6 months post-contact for those that received contact after 1 month compared to the TAU group: χ^2=4.7, p=0.03, difference=10%, 95% CI=2%, 18%; there were no significant differences between the 3-month contact group and the TAU group
Termansen and Bywater, 1975[13]	No	57 Intervention with same mental health worker 57 Intervention with crisis center volunteer 50 Assessment in ED 38 Identification from ED admission records	Subjects in the follow-up care conditions received either: (1) assessment in the ED and follow-up for 3 months by same mental health worker who assessed the patient in the ED; or (2) assessment in the ED and follow-up for 3 months with a crisis center volunteer; contact occurred with tapering frequency over the course of 12 weeks	Subjects in the control conditions received either: (1) assessment in the ED and no follow-up; or (2) identification from emergency admission records only	Suicide attempt	At 3-month follow-up, subjects in the first group who received follow-up by the same mental health clinician demonstrated significantly fewer suicide attempts compared to the other three groups (no test statistic reported, p=0.05)
Torhorst et al., 1987[14]	Yes	68 Treatment from same therapist 85 Routine referral to local agency 73 Treatment at suicide prevention center	Subjects received treatment from the same therapist they saw in the hospital	Subjects in the comparison conditions received either (1) a routine referral to a local agency; or (2) treatment from a different therapist at a specialized suicide prevention center	Suicide attempt	At 12-month follow-up, subjects who received treatment from a different therapist at a suicide prevention center had a lower suicide attempt rate than those in the experimental group (χ^2=5.363, df=2, $p<0.1$)
King et al., 2001[15]	No	600 Control 300 Deceased	This study was a retrospective chart review study; subjects were either discharged individuals who subsequently died by suicide or matched psychiatric controls; the presence of continuity of care and contact with the same professional were examined	NA	Death by suicide	Both continuous care (OR=0.57, 95% CI=0.37, 0.87, p=0.01) and contact with the same professional (OR=18.45, 95% CI=4.46, 76.32, $p<0.001$) predicted decreased risk of death by suicide

ED, emergency department; IRR, incidence risk ratio; RRR, relative risk reduction; TAU, treatment as usual

discontinued outpatient treatment in the month after discharge from the hospital, and then randomized them to receive either a caring letters intervention or no follow-up. The study found that the rate of suicide for the intervention condition was significantly lower than that for the control group for the first 2 years of follow-up.

The second study[7] enrolled suicide attempters from eight emergency departments (EDs) in five low- to middle-income countries and randomized them to receive either treatment as usual (TAU) or a brief intervention with follow-up contact. Follow-up over an 18-month period revealed that individuals in the intervention condition had a significantly lower rate of suicide than those receiving TAU.

More attention has been given to investigating the effect of follow-up care on preventing or reducing suicide attempts and self-directed violence (i.e., some studies reported one outcome that combined suicide attempts and non-suicidal self-injury) than has been given to the outcome of death by suicide. For example, one study[8] found that fewer participants who were assigned to receive an intensive follow-up contact intervention experienced a repeat suicide attempt over a 4-month follow-up period relative to those assigned to TAU.

Three studies have examined less time-intensive follow-up services. An Australian study[9,10] recruited patients from toxicology units following intentional self-poisoning and randomly assigned them to receive either follow-up postcards or no intervention. This study found that participants assigned to receive the postcards had fewer numbers of intentional self-poisoning behaviors than controls over a 24-month follow-up period.

A similar study[11] recruited individuals who intentionally self-poisoned and randomized participants to receive either follow-up postcards or TAU. Results indicated that those in the intervention condition demonstrated fewer instances of suicidal ideation and suicide attempts (both in terms of rate and total numbers) than those in TAU.

A third study[12] involving patients discharged from the ED following an intentional overdose randomized participants to receive a follow-up call 1-month post-discharge, a call at 3 months post-discharge, or TAU. Participants in the intervention condition that received the 1-month call were less likely to make subsequent suicide attempts than those in TAU over the first 6 months of the 13-month follow-up period.

Three other studies have found significant results for follow-up interventions, depending on the specific individual who performed the follow-up contact. One compared[13] follow-up by a mental health worker, follow-up by a crisis volunteer, and no follow-up for patients discharged from a hospital after a suicide attempt. The study found a significant reduction in repeat suicide attempts for follow-up by a mental health worker compared to follow-up by a crisis center volunteer or no follow-up.

Torhorst and colleagues[14] reported that the rate of suicide attempts in the group of patients who saw a different therapist for treatment following discharge from the hospital was lower than that of patients who saw the same clinician who treated them in the hospital. A retrospective chart review study,[15] on the other hand, found that both continuity of care alone and contact with the same professional predicted reduced suicide risk in discharged patients who had died by suicide and matched controls.

In summary, there are several studies with promising initial findings concerning the efficacy of follow-up care and suicide prevention. Specifically, research suggests that clinicians who reach out to patients (especially those patients not engaged in treatment) using caring letters to express concern and support may help to reduce the rate of suicide following discharge from a psychiatric hospital.

Additionally, low-cost follow-up interventions (e.g., phone calls, postcards) may be effective and particularly important for reducing death by suicide and repeat suicide attempts, especially in areas with limited resources. Outreach programs that provide comprehensive mental health treatment and emphasize follow-up and continuity of care following discharge from the hospital may also help to prevent repeat suicide attempts.

Gaps and Limitations of the Current State of the Science

Although findings from these studies warrant optimism that follow-up services can ultimately be an effective strategy for suicide prevention, there are several gaps in our current knowledge, as well as major limitations (i.e., methodological flaws) of the work that has been done thus far.

With regard to gaps in the literature, the first major limitation is the paucity of RCTs, especially those investigating effects of follow-up services on death by suicide.[4] Specifically, only two studies[6,7] have demonstrated efficacy for preventing suicide. Although several studies have demonstrated efficacious follow-up services for preventing suicide attempts and self-directed violence, these outcomes are only proxies for death by suicide and may not generalize to services that will actually prevent suicide. Additionally, the studies that have found positive results have not investigated the mechanisms by which the follow-up services affected outcomes (e.g., greater engagement in care).

Further, our knowledge of effective services for specific subpopulations, particularly those at high risk relative to the general population, is severely limited. For example,

there are no RCTs of follow-up services that have demonstrated efficacy to prevent suicide or related behaviors for adolescents, older adults, and other minority groups.

Additionally, existing studies have recruited patients mostly from acute treatment settings (e.g., hospitals, EDs). Research[16] has found that most individuals who attempt suicide seek no treatment following their attempt. Thus, it is unclear whether findings from studies of follow-up services conducted to date can be generalized to other settings, such as primary care, outpatient mental health, or other community settings.

Finally, the failure to replicate studies that have found significant effects is a major gap in the literature. Although developing novel interventions is important, there has been less emphasis placed on replicating studies with positive results or improving existing interventions that have been found to be effective.

With regard to methodological problems, there are many major flaws in the RCTs that have been conducted thus far that have been described in previous reviews.[2,4] Many of these methodological problems also apply to acute intervention research and were discussed in more detail in Brown and Jager-Hyman's psychotherapy review[17] in this issue.

Those problems discussed previously that also apply to follow-up services research include (1) failure to provide operational definitions or use a standardized nomenclature for assessing suicide, suicide attempts, suicidal ideation, and other related behaviors; (2) failure to include reliable and validated outcome measures; and (3) failure to control for sources of bias. Methodological problems such as those outlined here led to the following conclusion in the Veterans Affairs systematic review: "Overall, these intervention trials had methodological limitations that resulted in their providing only low strength and insufficient evidence to properly draw conclusions on the effectiveness of the various treatment interventions and follow-up strategies."[4]

Discussion

Future research should seek to achieve breakthroughs, which are needed to address these limitations and increase our knowledge about effective follow-up services for suicide prevention. These needs include (1) improving methodological rigor in future studies; (2) developing additional follow-up services and paradigms that are cost-effective and innovative; (3) expanding research to additional settings and subpopulations; and (4) replicating and disseminating evidence-based follow-up services.

Improving the methodological rigor in designing future RCTs and other studies is of paramount importance. There are several short-term research goals that can achieve this aim. First, it is important that studies use standardized assessments that have been found to be valid and reliable, and it is important that such measures correspond to standardized nomenclature of suicide ideation and behavior such as the CDC's Self-Directed Violence Classification System (SDVCS).[18]

Second, future research should be devoted to developing novel assessment methods, such as ecological momentary assessment, to more accurately track suicidal ideation and behavior over time. Third, future research should include methods to address ambivalent suicidal behavior (e.g., suicide adjudication boards).

Fourth, future studies should include methods for controlling sources of bias, such as performing intent-to-treat analyses, identifying and measuring non-study co-interventions, and blinding research staff and/or research participants and assessing any breaks in blinding. Finally, future studies should develop innovative methods for retaining participants in studies and monitoring long-term outcomes.

Developing and testing novel follow-up services for suicide prevention is also especially warranted. In order to improve the feasibility of conducting adequately powered studies to detect the treatment effects on death by suicide, it would be beneficial to develop interventions of minimal economic cost as a short-term research goal. Studies of these approaches should determine whether follow-up care actually facilitates treatment engagement and reduces rates of suicide, suicide attempts, or suicidal ideation. Cost-effectiveness studies should also be conducted alongside efficacy and effectiveness trials of tested interventions.

Additionally, the development of follow-up services that use innovative electronic health technologies (e.g., chat rooms, texting, smartphone apps, and other web-based applications) as stand-alone or adjunctive services is also needed and achievable over the short term. These technologies have the potential to reach a larger segment of the population at a low cost. Thus far, one small pilot test[19] of text messaging over 4 weeks following discharge found this intervention to be feasible and acceptable to patients who attempted suicide. To date, however, no study has been conducted to evaluate the impact of electronic services on suicide, suicide attempts, or suicidal ideation.

Ultimately, identifying and developing evidence-based follow-up services that can be delivered following discharge from acute care settings for the prevention of suicide is especially needed. This long-term goal can be attained by conducting large-scale, adequately powered RCTs. These studies should determine whether the effects of an intervention are partially mediated by engagement in mental health care or whether there is a

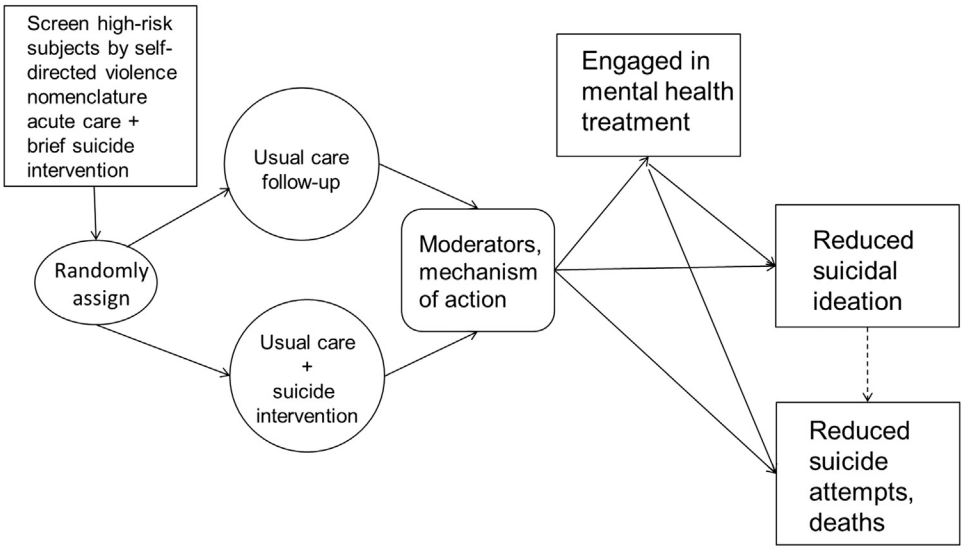

Figure 1. Proposed step-by-step research pathway for future RCTs

direct effect on outcomes. Such studies should also explore whether there are other moderating or mediating effects of the intervention by identifying and testing potential mechanisms of action in effective interventions and developing valid and reliable measures of such mechanisms.

Once effective follow-up services are identified, expanding the research into new settings and populations is also needed in order to investigate the generalizability of these interventions. Thus, over the long term, researchers should continue to develop novel methods to recruit and screen at-risk individuals both in acute care settings such as EDs as well as in the community at large. Schools, community centers, primary care settings, and workplaces are also potential areas to target in order to obtain more representative samples and reach individuals at risk for suicide who may not present to mental health facilities. Future research should also examine the relative efficacy of evidence-based follow-up services for specific subpopulations that are at an increased risk for suicide, such as adolescents, older adults, and other minority populations, as warranted by empirical data.

Finally, studies with positive findings of follow-up services should be replicated by independent research groups to ensure that robust effects are generalizable across locations and populations. An especially important long-term objective is for researchers to develop and test models to efficiently disseminate evidence-based follow-up services so that they can be widely available and become the standard of care for facilitating engagement in treatment and ultimately preventing suicide.

Figure 1 illustrates a proposed step-by-step research pathway that can serve as a model for future studies that test the effectiveness of follow-up services to reduce suicide risk. Briefly, following this pathway, research participants should be screened using standardized measures. Following screening, enrolled participants should be randomized to either TAU alone or in addition to the study intervention. Potential mechanisms of action should then be assessed over the course of care to determine what aspects of an intervention lead to reductions in suicide-related outcomes. Increased engagement in care as a result of the study intervention should also be evaluated as a potential mediator of the relationship between the intervention and outcome.

Conclusions

Although promising initial findings on follow-up care and services for suicide prevention exist in the literature, there are significant research gaps. Thus, additional research is warranted to both improve the quality of the research in this area and expand current knowledge. A major research goal involves the rigorous study of novel, cost-effective approaches to follow-up care across a variety of populations and settings. Ultimately, such studies may result in the improvement of the standard of care for individuals who are at risk for suicide by disseminating evidence-based strategies to prevent suicide.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. USDHHS Office of the Surgeon General and National Action Alliance for Suicide Prevention. 2012 National Strategy for Suicide Prevention: Goals and Objectives for Action. Washington, DC: HHS, September 2012. http://www.surgeongeneral.gov/library/reports/national-strategy-suicide-prevention/full-report.pdf.
2. Self-harm: The NICE guideline on longer-term management. London: The British Psychological Society and The Royal College of Psychiatrists, 2012.
3. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
4. O'Neil M, Peterson K, Low A, et al. Suicide prevention interventions and referral/follow-up services: a systematic review. VA-ESP Project #05-225 2012.
5. O'Connor E, Gaynes BN, Burda BU, Soh C, Whitlock EP. Screening for and treatment of suicide risk relevant to primary care: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med 2013;158(10):741–54.
6. Motto JA, Bostrom AG. A randomized controlled trial of postcrisis suicide prevention. Psychiatr Serv 2001;52(6):828–33.
7. Fleischmann A, Bertolote JM, Wasserman D, et al. Effectiveness of brief intervention and contact for suicide attempters: a randomized controlled trial in five countries. Bull World Health Organ 2008;86(9):703–9.
8. Welu TC. A follow-up program for suicide attempters: evaluation of effectiveness. Suicide Life Threat Behav 1977;7(1):17–29.
9. Carter GL, Clover K, Whyte IM, Dawson AH, D'Este C. Postcards from the EDge project: randomised controlled trial of an intervention using postcards to reduce repetition of hospital treated deliberate self poisoning. Br Med J 2005;331(7520):805–7.
10. Carter GL, Clover K, Whyte IM, Dawson AH, D'Este C. Postcards from the EDge: 24-month outcomes of a randomised controlled trial for hospital-treated self-poisoning. Br J Psychiatry 2007;191(6):548–53.
11. Hassanian-Moghaddam H, Sarjami S, Kolahi AA, Carter GL. Postcards in Persia: randomised controlled trial to reduce suicidal behaviours 12 months after hospital-treated self-poisoning. Br J Psychiatry 2011;198(4):309–16.
12. Vaiva G, Ducrocq F, Meyer P, et al. Effect of telephone contact on further suicide attempts in patients discharged from an emergency department: randomised controlled study. Br Med J 2006;332(7552):1241–5.
13. Termansen PE, Bywater C. S.A.F.E.R.: a follow-up service for attempted suicide in Vancouver. Can Psychiatr Assoc J 1975;20(1):29–34.
14. Torhorst A, Möller HJ, Bürk F, Kurz A. The psychiatric management of parasuicide patients: a controlled clinical study comparing different strategies of outpatient treatment. Crisis 1987;8(1):53–61.
15. King EA, Baldwin DS, Sinclair JM, Baker NG, Campbell MJ, Thompson C. The Wessex Recent In-Patient Suicide Study, 1. Case-control study of 234 recently discharged psychiatric patient suicides. Br J Psychiatry 2001;178:531–6.
16. Bruffaerts R, Demyttenaere K, Hwang I, et al. Treatment of suicidal people around the world. Br J Psychiatry 2011;199(1):64–70.
17. Brown GK, Jager-Hyman S. Evidence-based psychotherapies for suicide prevention: future directions. Am J Prev Med 2014;47(3S2):S186–S194.
18. Crosby AE, Ortega L, Melanson C. Self-directed violence surveillance: uniform definitions and recommended data elements, version 1.0. Atlanta GA: CDC, 2011 www.cdc.gov/violenceprevention/pdf/Self-Directed-Violence-a.pdf.
19. Chen H, Mishara BL, Liu XX. A pilot study of mobile telephone message interventions with suicide attempters in China. Crisis 2010;31(2):109–12.

Advancing Training to Identify, Intervene, and Follow Up with Individuals at Risk for Suicide Through Research

Philip J. Osteen, PhD, Jodi J. Frey, PhD, Jungyai Ko, MSSW

Research and training on suicide is critical given the fact that the majority of suicide deaths are preventable with accurate identification of risk and intervention by trained individuals. However, implementing and evaluating training is difficult because of the multiple factors involved, including, but not limited to, the heterogeneity of trainees, their diverse roles in suicide prevention, absence of clear guidelines for training content across settings, and limited methods for assessing outcomes. Here, three groups of trainees are discussed: community and professional gatekeepers and behavioral health providers. The roles each group plays in managing suicide risk and the training content it needs to be effective are addressed. A staged training approach is proposed, building on the core components of currently used suicide training: knowledge, attitudes, and skills/behaviors. Limitations of current assessment methods are identified and recommendations for alternative methods are provided. The article concludes with a discussion of next steps in moving the field forward, including overcoming challenges and identifying and engaging opportunities.

(Am J Prev Med 2014;47(3S2):S216–S221)

Introduction

According to the National Action Alliance for Suicide Prevention (Action Alliance) Research Prioritization Task Force (RPTF), there has been no significant reduction in the number of suicides in the U.S. over the past 50 years.[1] In 2010, there were more than 650,000 hospital visits for suicide attempts, and more than 38,000 suicide deaths. The majority of suicide deaths are preventable with accurate identification and assessment of risk and intervention by trained individuals.[1] Increasing the number of people with skills necessary for suicide assessment and risk management has been identified as one of the methods "most likely to rapidly reduce the burden of suicide attempts and deaths".[1] The Action Alliance RPTF stakeholder survey recognized training in identifying and treating at-risk individuals as one of the top four research goals.[1] The importance of developing, evaluating, and implementing effective, evidence-based trainings to reduce suicide deaths cannot be overstated.

Understanding and making recommendations about suicide training is a difficult and complex task, in part because of the heterogeneous groups needing training, including school teachers, emergency department staff, and licensed social workers and psychologists; diverse populations of at-risk individuals such as sexual minority youth, incarcerated adults, and veterans; diverse settings in which suicide prevention services occur, including community, primary care, and outpatient behavioral health settings; different tasks that providers perform such as identifying risk, assessing and managing risk, and treatment; lack of standardized measures of training effectiveness; and limited data linking training outcomes to reductions in suicide deaths.

It is not clear from existing research which training programs are best suited for the different providers who come into contact with individuals at risk for suicide. Training content and delivery methods often change based on provider needs, available resources, and time constraints. Researchers need to identify the critical elements of training that support best practices, with a concerted focus on those elements that transcend settings and populations. This article reviews the evidence base for suicide training for community and professional gatekeepers (GKs) and behavioral health providers (BHPs), as well as needed training content and methods for assessing training effectiveness.

Who Should Be Trained?

It is important to consider who has the most opportunities to come in contact with a person at risk for

From the School of Social Work, University of Maryland, Baltimore, Maryland

Address correspondence to: Philip J. Osteen, PhD, University of Maryland, School of Social Work, 525 W. Redwood St., Baltimore MD 21201. E-mail: posteen@ssw.umaryland.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.033

suicide,[1] but first, who is a "person at risk for suicide?" The authors' working definition is individuals exhibiting warning signs, acute risk factors, or chronic risk factors associated with suicidal behavior,[1] or who are members of groups with higher rates of suicide than the general public. The authors refer to individuals meeting this definition as *at-risk individuals*.

The Action Alliance RPTF identified six boundaried settings where at-risk individuals are most likely to be found: high schools, outpatient mental health services, emergency departments, probation/parole, colleges/universities, and substance use treatment facilities,[1] which are logical settings to concentrate GK and BHP training. To ensure that training is completed, some states have mandated training for GKs and BHPs who are most likely to have contact with at-risk individuals. For example, four states (Alabama, Kentucky, Louisiana, and Tennessee) require annual training on suicide prevention for school personnel under the Jason Flatt Act. Washington requires 6 hours of suicide training for BHPs under the 2012 Matt Adler Suicide Assessment, Treatment, and Management Act. Although this is not an inclusive move to train all people who have contact with at-risk individuals, it is a noteworthy step in increasing the number of people trained in suicide prevention.

Gatekeepers

The general label *GKs* refers to a heterogeneous group of non-BHPs who are likely to come into contact with at-risk individuals.[2] The philosophy behind GK training is that at-risk individuals may exhibit identifiable risk factors and warning signs but not seek help or treatment from a BHP; therefore, GKs can assist in connecting at-risk individuals in the community with additional resources. Basic GK training prepares people to identify at-risk individuals, assess the risk level, and make referrals to mental health services.[2]

The review conducted by Isaac et al.[2] of 13 GK training studies showed that, overall, training positively impacted knowledge, attitudes, and skills in the short term but with limited stability over time. The systematic review of Mann and colleagues[3] suggests that GK programs can reduce suicidal behavior in situations where the roles of GKs are formalized and access to treatment is readily available (e.g., military settings). GK training was also rated highly by Beautrais et al.[4] in their review of evidence for suicide prevention in New Zealand based on the findings of "strong evidence for effectiveness" for improving identification and referral of at-risk individuals.

A challenge of GK training research is the lack of clarity on who is considered a GK, and how differences between GK (e.g., social/professional roles, education, and population served) and training components affect generalizability of results. In the absence of a standardized GK training curriculum, providers must search for relevant and empirically supported programs. The Suicide Prevention Resource Center (sprc.org) provides a comparison of 31 different GK training programs listed in the Best Practices Registry. Information includes requirements for the training, target audiences, and program highlights and objectives. Trainings range from 30 minutes to 3 days and targeted GKs include diverse groups such as clergy, law enforcement, teachers and students, emergency department staff, foster parents, physicians, and veterans. Training objectives also vary but are focused on increasing suicide knowledge, understanding, or awareness (62%), compared to attitudes (8%) and skills (30%).

Training literature has established that knowledge does not always translate into practice behaviors, and the development of skills through training may be minimized from the weighted attention on knowledge. For example, knowing the warning signs of suicide is vital for GKs, but if the training does not also address GKs' ability to ask questions in response to warning signs, then the training is ultimately ineffective. The authors suggest reviewing Isaac and colleagues' key components of GK training[2] as a framework for mapping the content of current GK programs.

Community gatekeepers. Community GKs are individuals who are likely to come into contact with at-risk individuals,[4] but are not typically educated or trained in suicide prevention. Community GKs include formal groups such as teachers, clergy, veterans, and law enforcement officers and informal groups like family, peers, and coworkers. Despite the variability among community GKs, they all share basic training needs in recognizing suicide warning signs, developing effective communication skills to engage at-risk individuals, improving self-efficacy to carry out their roles, and knowledge of community resources.[1] Community GK training improves knowledge, attitudes such as self-efficacy and reduced stigma, and engagement skills, although results seem contingent on training methods with less positive outcomes for didactic training compared to training with experiential components.[5–7]

Professional gatekeepers. Professional GKs are providers who work in various community and health settings. They do not need to provide the same level of mental health intervention as BHPs, but their responsibilities are more advanced than most community GKs. Professional GKs should be trained in the identification of at-risk individuals, screening for risk level, provision of brief interventions, immediate risk management such as

safety planning, and referral to BHPs.[8,9] Two types of professional GKs are reviewed here: crisis line staff and healthcare workers.

Crisis line staff. Crisis call centers serve an important function in suicide prevention as they often provide a front-line response during times when traditional mental health services may not be available or tenable to an at-risk individual.[10,11] Crisis line staff need to be prepared to answer calls on any topic, including suicide, and must be trained in suicide risk identification, risk assessment and management, and making referrals.[12] In 2007, standards for assessing suicide risk among callers to the National Suicide Prevention Lifeline were published[12]; these standards can serve as a foundation for training crisis line call center staff.

Additional training needs include knowledge about suicide risk and protective factors, confidence to conduct assessments over the phone, effective listening and communication skills, and use of suicide risk screening tools.[13] Although studies have demonstrated positive short-term outcomes for generating referrals for high-risk callers,[10,11] the majority of callers are not using referrals to services.[11] To improve client outcomes, Gould et al.[11] advocate training crisis line staff in motivational interviewing, an evidence-based practice easily replicated across many settings.

Healthcare providers. Healthcare providers such as primary care physicians and emergency department staff are professional GKs whose role in suicide prevention is focused on screening and immediate risk management. GK training with healthcare professionals in primary care and emergency department settings has led to improved awareness and recognition of suicide warning signs and willingness to refer patients for additional mental health services.[8,14] Evidence also suggests that physician education impacts suicide through increased diagnosis and treatment of depression.[4] These results support the importance and feasibility of integrating brief screening interventions in emergency departments and other primary care settings as a means to quickly identify at-risk individuals and use screening results to prompt healthcare professionals to make referrals.[9,14]

Suggestions for improving skills-based training among professional GKs include providing advanced reading material and periodic skills checks with booster training.[15,16] Wintersteen[8] found that the inclusion of two standardized suicide screening questions into existing pediatric primary care practice assessments resulted in a 392% increase in case detection of suicide risks and increased referrals of youth to BHPs. However, the predictive validity and effectiveness of brief screening tools require greater attention, as do rates of follow through on referral and results of subsequent evaluations.[17]

Behavioral Health Providers

Behavioral health integrates mental health and substance abuse treatment, both of which are associated with increased suicide risk.[18] Despite the regularity with which BHPs see suicidal individuals,[1,19] research suggests that prior training of BHPs in assessment and risk management is inadequate.[19] Without adequately trained BHPs, at-risk individuals will not receive competent care and can in fact be at greater risk for suicide.[19] BHP training should begin in graduate school with continued evaluation of suicide knowledge questions on licensure exams and required training for license renewal.[19] Training should be developed to meet BHP roles, which include comprehensive biopsychosocial assessment, with a strong emphasis on suicide, developing a risk formulation plan for immediate risk management, and ongoing re-evaluation of risk and mental health services.[19]

Training for BHPs should be competency-based.[6,20] There are many risk assessment competency frameworks in the literature, and competencies range from as few as two[21] to as many as 24.[22] Even with a high degree of agreement among experts, there are too many identified competencies for training and practice purposes, but general consistency in overall content suggests the possibility of establishing a universal list of competencies.[6] Cramer and colleagues provide an excellent comparison of competency frameworks[20,22–24] before merging them into their own "ten core competencies"[6] that can serve as a framework for clinical trainings.[6]

All training for BHPs must include knowledge of suicide warning signs, risk, and protective factors, and skills for effective risk assessment and documentation. Additionally, BHPs need decision-making skills for ongoing risk management and advanced training on evidence-based practices for minimizing risk with longer term treatment (e.g., psychotherapy, means restriction, safety plans).[4] Required training for licensure renewal is one method to ensure that BHPs continue to receive updated knowledge and skills as new interventions are developed. Finally, identification of effective training methods for BHPs is needed. For example, prior research demonstrates that BHPs may learn better from skills-based training that includes role-playing and standardized patients as compared to purely didactic learning.[6,7]

To sustain new skills, experts recommend the use of booster sessions, as single-exposure training models are not optimal for producing changes in clinical behavior, owing in part to the time needed to practice and develop skills.[26] Possible approaches include scheduled contacts

(e.g., annual training) or "point-of-contact" support when encountering an individual at imminent risk for self-harm. A more cost-effective method for providing ongoing contact may be through ongoing, targeted online sessions or webinars.[25]

Specification and Assessment of Core Training Components

Knowledge, attitudes, and skills/practice behaviors are the core components of suicide training,[1,2,27,28] and although provider groups provide varied services, the foundation level of preparation to manage suicide risk is consistent.

A basic level of knowledge about warning signs, risk and protective factors, and referral resources is necessary for GK and BHP. Knowing how to identify an at-risk individual is the essential first step in preventing suicide, followed by familiarity with local resources such as crisis hotlines, emergency departments, and outpatient behavioral health clinics. As intervention techniques move from identification of risk to assessment and management of risk up to treatment, the need for more advanced knowledge increases.

Many studies have demonstrated the effectiveness of training in increasing knowledge among community and professional GKs and BHPs,[15,27,28] but linking increased knowledge to improved practice behaviors and reduced deaths is difficult. The assessment of knowledge is often specific to individual training curricula, limiting generalizability.[29] Instead, the authors recommend the use of a standardized knowledge measure with warning signs, risk and protective factors, and locale-specific referral resources.

In relationship to risk management, *attitudes* have been defined in multiple ways, including providers' views towards at-risk individuals, the effectiveness of prevention efforts, and a provider's sense of self-efficacy to work with at-risk individuals.[4,16] Research shows that training can yield more positive attitudes,[30–32] but changes are often not consistent across studies or sustained over time, indicating the need for ongoing training.[12,28,33] Given the limited number of existing attitude scales, efforts to create more standardized measures that can be cross-validated should continue.

Foundation skills and practice behaviors include identification of at-risk individuals, assessment of risk level, and referral for additional mental health services. Professional GKs require additional training to engage patients in risk management, including standardized screening tools and possible brief intervention such as safety planning. BHPs need to be trained to deliver the most advanced services including comprehensive assessment and suicide risk screening, short- and long-term risk management and treatment,[29] and implementation of evidence-based interventions to prevent death.[6] Assessing skill-based outcomes is a challenging task, especially in the absence of observable client data. Assessment measures such as role-plays,[34] vignettes,[29] and videotaped interviews[35] are superior to self-report but lack sufficient evidence of validity and effectiveness.

Cramer et al.[6] propose using an Objective Structured Clinical Evaluation or Examination (OSCE), a method commonly used in medical competency training. The OSCE training method relies on observed practice behaviors using standardized patients or actors under the supervision of a trained clinician. Although this method is time consuming and costly, Cramer and colleagues[6] suggest that the time and cost associated with such comprehensive training are justified as a means to improving life-saving skills.

Discussion

Although the field has made great strides in developing suicide training for various key groups, many challenges exist. In addition to standardizing training as an intervention to reduce suicide deaths, researchers need to identify methods for improving the overall adoption of training methods and fidelity of implementation over time to sustain the skills and practice behaviors emphasized during training.

The lack of a methodologically sound evidence base requires attention. Incorporating specific methods into future research will significantly advance the field. Recommendations include (1) implementing experimental or quasi-experimental designs, as the absence of control or comparison groups has made it difficult to evaluate training impact[1,4,7]; (2) implementing longitudinal research designs, as the majority of studies employ pre/post designs without follow-up assessments; (3) using larger, more diverse trainee and client samples; and (4) using standardized measures to assess training outcomes, with public dissemination of psychometric evaluations of assessment tools.

Additional training research is also recommended for several key factors: (1) the need for more GK and BHP trainings is questionable, and replicating existing trainings with promising evidence of effectiveness across different provider and at-risk groups may be more informative and lead to faster advancements[18]; (2) training modalities need to be compared, and thus feasibility of implementation, equivalency of outcomes, and cost-benefit analyses of different modalities should be studied using evidence-supported trainings,[16,37] providers should be surveyed on suicide training received in their degree programs, and licensing bodies should be surveyed on which skills for assessment and management of suicidal behavior are required[1]; (3) researchers should investigate

the long-term impact of supervision and ongoing training on training outcomes; and (4) the broader context of the organization should be evaluated in concert with training evaluations. The Organizational Social Context model of Glisson et al[36] can be used to evaluate organizational factors that support or inhibit the use of training skills and evidence-based interventions.

On the basis of the currently available evidence, the following recommendations are made regarding training practices: (1) concentrating trainings on staff working in boundaried settings where at-risk individuals are found; (2) implementing a "developmental" or staged approach to training by creating a universal foundation-level training in knowledge, attitudes, and skills with the ability to add advanced modules tailored to the specific needs of different provider groups or the populations they interact with; (3) avoiding didactic-only training formats, as evidence-based teaching and training methods for interactive learning such as practicing and role-playing skills, small and large group discussions, training cases, and expert demonstrations should be integrated[6,7] and pre-training strategies (e.g., sending self-assessments and research and practice literature in advance) should be implemented; and (4) integrating methods of providing post-training support such as booster sessions.

This article describes best practices and necessary next steps for research in training on suicide. To accomplish the Action Alliance's goal of reducing suicide deaths by 40% in the next 10 years, training of community and professional GKs and BHPs is critical to ensure effective assessment of and immediate provision to suicidal individuals. The timing is ripe for research institutions and foundations to invest in studies that support the development of evidence-based training practices designed to improve provider practices that will ultimately result in improved suicide case finding, minimization of suicide risk, and prevention of suicide death.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
2. Isaac M, Elias B, Katz LY, et al. Gatekeeper training as a preventative intervention for suicide: a systematic review. Can J Psychiatry 2009;54(4):260–8.
3. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
4. Beautrais A, Fergusson D, Coggan C, et al. Effective strategies for suicide prevention in New Zealand: a review of the evidence. N Z Med J 2007;120(1251):U2459.
5. Pasco S, Wallack C, Sartin RM, Dayton R. The impact of experiential exercises on communication and relational skills in a suicide prevention gatekeeper-training program for college resident advisors. J Am Coll Health 2012;60(2):134–40.
6. Cramer RJ, Johnson SM, McLaughlin J, Rausch EM, Conroy MA. Suicide risk assessment training for psychology doctoral programs: core competencies and a framework for training. Train Educ Prof Psychol 2013;7(1):1.
7. Hershell AD, Kolko DJ, Baumann BL, Davis AC. The role of therapist training in the implementation of psychosocial treatments: a review and critique with recommendations. Clin Psychol Rev 2010;30(4):448–66.
8. Wintersteen MB. Standardized screening for suicidal adolescents in primary care. Pediatrics 2010;125(5):938–44.
9. Ronquillo L, Minassian A, Vilke GM, Wilson MP. Literature-based recommendations for suicide assessment in the emergency department: a review. J Emerg Med 2010;43(5):836–42.
10. Britton PC, Bossarte RM, Thompson C, et al. Influences on call outcomes among veteran callers to the national veterans crisis line. Suicide Life Threat Behav 2013;43(5):494–502.
11. Gould MS, Munfakh JLH, Kleinman M, Lake AM. National suicide prevention hotline: enhancing mental health care for suicidal individuals and other people in crisis. Suicide Life Threat Behav 2012;42(1):22–35.
12. Joiner T, Kalafat J, Draper J, et al. Establishing standards for the assessment of suicide risk among callers to the National Suicide Prevention Lifeline. Suicide Life Threat Behav 2007;37(3):353–65.
13. American Association of Suicidology Individual Certification Committee. Applicant's manual—individual crisis worker. Washington DC: American Association of Suicidology, 2005. www.suicidology.org/c/document_library/get_file?folderId=251&name=DLFE-515.pdf.
14. Bryan C, Rudd M. Advances in the assessment of suicide risk. J Clin Psychol 2006;62(2):185–200.
15. Cross WF, Seaburn D, Gibbs D, et al. Does practice make perfect? A randomized control trial of behavioral rehearsal on suicide prevention gatekeeper skills. J Prim Prev 2011;32(3–4):195–211.
16. Wyman PA, Inman J, Guo J, et al. Randomized trial of a gatekeeper program for suicide prevention: 1-year impact on secondary school staff. J Consult Clin Psychol 2008;76(1):104–55.
17. O'Connor E, Gaynes B, Burda BU, Williams C, Whitlock EP. Screening for suicide risk in primary care: a systematic evidence review for the U.S. Preventive Services Task Force. Evidence Synthesis No. 103. Rockville MD: Agency for Healthcare Research and Quality, 2013. Agency for Healthcare Research and Quality Publication No. 13-05188-EF-1.
18. Pringle B, Colpe LJ, Heinssen RK, et al. A strategic approach for prioritizing research and action to prevent suicide. Psychol Serv 2013;64(1):71–5.
19. Schmitz WM, Allen MH, Feldman BN, et al. Preventing suicide through improved training in suicide risk assessment and care: an American Association of Suicidology task force report addressing serious gaps in U.S mental health training. Suicide Life Threat Behav 2012;42:292–304.
20. Joiner T. Why people die by suicide. Cambridge MA: Harvard University Press, 2005.

21. Kleespies PM, Hough S, Romeo AM. Suicide risk in people with medical and terminal illness. In: Kleespies PM, ed. Behavioral emergencies: an evidenced-based resource for evaluating and managing risk of suicide, violence, and victimization. Washington DC: American Psychological Association, 2009.
22. American Association of Suicidology. Some facts about suicide and depression. Washington DC: American Association of Suicidology, 2010. www.suicidology.org/c/document_library/get_file?folderId=232&name=DLFE-246.pdf.
23. Sullivan GR, Bongar B. Assessing suicide risk in the adult patient. In: Kleespies PM, ed. Behavioral emergencies: an evidenced-based resource for evaluating and managing risk of suicide, violence, and victimization. Washington DC: American Psychological Association, 2009.
24. Rudd MD. Assessment and management of suicidality. Sarasota FL: Professional Resource Press, 2006.
25. Dimeff LA, Koerner K, Woodcock EA, et al. Which training method works best? A randomized controlled trial comparing three methods of training clinicians in dialectical behavior therapy skills. Behav Res Ther 2009;47:921–30.
26. Beidas RS, Kendall PC. Training therapists in evidence-based practice: a critical review of studies from a systems-contextual perspective. Clin Psychol (New York) 2010;17(1):1–30.
27. Jacobson JM, Osteen PJ, Sharpe TL, Pastoor JB. Randomized trial of suicide gatekeeper training for social work students. Res Soc Work Pract 2012;22:270–81.
28. Pisani AR, Cross WF, Gould MS. The assessment and management of suicide risk: state of workshop education. Suicide Life Threat Behav 2011;41(3):255–76.
29. Jacobson JM, Osteen PJ, Jones A, Berman A. Evaluation of the recognizing and responding to suicide risk training. Suicide Life Threat Behav 2012;42(5):471–85.
30. Herron J, Ticehurst H, Appleby L, Perry A, Cordingley L. Attitudes toward suicide prevention in front-line health staff. Suicide Life Threat Behav 2001;31(3):342–7.
31. Price JH, Kinnison A, Dake JA, Thompson AJ, Price JA. Psychiatrists' practices and perceptions regarding anticipatory guidance on firearms. Am J Prev Med 2007;33(5):370–3.
32. Botega NJ, Reginato DG, Silva SV, et al. Nursing personnel attitudes towards suicide: the development of a measure scale. Revista Brasileira de Psiquiatria 2005;27(4):315–8.
33. Link BG, Yang LH, Phelan JC, Collins PY. Measuring mental illness stigma. Schizophr Bull 2004;30(3):511–41.
34. Oordt MS, Jobes DA, Fonseca VP, Schmidt SM. Training mental health professionals to assess and manage suicidal behavior: can provider confidence and practice behaviors be altered? Suicide Life Threat Behav 2009;39(1):21–32.
35. Hung EK, Binder RL, Fordwood SR, et al. A method for evaluating competency in assessment and management of suicide risk. Acad Psychiatry 2012;36(1):23–38.
36. Glisson C, Landsverk J, Schoenwald S, et al. The Research Network on Youth Mental Health. Assessing the organizational social context (OSC) of mental health services: implications for research and practice. Adm Policy Ment Health 2008;35(1–2):98–113.
37. Stone DM, Barber CW, Potter L. Public health training online: the National Center for Suicide Prevention Training. Am J Prev Med 2005;29(2S):S247–S251.

National Pathways for Suicide Prevention and Health Services Research

Brian K. Ahmedani, PhD, Steven Vannoy, PhD, MPH

Context: In 2012, the National Action Alliance for Suicide Prevention's Research Prioritization Task Force (RPTF) released a series of Aspirational Goals (AGs) to decrease suicide deaths and attempts. The RPTF asked experts to summarize what was known about particular AGs and to propose research pathways that would help reach them. This manuscript describes what is known about the benefits of access to health care (AG8) and continuity of care (AG9) for individuals at risk for suicide. Research pathways are proposed to address limitations in current knowledge, particularly in U.S. healthcare-based research.

Evidence acquisition: Using a three-step process, the expert panel reviewed available literature from electronic databases. For two AGs, the experts summarized the current state of knowledge, determined breakthroughs needed to advance the field, and developed a series of research pathways to achieve prevention goals.

Evidence synthesis: Several components of healthcare provision have been found to be associated with reduced suicide ideation, and in some cases they mitigated suicide deaths. Randomized trials are needed to provide more definitive evidence. Breakthroughs that support more comprehensive patient data collection (e.g., real-time surveillance, death record linkage, and patient registries) would facilitate the steps needed to establish research infrastructure so that various interventions could be tested efficiently within various systems of care. Short-term research should examine strategies within the current healthcare systems, and long-term research should investigate models that redesign the health system to prioritize suicide prevention.

Conclusions: Evidence exists to support optimism regarding future suicide prevention, but knowledge is limited. Future research is needed on U.S. healthcare services and system enhancements to determine which of these approaches can provide empirical evidence for reducing suicide.
(Am J Prev Med 2014;47(3S2):S222–S228)

Introduction

Suicide is a major public health concern.[1,2] Despite numerous prevention and intervention efforts, the overall rates of suicide in the U.S. have not decreased significantly over time.[3,4] In fact, according to the CDC, adult suicide rates have actually risen by nearly 30% over the last decade.[5] This is due, in part, to the limited evidence available to support informed and targeted strategies to reduce suicide.

In 2012, the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF) identified a series of Aspirational Goals (AGs), which, if achieved, might make a difference in mitigating suicide in the U.S.[6] Following the establishment of these goals, the RPTF teamed with researchers who had expertise related to each of the goals. Experts were asked to review the state of knowledge for each AG, identify areas where breakthroughs were needed, and develop pathways to guide future research most likely to reduce suicide mortality and morbidity.

This review discusses the expert panel findings for AGs 8 and 9. The first of these goals (AG8) is "to design new healthcare delivery strategies to ensure that affordable, accessible, effective care is available to all individuals at risk for suicidal behavior." The second of these goals (AG9) is "for suicidal individuals, reduce treatment dropout at all stages of the care process by providing

From the Center for Health Policy and Health Services Research (Ahmedani), Henry Ford Health System, Detroit, Michigan; and the Department of Counseling and School Psychology (Vannoy), University of Massachusetts–Boston, Boston, Massachusetts

Address correspondence to: Brian K. Ahmedani, PhD, Center for Health Policy and Health Services Research, Henry Ford Health System, 1 Ford Place, 3A, Detroit MI 48202. E-mail: bahmeda1@hfhs.org.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.038

better continuity."[6] Because much of the current evidence overlaps for these goals, they have been combined in this review. The other manuscripts in this supplement address research pathways for the remainder of the AGs.

Evidence Acquisition

Using a three-step process, evidence was compiled from a comprehensive search of all available electronic databases for published literature on access to and engagement in health services for individuals at risk for suicide. First, the RPTF identified systematic reviews and other primary studies from all of the major electronic databases, including MEDLINE, the Cochrane Library, PsychINFO, and Google Scholar. All English-language studies using human subjects were evaluated by doctoral-level researchers.

Second, the information obtained by the RPTF was shared with the topic area experts examining AG8 and AG9: Drs. Steven Vannoy and Jürgen Unützer, from the University of Washington. Drs. Vannoy and Unützer supplemented the information with their experience, and additional articles of importance to the field. They summarized the findings from both sets of reviews in presentation format for a panel of overview experts. Finally, in the third step, Dr. Brian Ahmedani, from Henry Ford Health System (HFHS), and Dr. Vannoy conducted a final investigation and examination of the literature. The three-step search process yielded evidence to support future research pathways for AG8 and AG9.

Suicide prevention efforts exist on several levels across the entire continuum of health care and can target the spectrum of suicide-related behavior, including (1) suicide deaths; (2) suicide attempts; and (3) suicide ideation (thoughts or plans). Intermediate outcomes, such as improved treatment adherence or a reduction in repeated crisis visits to emergency care, should also be considered outcomes in research efforts, as these behaviors incur high levels of burden.

Gordon's[7] definitions of prevention have been applied to public health approaches for preventing mental disorders and can be applied to suicide prevention. Specifically, universal approaches are applied to all individuals in a population. In the healthcare system, this could translate to a universal screening effort. Selective approaches are for those with characteristics that are associated with increased risk, such as among individuals with behavioral health conditions.

Indicated approaches focus on those with specific known risk, such as those individuals who exhibit suicide-related thoughts or have a history of attempting suicide. Suicide risk management can be considered skills needed to assess these levels of risk, and then to inform patients, provide treatment, coordinate care, and respond to crises for those who have been identified.[8] Risk management activities can be distributed across settings and types of providers.

The authors draw from research demonstrating the benefits of the chronic care management model as it has been applied to common mental disorders.[9] This model involves patient engagement in care, delivering brief assessment and intervention, care coordination across the system, and tracking outcomes as components of quality improvement efforts.

Evidence Synthesis

There are significant challenges to determining which health services are, or are not, helping individuals to engage in care and receive the help they need. Few healthcare systems routinely link patient care history with suicide attempt or death outcomes, and ideation is not routinely assessed.[10] Universal screening in primary care is likely to lead to many false positives,[11,12] and few studies have shown how best to identify those at risk in general medicine settings and refer them to effective specialty care. The U.S. Preventive Services Task Force (USPSTF) currently does not recommend screening for suicide risk in primary care owing to the lack of evidence-based interventions.[13]

Moreover, individuals who need care do not always seek help for suicide-related concerns from healthcare providers for various reasons, some associated with the healthcare system (e.g., beliefs about ineffective care).[14] In other cases, embarrassment or shame felt by the individuals or family members and friends who might help the at-risk individual may result in fewer opportunities for intervention when these beliefs are not adequately addressed by healthcare outreach efforts.[15,16]

Even if individuals access health care, the majority of those who die by suicide are likely to be seen in primary care settings, where suicide risk is often underdetected and undertreated.[17–19] For example, the Mental Health Research Network recently found that most healthcare visits prior to suicide occur in primary care or general medical specialty settings, and half of all visits are not coded with mental health diagnoses.[20] This is troubling for individuals at risk for suicide, as more than 90% meet criteria for mental health conditions in psychological autopsy studies.[21]

As discussed in this supplement and elsewhere, one concern is that general medical providers often lack the training and knowledge needed to identify and treat mental health and suicide risk, as well as limited time to discuss these issues with patients.[22,23] Thus, the current healthcare system relies on the limited number of referrals that make it to specialty mental health care and emergency services, where the skill levels of providers may also be limited with regard to suicide risk management.

Access to specialty mental health and substance use care has been limited, and where available, it may be cost prohibitive.[24] Thus, affordability has been a barrier to accessing needed care, particularly for individuals without health insurance. Recent healthcare legislation may improve these circumstances and in turn decrease suicide risk.

For example, one study[25] found that increased access to healthcare services attributed to the passage of state mental health parity laws was associated with a 5% reduction in the suicide death rate in those states. Parity laws mandate equal insurance coverage for mental health

and general medical care on select health plans. The research pathways considered here are timely, as the federal Affordable Care Act, along with numerous other state and federal parity laws, has provisions that aim to extend mental health care insurance coverage, which could improve access and thereby potentially mitigate suicide risk.[24]

Several studies describing deliberate changes in health system models to enhance care of suicidal individuals or depression as a major risk factor have shown promise. Chronic disease care models have improved treatment access, adherence, and continuity for mental health conditions. Collaborative care, as one approach to chronic care management, has been applied to depression, resulting in reduced frequency and intensity of suicidal ideation.[26,27] Similarly, mandated coordinated care in the United Kingdom (UK) resulted in a decrease in suicide attempts.[28] While and colleagues[29] also found that a series of large healthcare system enhancements in the UK were associated with a reduction in suicide deaths.

Alternative treatments, such as telephone and web-based interventions, are effective for mental health conditions.[30,31] These alternative treatments may improve continuity of care in mental health services and subsequently enhance suicide prevention. However, the U.S. healthcare model is vastly different from that of the UK, as it relies upon reimbursement from multiple sources (e.g., government, private payers, and individuals). Thus, implementation of these prevention models requires advancements in methods of billing and reimbursement. There may be opportunities to reform reimbursement methods as part of the Affordable Care Act. Although each of these interventions appears suited for suicide prevention in the U.S., evidence of their potential impact remains limited.

Interventions that target suicide behavior directly are considered by many to be essential in selective suicide prevention efforts, with current studies focused on individuals who have either presented to emergency or specialty care, as discussed in this supplement.[32] As noted by the recent USPSTF report,[13] few studies have tested interventions for suicide mitigation in primary care beyond collaborative depression care for older adults. Two European randomized trials[33,34] promoting continuity of care in health systems did not find evidence for reduction of suicidal behavior.

Furthermore, very limited data are available on suicide-related outcomes from treatment adherence interventions, which have shown effectiveness for individuals with depression.[35] Suicide crisis phone lines, such as the National Suicide Prevention Lifeline, are showing promise for reducing distress and linking callers to services.[36,37] The Lifeline was recently established in response to prior National Suicide Goals to enhance access and community outreach.[38] The means restriction method of suicide prevention, including removing access to firearms and other lethal items, has shown promise in previous research.[39–41] However, expanding means restriction may require public health changes.[42] This is discussed in more detail elsewhere in this supplement.

Currently funded research on suicide approaches within care systems is underway to examine several questions. For example, the Department of Defense (DoD) has funded a Military Suicide Research Consortium to examine multiple assessment and intervention models for service members and veterans (msrc.fsu.edu/). The Mental Health Research Network has begun a feasibility study of two population-based health system interventions to reduce suicide attempts (NIH #UH2AT007755). A potential second phase could include a large pragmatic trial across multiple health systems.

Although some evidence exists to support optimism regarding suicide prevention in the future, numerous gaps remain in our knowledge. Breakthroughs are needed in a number of areas in order to enhance suicide prevention (Table 1). First, suicide prevention must be prioritized across all levels of care, as evidenced in the Henry Ford Health System (HFHS) and U.S. Air Force Initiatives.[43–45]

The Perfect Depression Care (PDC) Initiative at HFHS shifted the behavioral health department's cultural focus toward the goal of eliminating suicides among all patients, included multi-level suicide risk assessment to inform care pathways, and offered numerous access points to care.[44,45] The PDC initiative also has a

Table 1. Breakthroughs needed to enhance suicide prevention by improving health services access and engagement

1. Prioritization of suicide across all levels of care
2. Effective identification and assessment strategies
3. Comprehensive surveillance systems and outcome tracking
4. Large registries linking risk across systems and providers
5. Enhanced electronic medical records with real-time notification of risk
6. Care coordination within and between providers, departments, and systems
7. Effective interventions using existing and alternative approaches to care
8. Informed care pathways
9. Stepped care treatment approaches
10. Treatment engagement

component on means restriction, which encourages individuals and their families to remove access to firearms and other lethal means. The "Zero Suicides" goal from PDC has been adopted as a national standard by the Action Alliance.

To achieve a suicide prevention–prioritized health system, the first step is to develop improved surveillance systems that are capable of tracking patient suicidal behavior (i.e., ideation, attempts, and deaths). These systems can be modeled after the recently launched DoD Suicide Event Report (DODSER) surveillance system, which was created in response to a prior national suicide goal.[38,46] This system tracks suicide-related behavior, including mortality, attempts, and ideation, across all divisions of the U.S. Armed Forces and links events to military, psychosocial, and treatment history for each person.

In practice, the electronic medical record (EMR) can be leveraged to screen for suicide risk, and make information immediately available to providers. Once individuals are identified, large registries can link information across systems and care platforms. These systems can provide real-time notifications to healthcare providers regarding each individual's status within the EMR. Using this information, care systems can also investigate and learn from adverse events and be optimally informed to prevent future events through more effective identification and risk assessment strategies for acute risk, especially in primary care and general medical settings.

Second, based on these surveillance efforts, leaders can make decisions as to where improved care is needed, implement changes, and again evaluate whether suicide risk is reduced through improved processes. Third, improved care coordination strategies within and between care disciplines can support systemwide improvements that may lead to synergistic benefits that would exceed any combination of individual care improvement components. These can leverage the EMR to share information.

Most importantly, each of these processes must be designed practically, so that health systems and providers can easily incorporate them into their daily routines. As discussed elsewhere in this supplement, enhanced technologies, detailed training, and workforce development interventions need to be developed and tested to improve each of these processes.

Fully connected systems and providers need tools to provide effective treatment. Thus, additional strategies are needed to improve suicide interventions that are tested in care systems. This includes optimizing and refining suicide research methodology, which encompasses developing targeted RCTs with larger sample sizes and well-planned quasi-experimental and observational studies. RCTs using waitlist control designs are an optimal approach for large implementation studies in healthcare settings. Interventions should specifically focus on suicide risk and behavior. This includes identifying the best ways to increase the willingness of non–mental health specialists to engage in prevention and intervention. Interventions should also be tested within the daily routines of standard health care to ensure that, if successful, they can be efficiently implemented.

One feasible and practical approach for busy healthcare providers may be brief interventions. These can be developed to provide immediate assessment and treatment, improve access, and inform care pathways.[47] The lack of empirically based risk stratification screening and assessment limits providers' abilities to match patient needs to care. Stepped care treatment models may offer a solution for indicated suicide risk, but should be tested in more rigorous ways. Finally, strategies should be developed to track and facilitate engagement in care once individuals have accessed the service system.

Figure 1 depicts a proposed research pathway based upon available evidence, which provides a hypothesis for how suicide prevention could be designed in a healthcare setting. Using this hypothesis-driven model, suicide prevention should begin the moment individuals make contact with the health system. Furthermore, all at-risk individuals should be accurately identified and assessed. All care providers should be able to assess and manage patients at a level appropriate to their healthcare role, and be able to successfully participate in coordinated care efforts with specialists and other care providers.

Once identified, individuals should be entered into a stepped care treatment pathway. They may be offered numerous opportunities to access and engage in effective treatment, including standard in-person options as well as telephonic, interactive video, web-based, and smartphone interventions. Healthcare professionals should be encouraging and supportive of participation. Care management should be collaborative across all health service settings.

In this proposed model, acute, primary, specialty, mental health, and chemical dependency care are all part of one united system with a common goal of preventing suicide. The focus of care management may be enhancing engagement, care coordination, risk monitoring, continued stepped care, and provision of mental health services. Combined, a comprehensive system using all of these efforts may help mitigate suicide risk by improving access to, and engagement in, healthcare services.

Although this utopian health system may exist in the future, there is not enough evidence available on the best approaches along each step in the process, how to implement and tailor the best protocols within the

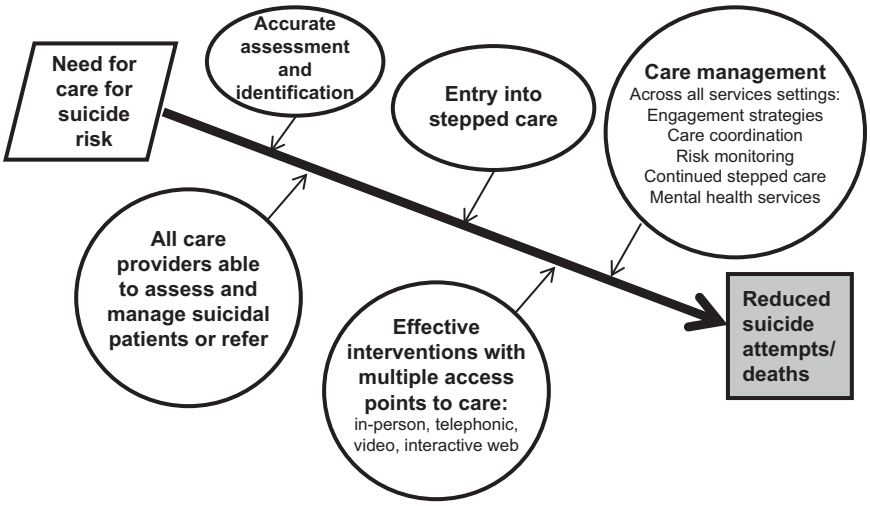

Figure 1. Proposed research pathways for suicide prevention research on health services access and engagement

current healthcare delivery system, or ways to reinvent the healthcare system for optimal suicide prevention. In particular, evidence is lacking on specific ideas that are practical for health providers and are easy to implement within health systems, given increasing demands. This may be one of the largest barriers to successful suicide prevention in healthcare settings. Thus, practical dissemination and implementation approaches must also be studied.

In order to achieve the goals set forth by the Action Alliance, innovative and well-designed projects need to be conducted within and across each area of the proposed research pathway. New projects need to use radical new ideas, designs, methods, and analyses that revolutionize the field, as the current models have not produced the intended reductions in suicide. There are several short- and long-term priorities that can facilitate learning over time.

Short-term research must first include epidemiologic and observational studies examining the best ways to identify those at risk and provide adequate monitoring approaches without taxing the system, particularly among those with universal risk in primary care and general medical settings who have not been diagnosed with a mental health condition. For individuals with risk factors (indicated prevention approaches), identification and assessment strategies could consider testing collaborative stepped care models. For those identified as being at risk (selective prevention), research investigating the effectiveness of existing interventions (or their pragmatic adaptations such as Screening, Brief Intervention, and Referral to Treatment for improving treatment engagement)[48] targeting suicidal thoughts and behavior is needed.

These studies should use strong research methodology, such as randomized trials or carefully planned quasi-experimental designs, while developing collaborative partnerships across systems to increase sample sizes. Researchers also can develop and test new and innovative ways to measure the effectiveness of suicide interventions. For example, researchers can harness the power of the EMR to capture longitudinal information on standardized mental health and suicide risk assessments and treatment utilization. Many systems have already incorporated mental health and suicide screening practices into their daily workflows.[49,50]

Long-term research can evaluate innovative techniques to redesign the healthcare system to provide treatment and follow-up in novel ways, with a particular focus on suicide prevention. New interventions should be pragmatic and include technology-based strategies that may be able to reach more individuals beyond standard care seekers. Care systems may also evaluate new health plan reimbursement models, which fit within recent healthcare legislations expanding coverage for more individuals. These models may follow the innovative approach developed and implemented in Minnesota for collaborative depression care reimbursement as part of the Depression Improvement Across Minnesota, Offering a New Direction (DIAMOND) initiative.[51]

In all research, but particularly in intervention studies, protocols must account for ethical and safety concerns.[52,53] There should be a clear protocol to monitor and intervene regarding suicide risk for all participants (both treatment and control/comparison groups), including detailing specific steps based on varying levels of severity. Researchers should consider expanded monitoring of all participants for suicide risk and set clear guidelines for when individuals should be censored or referred for specialized care as well as rules for "stopping" any study.[52]

The consent process is also critical, specifically for intervention studies. It is essential to provide detailed information regarding the risks and benefits to participants, and to the parent/guardian for youth participants, while outlining the rules and regulations about confidentiality and duty to protect. In some circumstances, researchers should consult local laws regarding possible involvement of youth in studies in which it may be difficult to obtain parent/guardian consent to do history of abuse/neglect, drug use, or other circumstances.[53]

Conclusions

Overall, research implies that suicide is preventable, and at-risk individuals served by healthcare systems deserve care that is evidence-based. More research is needed on practical ways to identify and assess suicide risk and to test and implement effective interventions. Major progress has already been made by the Action Alliance through the declaration of the AGs. The research pathways presented here can help facilitate future suicide prevention and health services research.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

Sources of funding: Fund for Henry Ford Hospital; NIH (U19MH092201; UH2AT007755)

No financial disclosures were reported by the authors of this paper.

References

1. Heron M. Deaths: leading causes for 2009. Natl Vital Stat Rep 2012; 61(7):1–94.
2. Rockett IR, Regier MD, Kapusta ND, et al. Leading causes of unintentional and intentional injury mortality: U.S., 2000–2009. Am J Public Health 2012;102(11):e84–e92.
3. Crosby AE, Ortega L, Stevens MR. Suicides—U.S., 1999–2007. MMWR Surveill Summ 2011;60(1S):S56–S59.
4. Holinger PC, Klemen EH. Violent deaths in the U.S., 1900–1975. Relationships between suicide, homicide and accidental deaths. Soc Sci Med 1982;16(22):1929–38.
5. CDC. Suicide among adults aged 35–64 years—U.S., 1999–2010. MMWR Morb Mortal Wkly Rep 2013;62(17):321–5.
6. USDHHS Office of the Surgeon General and National Action Alliance for Suicide Prevention. 2012 National Strategy for Suicide Prevention: Goals and Objectives for Action. Washington, DC: HHS, September 2012. http://www.surgeongeneral.gov/library/reports/national-strategy-suicide-prevention/full-report.pdf.
7. Mrazek PJ, Haggerty RJ. Reducing risks for mental disorders: frontiers for preventive intervention research. Washington DC: National Academies Press, 1994.
8. McDowell AK, Lineberry TW, Bostwick JM. Practical suicide-risk management for the busy primary care physician. Mayo Clin Proc 2011;86(8):792–800.
9. Unutzer J, Schoenbaum M, Druss BG, Katon WJ. Transforming mental health care at the interface with general medicine: report for the presidents commission. Psychiatr Serv 2006;57(1):37–47.
10. Ahmedani BK, Coffey MJ, Coffey CE. Collecting mortality data to drive real-time improvement in suicide prevention. Am J Manag Care 2013;19(11):e386–e390.
11. Simon GE, VonKorff M. Suicide mortality among patients treated for depression in an insured population. Am J Epidemiol 1998;147(2):155–60.
12. McMillan D, Gilbody S, Beresford E, Neilly L. Can we predict suicide and non-fatal self-harm with the Beck Hopelessness Scale? A meta-analysis. Psychol Med 2007;37(6):769–78.
13. O'Connor E, Gaynes BN, Burda BU, Soh C, Whitlock EP. Screening for and treatment of suicide risk relevant to primary care: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med 2013;158(10):741–54.
14. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. N Engl J Med 2004;351(1):13–22.
15. Ahmedani BK. Mental health stigma: society, individuals, and the profession. J Soc Work Values Ethics 2011;8(2):4-1–16.
16. Ahmedani BK, Kubiak SP, Kessler RC, et al. Embarrassment when illness strikes a close relative: a World Mental Health Survey Consortium Multi-Site Study. Psychol Med 2013;43(10):2191–202.
17. Vannoy SD, Tai-Seale M, Duberstein P, Eaton LJ, Cook MA. Now what should I do? Primary care physicians' responses to older adults expressing thoughts of suicide. J Gen Intern Med 2011;26(9):1005–11.
18. Vannoy SD, Fancher T, Meltvedt C, Unutzer J, Duberstein P, Kravitz RL. Suicide inquiry in primary care: creating context, inquiring, and following up. Ann Fam Med 2010;8(1):33–9.
19. Luoma JB, Martin CE, Pearson JL. Contact with mental health and primary care providers before suicide: a review of the evidence. Am J Psychiatry 2002;159(6):909–16.
20. Ahmedani BK, Simon GE, Stewart C, et al. Health care contacts in the year before suicide death. J Gen Intern Med 2014;29(6):870–7.
21. Cavanagh JT, Carson AJ, Sharpe M, Lawrie SM. Psychological autopsy studies of suicide: a systematic review. Psychol Med 2003;33(3):395–405.
22. Hooper LM, Epstein SA, Weinfurt KP, DeCoster J, Qu L, Hannah NJ. Predictors of primary care physicians' self-reported intention to conduct suicide risk assessments. J Behav Health Serv Res 2012;39(2):103–15.
23. Graham RD, Rudd MD, Bryan CJ. Primary care providers' views regarding assessing and treating suicidal patients. Suicide Life Threat Behav 2011;41(6):614–23.
24. Garfield RL, Druss BG. Health reform, health insurance, and mental health care. Am J Psychiatry 2012;169(7):675–7.
25. Lang M. The impact of mental health insurance laws on state suicide rates. Health Econ 2013;22(1):73–88.
26. Bruce ML, Ten Have TR, Reynolds CF III, et al. Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA 2004;291(9):1081–91.
27. Unutzer J, Katon W, Callahan CM, et al. Collaborative care management of late-life depression in the primary care setting: a randomized controlled trial. JAMA 2002;288(22):2836–45.
28. Gunnell D, Metcalfe C, While D, et al. Impact of national policy initiatives on fatal and non-fatal self-harm after psychiatric hospital discharge: time series analysis. Br J Psychiatry 2012;201(3):233–8.
29. While D, Bickley H, Roscoe A, et al. Implementation of mental health service recommendations in England and Wales and suicide rates, 1997–2006: a cross-sectional and before-and-after observational study. Lancet 2012;379(9820):1005–12.

30. Mohr DC, Ho J, Duffecy J, et al. Effect of telephone-administered vs face-to-face cognitive behavioral therapy on adherence to therapy and depression outcomes among primary care patients: a randomized trial. JAMA 2012;307(21):2278–85.
31. Andrews G, Cuijpers P, Craske MG, McEvoy P, Titov N. Computer therapy for the anxiety and depressive disorders is effective, acceptable and practical health care: a meta-analysis. PLoS One 2010;5(10): e13196.
32. Linehan MM. Suicide intervention research: a field in desperate need of development. Suicide Life Threat Behav 2008;38(5):483–5.
33. Morthorst B, Krogh J, Erlangsen A, Alberdi F, Nordentoft M. Effect of assertive outreach after suicide attempt in the AID (assertive intervention for deliberate self harm) trial: randomised controlled trial. BMJ 2012;345:e4972.
34. Johannessen HA, Dieserud G, De LD, Claussen B, Zahl PH. Chain of care for patients who have attempted suicide: a follow-up study from Baerum, Norway. BMC Public Health 2011;11:81.
35. Simon GE, Ludman EJ, Rutter CM. Incremental benefit and cost of telephone care management and telephone psychotherapy for depression in primary care. Arch Gen Psychiatry 2009;66(10):1081–9.
36. Britton PC, Bossarte RM, Thompson C, Kemp J, Conner KR. Influences on call outcomes among veteran callers to the National Veterans Crisis Line. Suicide Life Threat Behav 2013;43(5):494–502.
37. Gould MS, Munfakh JL, Kleinman M, Lake AM. National suicide prevention lifeline: enhancing mental health care for suicidal individuals and other people in crisis. Suicide Life Threat Behav 2012;42(1):22–35.
38. DeMartino RE, Crosby AE, EchoHawk M, et al. A call to collaboration: the federal commitment to suicide prevention. Suicide Life Threat Behav 2003;33(2):101–10.
39. Miller M, Hemenway D. Guns and suicide in the U.S. N Engl J Med 2008;359(10):989–91.
40. Miller M, Warren M, Hemenway D, Azrael D. Firearms and suicide in U.S. cities. Inj Prev 2013.
41. Reisch T, Steffen T, Habenstein A, Tschacher W. Change in suicide rates in Switzerland before and after firearm restriction resulting from the 2003 "Army XXI" reform. Am J Psychiatry 2013;170(9):977–84.
42. Hemenway D. Preventing gun violence by changing social norms. JAMA Intern Med 2013;173(13):1167–8.
43. Knox KL, Litts DA, Talcott GW, Feig JC, Caine ED. Risk of suicide and related adverse outcomes after exposure to a suicide prevention programme in the U.S. Air Force: cohort study. BMJ 2003;327(7428): 1376.
44. Hampton T. Depression care effort brings dramatic drop in large HMO population's suicide rate. JAMA 2010;303(19):1903–5.
45. Coffey CE, Coffey MJ, Ahmedani BK. An update on perfect depression care. Psychiatr Serv 2013;64(4):396.
46. Gahm GA, Reger MA, Kinn JT, Luxton DD, Skopp NA, Bush NE. Addressing the surveillance goal in the National Strategy for Suicide Prevention: the Department of Defense Suicide Event Report. Am J Public Health 2012;102(1S):S24–S28.
47. Britton PC, Conner KR, Maisto SA. An open trial of motivational interviewing to address suicidal ideation with hospitalized veterans. J Clin Psychol 2012;68(9):961–71.
48. Pecoraro A, Royer-Malvestuto C, Rosenwasser B, et al. Factors contributing to dropping out from and returning to HIV treatment in an inner city primary care HIV clinic in the U.S. AIDS Care 2013; 25(11):1399–406.
49. Simon GE, Rutter CM, Peterson D, et al. Does response on the PHQ-9 Depression Questionnaire predict subsequent suicide attempt or suicide death? Psychiatr Serv 2013;64(12):1195–202.
50. Reiss-Brennan B, Briot P, Daumit G, Ford D. Evaluation of "depression in primary care" innovations. Adm Policy Ment Health 2006;33(1):86–91.
51. Solberg LI, Glasgow RE, Unutzer J, et al. Partnership research: a practical trial design for evaluation of a natural experiment to improve depression care. Med Care 2010;48(7):576–82.
52. Pearson JL, Stanley B, King CA, Fisher CB. Intervention research with persons at high risk for suicidality: safety and ethical considerations. J Clin Psychiatry 2001;62(25S):S17–S26.
53. King CA, Kramer AC. Intervention research with youths at elevated risk for suicide: meeting the ethical and regulatory challenges of informed consent and assent. Suicide Life Threat Behav 2008;38(5): 486–97.

Prioritizing Research to Reduce Youth Suicide and Suicidal Behavior

Jeffrey A. Bridge, PhD, Lisa M. Horowitz, PhD, MPH, Cynthia A. Fontanella, PhD, Jackie Grupp-Phelan, MD, MPH, John V. Campo, MD

The goal of the National Action Alliance for Suicide Prevention is to reduce suicide and suicide attempts in the U.S. by 40% in the next decade. In this paper, a public health approach is applied to suicide prevention to illustrate how reductions in youth suicide and suicidal behavior might be achieved by prioritizing research in two areas: (1) increasing access to primary care–based behavioral health interventions for depressed youth and (2) improving continuity of care for youth who present to emergency departments after a suicide attempt. Finally, some scientific, clinical, and methodologic breakthroughs needed to achieve rapid, substantial, and sustained reductions in youth suicide and suicidal behavior are discussed.

(Am J Prev Med 2014;47(3S2):S229–S234)

Introduction

Suicide is the third-leading cause of death in young people aged 10–19 years in the U.S. and represents a worldwide public health problem.[1,2] Nonfatal suicidal behavior is more prevalent and results in significant morbidity and increased risk of suicide.[2–4] The National Action Alliance for Suicide Prevention (Action Alliance) envisions "a nation free from the tragic experience of suicide"[5,6] and charged its Research Prioritization Task Force (RPTF) with developing a public health–oriented research agenda aimed at reducing rates of suicide and suicidal behavior in the U.S. by 40% within the next decade.[6] For young people aged 10–19 years, this would represent roughly 700 fewer suicide deaths and more than 100,000 averted suicide attempts annually.[1,3]

The RPTF's research agenda development process identified 12 aspirational goals (AGs), defined as important, practical, and results-oriented research efforts that have the potential to rapidly and substantially reduce suicide in the U.S.[7] AGs are assumed to be "big ideas" rather than circumscribed research projects.[5,7] This article will discuss youth suicide prevention within the context of two AGs: (1) AG8 aims to ensure that affordable, accessible, and effective care is available to all individuals at risk for suicidal behavior; and (2) AG9 aims to reduce treatment dropout at all stages of the care process by enhancing continuity of care for suicidal individuals.[5]

The authors first describe how rapid reductions in youth suicide might be achieved by prioritizing research targeting access to behavioral health interventions for depressed youth in pediatric primary care settings. Next, rapid reductions in youth suicide are discussed within the context of improving continuity of care for young people who present to emergency departments (EDs) after a suicide attempt. These two service settings are emphasized because the majority of young people who die by suicide have had contact with a primary care clinician (PCC) or ED in the year prior to death.[8,9] Finally, some methodologic/conceptual barriers to achieving these AGs in youth suicide prevention research are discussed.

Public Health Approach to Youth Suicide Prevention

The public health–based approach to suicide prevention adopted by the Action Alliance and the National Institute of Mental Health (NIMH) involves four steps: (1) identifying large subgroups of individuals with elevated risk of suicide and in service settings appropriate for intervention; (2) pairing at-risk subgroups with effective interventions; (3) estimating the results of implementation; and (4) assessing timelines for implementation and research.[6] An additional element is to identify targets for

From the Research Institute at Nationwide Children's Hospital (Bridge), and Department of Pediatrics (Bridge), Department of Psychiatry (Fontanella, Campo), The Ohio State University College of Medicine, Columbus; Division of Emergency Medicine (Grupp-Phelan), Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; and Office of the Clinical Director (Horowitz), National Institute of Mental Health, Bethesda, Maryland

Address correspondence to: Jeffrey A. Bridge, PhD, The Research Institute at Nationwide Children's Hospital, Center for Innovation in Pediatric Practice, 700 Children's Drive, Columbus OH 43205. E-mail: jeff.bridge@nationwidechildrens.org.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.06.001

intervention that are prevalent, strongly associated with suicide risk, and modifiable.[10]

Two risk factors, depression and suicide attempts, are highlighted below as targets for intervention in pediatric primary care and ED settings. Depression is common, impairing, and likely the most relevant remediable risk factor for youth suicide, given its association with suicide attempts and 30-fold increased risk of completed suicide.[2,11] According to the 2011 National Youth Risk Behavior Survey, 7.8% of all students in Grades 9–12 attending public and private school in the U.S. attempted suicide in the past year, and 2.4% made a serious attempt requiring medical attention.[3] A prior suicide attempt is the single most potent predictor of youth suicide.[2]

The authors describe below how the first three steps of the public health–based approach to suicide prevention can be applied to prioritizing research to improve access to care for depressed youth and continuity of care for adolescent suicide attempters. It must be emphasized that the estimates and underlying assumptions used to calculate potential reductions in youth suicide are imprecise, owing to limitations of the existing evidence base.

Aspirational Goal 8: Access to Effective Care

Pediatric primary care is an ideal service setting for intervention research aimed at rapidly reducing suicide and suicidal behaviors among U.S. youth. In 2010, there were more than 25 million adolescents aged 12–17 years in the U.S.,[1] and national survey data suggest that 82% visit their PCC at least once annually.[12] PCCs prescribe most pediatric psychoactive medications[13] and up to 80% of youth who die by suicide were seen by their PCC or an outpatient physician in the year prior to their death.[8,9] The American Academy of Pediatrics recognizes suicide prevention as a priority for pediatricians[14] and has endorsed guidelines for the care of depressed youth in primary care.[15,16]

Meaningful improvements in the management of psychiatric disorders in primary care settings require systemic changes in primary care practice and access to a comprehensive system of mental health services.[17] Collaborative care models integrate mental health professionals into primary care as educators, consultants, and clinicians in order to bridge the gap between specialty and primary care, improve communication and continuity of care, and determine the most appropriate level of care.[18]

Collaborative care interventions for depressed older adults within primary care that improve recognition of depression and access to evidence-based diagnosis and treatment have proven successful in decreasing both depressive symptomatology and suicidal ideation.[19–22] Applying lessons learned from these studies, the Youth Partners in Care (YPIC) study compared a 6-month quality improvement intervention designed to improve access to evidence-based cognitive–behavioral therapy (CBT) and antidepressant medication for adolescent depression in primary care (n=211) to usual care (n=207) enhanced by PCC education. Six months after baseline assessment, patients who received the intervention experienced significantly greater improvements in access to mental health care, depressive symptoms, mental health–related quality of life, and satisfaction with care.[23]

The rate of suicide attempts or self-harm declined by 55% in participants receiving the intervention, from 14.2% at baseline to 6.4% at 6 months, compared to an 18% reduction (11.6% to 9.5%) for patients receiving usual care. The difference was not statistically significant (OR=0.55, 95% CI=0.23, 1.34; p=0.19), perhaps because of the low base rate of suicidal behavior at study entry.[23] Collectively, collaborative care interventions in primary care show promise in improving care for youth with depression and reducing suicidal ideation and attempts.

The following example assumes an annual prevalence rate of roughly 8% for suicide attempts in youth with depression, and that 200–300 suicide attempts are made for every completed pediatric suicide.[1,2,11,24] Based on the available literature[23,25] and assuming a screening measure with adequate sensitivity and specificity,[26] broad-scale screening for depression in pediatric primary care that reached 25% of adolescents aged 12–17 years in the U.S. would identify more than 1 million youths who are screen positive for major or minor depression (Table 1). According to the promising YPIC study results,[23] if the rate of suicide attempt within 1 year could be halved by a collaborative care depression intervention relative to usual care, then about 125–208 lives a year could be saved. This represents 13%–22% of the 936 suicide deaths that occurred on average in the U.S. among 12–17-year-olds between 2006 and 2010 (Table 1).

Aspirational Goal 9: Continuity of Care

Adolescents presenting to the ED after a suicide attempt represent a high-risk target subgroup,[6] with more than 103,000 presenting to U.S. EDs in 2011 after deliberate self-harm, and 77,000 after a suicide attempt (Table 2).[27] Most (73%) are discharged to the community from the ED, yet less than 40% receive a follow-up visit within 30 days[28] despite being at high risk for reattempt, especially within the first 6 months.[2] Moreover, up to 50% of youth who die by suicide present to the ED within the year preceding death.[8]

Three RCTs of interventions to promote mental health treatment engagement and compliance for adolescents

Table 1. Estimated number of suicide deaths in youth aged 12–17 years averted with primary care–based collaborative care intervention for depression

U.S. Census Data (2010)	
Number of youths aged 12–17 years in the U.S.	25,344,492
Expected number of youths having an annual primary care visit (0.82) (USDHHS, 2009)	20,782,483
Screening for depression implemented in primary care practices impacting 25% of all patients	5,195,621
Expected number of youths screening positive for depression (0.2)[25–27]	1,039,124
Expected estimates of suicide attempt within 1 year[a]	
Group A: Suicide attempts expected within 12 months of primary care visit after usual follow-up care (0.08 × 1,039,124)	83,130
Group B: Suicide attempts expected within 12 months of primary care visit after collaborative care intervention (0.04 × 1,039,124)	41,565
Expected estimates of suicide deaths (based on roughly 200–300 suicide attempts for every completed suicide)	
Group A: Deaths expected within 12 months of ED discharge after usual follow-up care (0.003 × 83,130) (0.005 × 83,130)	250–416
Group B: Deaths expected within 12 months of ED discharge after collaborative care intervention (0.003 × 41,565) (0.005 × 41,565)	125–208
Range of potential number of suicide deaths averted through application of collaborative care interventions in primary care	
(250 − 125 = **125**)	**125–208**[b]
(416 − 208 = **208**)	

Note: Average annual number of suicide deaths in young persons aged 12–17 years, 2006–2010, U.S.=936.[1]
[a]Assumes annual suicide attempt rate of 8% in usual follow-up care patients and a 4% attempt rate in patients receiving the collaborative care intervention
[b]125–208 averted suicide deaths would represent an approximate 13%–22% annual reduction
ED, emergency department

presenting with suicidal behaviors in the ED have yielded encouraging results.[29–32] One promising approach is the Family Intervention for Suicide Prevention (FISP), a family-based CBT intervention specifically designed for use in the ED to increase motivation for follow-up treatment, support, coping, and safety.[33] Asarnow and colleagues[32] randomized 181 suicidal adolescents to usual care (provider education alone) or FISP with care linkage via telephone to increase motivation for follow-up. FISP intervention patients were significantly more likely to attend any outpatient treatment (92% vs 76%, p=0.004); attend more outpatient treatment visits; receive psychotherapy; and receive combined psychotherapy and medication.[32]

The following example assumes that the 12-month recurrence rate of youth suicide attempts is 18% and that roughly 0.5%–2.0% of recurrent attempters will die by suicide within 12 months.[34,35] Applying the findings of Asarnow et al.[32] to the CDC data (Table 2), approximately 71,000 youths who received a treatment engagement intervention will attend outpatient mental health care after ED discharge compared with 58,000 youths receiving usual care. CBT is effective in preventing recurrent suicide attempts in adults.[36] Although there is currently no intervention specifically designed to prevent adolescent suicide reattempts,[37] if such an intervention could halve the reattempt rate compared with usual care, then about 27–127 lives each year may be saved. This represents 1%–7% of the 1,821 suicide deaths that occurred on average in the U.S. among 10–19-year-olds between 2006 and 2010.

Breakthroughs Needed

The above-noted examples are simple illustrations of how the public health approach to suicide prevention might be applied to high-risk pediatric subgroups in two important general medical settings. A full discussion of other promising approaches and service settings is beyond the scope of this article. Although it is likely that improving access to care in general diminishes youth suicide risk,[38] a major scientific roadblock toward achieving rapid reductions in youth suicide and suicidal behavior is the lack of specific interventions with proven effectiveness in reducing recurrent suicide attempts in RCTs.[37,39]

Most RCTs testing psychotherapeutic or psychopharmacologic interventions for depression have excluded suicidal youth, making findings from these studies difficult to translate to depressed, suicidal youth. This means that scientific guidance is lacking with regard to treatment choice, even if treatment engagement interventions are 100% effective in linking suicidal youth with mental health services after discharge from the ED or other general medical settings.

There is an urgent need to develop, test, and refine the most promising interventions to reduce adolescent suicide attempts, which include (1) attachment-based family therapy to target family processes associated with depression and suicide[40]; (2) integrated CBT for suicidal, alcohol- or substance-abusing adolescents[41]; and (3) CBT for suicide prevention, which consists of a chain analysis of the index suicide attempt, development of a safety plan, and an individualized treatment plan designed to reduce reattempts.[37]

Table 2. Estimated number of suicide deaths in youth aged 10–19 years averted with ED-based mental health treatment engagement interventions and interventions to reduce suicide attempts

WISQARS Non-fatal Injury Reports (2011)[28]	
Number of youths treated in an ED for any reason	5,354,995
Number of youths presenting for self-harm (all injury causes)	103,342
Expected number of youths presenting after a suicide attempt	76,640
(1.0 × 49,937 self-poisoning) + (0.5 × 30,943 self-cutting) + (0.5 × 22,462 all other causes)	
Application of the findings of Asarnow et al.[33] to estimate outpatient follow-up mental health treatment engagement	
Group A: Number of youths expected to attend mental health treatment after ED discharge in usual care (0.762 × 76,640)	58,400
Group B: Number of youths expected to attend mental health treatment after ED discharge in enhanced mental health intervention (0.921 × 76,640)	70,586
Expected estimates of suicide reattempt	
Group A_1: Reattempts expected within 12 months of ED discharge after usual follow-up care (0.18 × 58,400)	10,512
Group A_2: Reattempts expected within 12 months of ED discharge after EB intervention (0.09 × 58,400)	5,256
Group B_1: Reattempts expected within 12 months of ED discharge after usual follow-up care (0.18 × 70,586)	12,706
Group B_2: Reattempts expected within 12 months of ED discharge after EB intervention (0.09 × 70,586)	6,353
Expected estimates of suicide deaths	
Group A_1: Deaths expected within 12 months of ED discharge after usual follow-up care (0.005 × 10,512) (0.02 × 10,512)	53–212
Group A_2: Deaths expected within 12 months of ED discharge after EB intervention (0.005 × 5,256) (0.02 × 5,256)	26–105
Group B_1: Deaths expected within 12 months of ED discharge after usual follow-up care (0.005 × 12,706) (0.02 × 12,706)	64–254
Group B_2: Deaths expected within 12 months of ED discharge after EB intervention (0.005 × 6,353) (0.02 × 6,353)	32–127
Range of potential number of suicide deaths averted through application of mental health treatment engagement interventions in EDs and subsequent EB suicide prevention interventions after discharge from the ED	
Intervention with no additional treatment engagement intervention: (53 − 26 = **27**) (212 − 105 = 107)	**27–127**[a]
Intervention plus treatment engagement intervention: (64 − 32 = 32) (254 − 127 = 127)	

Note: Average annual number of suicide deaths in youth aged 10–19 years, 2006–2010, U.S.=1,821.[1]
[a]27–127 averted suicide deaths would represent an approximate 1%–7% annual reduction.
EB, evidence-based; ED, emergency department; WISQARS, Web-based Injury Statistics Query and Reporting System

The lack of psychopharmacologic research specifically targeting suicidal behavior in youth is particularly striking. Accumulating evidence suggests that lithium carbonate has a preventive effect on suicide in adults with mood disorders,[42] yet claims data suggest that adolescent use of lithium is declining in favor of other medications.[43] Studies must be statistically powered to examine treatment effects on the rate of suicide attempts, not just proxy outcomes like ED visits or suicidal ideation, and should explore predictors of treatment dropout. If specific interventions prove efficacious, future studies can examine effectiveness, alone or in combination with other promising interventions.

Dissemination, implementation, and diffusion studies in real-world treatment settings can follow if effectiveness studies demonstrate a robust treatment signal. Over time, it will be necessary to demonstrate the cost-effectiveness of intervention programs designed to treat and ameliorate suicidal behavior in young people, but such cost-effectiveness calculations are complex and difficult to model. As patients who are suicidal or who have attempted suicide are often excluded from clinical trials, it is also essential to test interventions of known efficacy in reducing depression, substance abuse, or other known, modifiable risk factors of suicide in patients at acutely elevated risk for suicide such as in inpatient/ED settings.

Rapid, substantial, and sustained reductions in youth suicide are unlikely to occur in the U.S. unless effective interventions penetrate community healthcare settings. Although collaborative care interventions for depression have been well tested for older adults in primary care, a large-scale pediatric study analogous to the Improving Mood-Promoting Access to Collaborative Treatment (IMPACT) study[21,22] of depressed elderly deserves consideration, particularly if potentially suicidal youth are not excluded and the study is adequately powered.

Suicide risk stratification tools are needed to optimally implement collaborative care interventions, and if used in conjunction with validated suicide risk screening measures, could help clinicians identify and refer suicidal youth to the most appropriate level of care.[26] Similarly, large-scale quality improvement interventions such as

the Perfect Depression initiative,[44] which succeeded in reducing the rate of suicide in a large HMO, deserve study in pediatric settings.

Academic–community research partnerships targeting vulnerable yet hard-to-reach patients could make effective interventions accessible to youth from racially/ethnically and geographically diverse backgrounds while fostering a science-to-practice process that culturally refines, adapts, and translates evidence-based interventions into community interventions. Federally Qualified Health Centers (FQHCs) serving predominantly low-income, uninsured, and racial/ethnic minority populations may be prime settings for such collaborative research.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

No financial disclosures were reported by the authors of this paper.

References

1. CDC. National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). cdc.gov/ncipc/wisqars.
2. Bridge JA, Goldstein TR, Brent DA. Adolescent suicide and suicidal behavior. J Child Psychol Psychiatry 2006;47(3/4):372–94.
3. Eaton DK, Kann L, Kinchen S, et al. Youth Risk Behavior Surveillance—U.S., 2011. MMWR Morb Mortal Wkly Rep 2012;61(4):1–162.
4. Reinherz HZ, Tanner JL, Berger SR, Beardslee WR, Fitzmaurice GM. Adolescent suicidal ideation as predictive of psychopathology, suicidal behavior, and compromised functioning at age 30. Am J Psychiatry 2006;163(7):1226–32.
5. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
6. Pringle B, Colpe LJ, Heinssen RK, et al. A strategic approach for prioritizing research and action to prevent suicide. Psychiatr Serv 2013;64(1):71–5.
7. Claassen CA. The agenda development process of the U.S. National Action Alliance for Suicide Prevention Research Prioritization Task Force. Crisis 2013;34(3):147–55.
8. Rhodes AE, Khan S, Boyle MH, et al. Sex differences in suicides among children and youth: the potential impact of help-seeking behaviour. Can J Psychiatry 2013;58(5):274–82.
9. Farand L, Renaud J, Chagnon F. Adolescent suicide in Quebec and prior utilization of medical services. Can J Psychiatry 2004;95(5):357–60.
10. Bruce ML, Pearson JL. Designing an intervention to prevent suicide: PROSPECT (Prevention of Suicide in Primary Care Elderly: Collaborative Trial). Dialogues Clin Neurosci 1999;1(2):100–12.
11. Birmaher B, Brent D, Bernet W, et al. Practice parameter for the assessment and treatment of children and adolescents with depressive disorders. J Am Acad Child Adolesc Psychiatry 2007;46(11):1503–26.
12. USDHHS. Health Resources and Services Administration–Maternal and Child Health Bureau. The National Survey of Children's Health 2007. Rockville Maryland: USDHHS, 2009.
13. Kelleher KJ, Hohmann AA, Larson DB. Prescription of psychotropics to children in office-based practice. Am J Dis Child 1989;143(7):855–9.
14. Shain BN. Suicide and suicide attempts in adolescents. Pediatrics 2007;120(3):669–76.
15. Cheung AH, Zuckerbrot RA, Jensen PS, Ghalib K, Laraque D, Stein RE. Guidelines for adolescent depression in primary care (GLAD-PC): II. Treatment and ongoing management. Pediatrics 2007;120(5):e1313–e1326.
16. Zuckerbrot RA, Cheung AH, Jensen PS, Stein RE, Laraque D. Guidelines for adolescent depression in primary care (GLAD-PC): I. Identification, assessment, and initial management. Pediatrics 2007;120(5):e1299–e1312.
17. Thielke S, Vannoy S, Unutzer J. Integrating mental health and primary care. Prim Care 2007;34(3):571–92, vii.
18. Thota AB, Sipe TA, Byard GJ, et al. Collaborative care to improve the management of depressive disorders: a community guide systematic review and meta-analysis. Am J Prev Med 2012;42(5):525–38.
19. Bruce ML, Ten Have TR, Reynolds CF 3rd, et al. Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA 2004;291(9):1081–91.
20. Alexopoulos GS, Reynolds CF 3rd, Bruce ML, et al. Reducing suicidal ideation and depression in older primary care patients: 24-month outcomes of the PROSPECT study. Am J Psychiatry 2009;166(8):882–90.
21. Unützer J, Katon W, Callahan CM, et al. Collaborative care management of late-life depression in the primary care setting: a randomized controlled trial. JAMA 2002;288(22):2836–45.
22. Unützer J, Tang L, Oishi S, et al. Reducing suicidal ideation in depressed older primary care patients. J Am Geriatr Soc 2006;54(10):1550–6.
23. Asarnow JR, Jaycox LH, Duan N, et al. Effectiveness of a quality improvement intervention for adolescent depression in primary care clinics: a randomized controlled trial. JAMA 2005;293(3):311–9.
24. Fergusson DM, Beautrais AL, Horwood LJ. Vulnerability and resiliency to suicidal behaviours in young people. Psychol Med 2003;33(1):61–73.
25. Stevens J, Kelleher KJ, Gardner W, et al. Trial of computerized screening for adolescent behavioral concerns. Pediatrics 2008;121(6):1099–105.
26. Horowitz L, Bridge JA, Pao M, Boudreaux ED. Ask and they will tell you: screening youth for suicide risk in medical settings. Am J Prev Med 2014.
27. CDC. WISQARS™ nonfatal injury reports. cdc.gov/injury/wisqars/nonfatal.html.
28. Bridge JA, Marcus SC, Olfson M. Outpatient care of young people after emergency treatment of deliberate self-harm. J Am Acad Child Adolesc Psychiatry 2012;51(2):213–22, e211.
29. Rotheram-Borus MJ, Piacentini J, Cantwell C, Belin TR, Song J. The 18-month impact of an emergency room intervention for adolescent female suicide attempters. J Consult Clin Psychol 2000;68(6):1081–93.
30. Rotheram-Borus MJ, Piacentini J, Van Rossem R, et al. Enhancing treatment adherence with a specialized emergency room program for adolescent suicide attempters. J Am Acad Child Adolesc Psychiatry 1996;35(5):654–63.
31. Spirito A, Boergers J, Donaldson D, Bishop D, Lewander W. An intervention trial to improve adherence to community treatment by adolescents after a suicide attempt. J Am Acad Child Adolesc Psychiatry 2002;41(4):435–42.
32. Asarnow JR, Baraff LJ, Berk M, et al. An emergency department intervention for linking pediatric suicidal patients to follow-up mental health treatment. Psychiatr Serv 2011;62(11):1303–9.

33. Hughes JL, Asarnow JR. Enhanced mental health interventions in the emergency department: suicide and suicide attempt prevention. Clin Pediatr Emerg Med 2013;14(1):28–34.
34. Hawton K, Bergen H, Kapur N, et al. Repetition of self-harm and suicide following self-harm in children and adolescents: findings from the multicentre study of self-harm in England. J Child Psychol Psychiatry 2012;53(12):1212–9.
35. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. Brit J Psychiat 2002;181:193–9.
36. Brown GK, Ten Have T, Henriques GR, Xie SX, Hollander JE, Beck AT. Cognitive therapy for the prevention of suicide attempts: a randomized controlled trial. JAMA 2005;294(5):563–70.
37. Stanley B, Brown G, Brent D, et al. Cognitive-behavioral therapy for suicide prevention (CBT-SP): treatment model, feasibility, and acceptability. J Am Acad Child Adolesc Psychiatry 2009;48(10):1005–13.
38. Campo JV. Youth suicide prevention: does access to care matter? Curr Opin Pediatr 2009;21(5):628–34.
39. Gould MS, Greenberg T, Velting DM, Shaffer D. Youth suicide risk and preventive interventions: a review of the past 10 years. J Am Acad Child Adolesc Psychiatry 2003;42(4):386–405.
40. Diamond GS, Wintersteen MB, Brown GK, et al. Attachment-based family therapy for adolescents with suicidal ideation: a randomized controlled trial. J Am Acad Child Adolesc Psychiatry 2010;49(2):122–31.
41. Esposito-Smythers C, Spirito A, Kahler CW, Hunt J, Monti P. Treatment of co-occurring substance abuse and suicidality among adolescents: a randomized trial. J Consult Clin Psychol 2011;79(6):728–39.
42. Cipriani A, Hawton K, Stockton S, Geddes JR. Lithium in the prevention of suicide in mood disorders: updated systematic review and meta-analysis. BMJ 2013;346:f3646.
43. Hunkeler EM, Fireman B, Lee J, et al. Trends in use of antidepressants, lithium, and anticonvulsants in Kaiser Permanente-insured youths, 1994–2003. J Child Adolesc Psychopharmacol 2005;15(1):26–37.
44. Coffey CE. Pursuing perfect depression care. Psychiatr Serv 2006;57(10):1524–6.

Increasing Help-Seeking and Referrals for Individuals at Risk for Suicide by Decreasing Stigma

The Role of Mass Media

Thomas Niederkrotenthaler, MD, PhD, MMSc, Daniel J. Reidenberg, PsyD, Benedikt Till, DSc, Madelyn S. Gould, PhD, MPH

Increasing help-seeking and referrals for at-risk individuals by decreasing stigma has been defined as Aspirational Goal 10 in the National Action Alliance for Suicide Prevention's Research Prioritization Task Force's 2014 prioritized research agenda. This article reviews the research evidence on the impact of mass media awareness campaigns on reducing stigma and increasing help-seeking. The review will focus on both beneficial and iatrogenic effects of suicide preventive interventions using media campaigns to target the broad public. A further focus is on collaboration between public health professionals and news media in order to reduce the risk of copycat behavior and enhance help-seeking behavior. Examples of multilevel approaches that include both mass media interventions and individual-level approaches to reduce stigma and increase referrals are provided as well.

Multilevel suicide prevention programs that combine various approaches seem to provide the most promising results, but much more needs to be learned about the best possible composition of these programs. Major research and practice challenges include the identification of optimal ways to reach vulnerable populations who likely do not benefit from current awareness strategies. Caution is needed in all efforts that aim to reduce the stigma of suicidal ideation, mental illness, and mental health treatment in order to avoid iatrogenic effects. The article concludes with specific suggestions for research questions to help move this line of suicide research and practice forward.
(Am J Prev Med 2014;47(3S2):S235–S243)

Introduction

The stigma of mental illness is a complex construct with affective, cognitive, and behavioral components that affects attitudes and behavior patterns at both the individual and population levels. Its reduction requires a multidirectional approach.[1] Measures such as federal antidiscrimination legislation have been shown to be an important cornerstone against stigmatization of mental illness, but multiple components of the stigma process are beyond the reach of legislation, and need to be coupled with preventive programs to positively impact people's perceptions of mental illness or increase help-seeking across heterogeneous populations.[1,2]

The reduction of stigmatization of mental illness is considered to be relevant to the prevention of a variety of adverse mental health outcomes, including suicide. From the perspective of a public health approach to suicide prevention, some suicide prevention advocates consider raising public awareness of the scope of the problem of mental illness and suicide as a first key step in reducing the public health problem.[3]

However, there is also the counter-argument that targeting the broader public to raise awareness of the scope of the problem may adversely affect vulnerable individuals.[4–6] Adverse effects may be due to an increase in norms that describe suicidal behavior as common or frequent. This may increase the likelihood that individuals will believe that engaging in suicidal behavior is widespread and therefore acceptable.[7,8]

Suicide prevention researchers and practitioners alike are frequently torn between these two lines of thinking, and there is currently mixed evidence regarding

From the Institute of Social Medicine (Niederkrotenthaler, Till), Suicide Research Unit, Center for Public Health, Medical University of Vienna, Vienna, Austria; Suicide Awareness Voices of Education (Reidenberg), Bloomington, Minnesota; and the Columbia University/New York State Psychiatric Institute (Gould), New York, New York

Address correspondence to: Thomas Niederkrotenthaler, MD, PhD, MMSc, Medical University of Vienna, Center for Public Health, Institute of Social Medicine, Suicide Research Unit, Kinderspitalgasse 15, 1090 Vienna Austria. E-mail: thomas.niederkrotenthaler@meduniwien.ac.at.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.06.010

beneficial and harmful effects of broad-scale awareness programs.[4,5,9] A 2006 survey by Research!America[10,11] found that 89% of the U.S. population believed that mental health was as important as physical health, and 48% strongly agreed that "many suicides and suicide attempts can be prevented." Further, input from the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF) stakeholder survey highlighted the reduction of stigma and increased help-seeking as a priority, because of a prevalent perception that suicidality continues to be stigmatized.[11] Persons bereaved by suicide describe isolation and misunderstanding of their loss as a result of this stigma.[12,13]

This report focuses on various types of broad public health messaging/media-based approaches that aim at reducing the burden of suicide. These approaches include campaigns to reduce the stigma of mental illness and increase public awareness of suicide, media campaigns to increase help-seeking as well as efforts to prevent copycat suicides. The authors elaborate on how multilevel approaches are related to Aspirational Goal 10 and provide examples of research efforts that seem necessary to move the field of suicide prevention forward.

Influences on Help-Seeking

Individuals generally seek mental health services in a series of interactive stages that involve problem recognition, decision to seek help, and service selection. These stages can be influenced by a number of other factors, including attitudes and beliefs about suicide, health literacy, internal and external barriers, and perceived need for treatment.[14,15] Studies on help-seeking often use heterogeneous definitions of help-seeking, and methodologic inconsistencies across studies have been noted in the literature.[16]

One of the few available conceptual frameworks that may help increase consistency across studies is the framework proposed by Rickwood and Thomas,[16] which takes into account the specific part of the help-seeking process to be investigated, the source and type of assistance, and the type of mental health concern. Studies have inventoried reasons why individuals with suicidal ideation do not frequently seek help, some of which are outlined below.

Stigma—both self- and other-induced—is believed to reduce the likelihood that an individual will seek help to resolve a suicidal crisis.[17,18] Men, who have the highest rate of suicide and lower rates of accessing care for many health problems, particularly mental health services, are assumed to have more stigma and resistance to help-seeking, as are people with less exposure to suicide, of older age, with less education, or from culturally diverse backgrounds.[18]

According to Corrigan,[19] stigma can be described "in terms of prejudice (agreement with stereotypic beliefs leading to hostile emotional responses, such as fear and anger) and discrimination (the behavioral consequence of prejudice, which leads to social distance and the loss of opportunity)." However, research on stigma of mental illness and suicidal ideation has been hampered by heterogeneous definitions of stigma. Furthermore, a shortage of validated scales to measure stigma has been noted in the literature.[20] A scale to directly measure the stigma of suicide in the community has recently been proposed by Batterham and colleagues[20] in Australia and was found to have robust psychometric properties that require international validation.

A lack of problem recognition has been found to be one of the most prevalent reasons among teenagers and adults for not seeking help for suicidal ideation or mental health issues.[14,21–24] It is a more prevalent barrier to help-seeking among callers to the National Suicide Prevention Lifeline than financial or personal barriers (e.g., shame) or barriers related to perceptions about mental health services.[21]

Furthermore, maladaptive coping strategies, such as not considering external help, have been found most prevalent among high-risk youth,[15] and help-seeking intentions seem to further decrease with increasing suicidal ideation (so-called help-negation).[24]

News Media Approaches to Preventing Suicide

The media play an important role in the stigmatization of mental illness, suicidal ideation, and persons bereaved by suicide. The reduction of stigmatization by influencing public perceptions of suicide has been an important target in media-related suicide prevention efforts over the last two decades. Unfortunately, there are many discrepancies between typical media reports of suicide and actual suicide in the population, which may generate and help maintain stereotypes of suicide.

Suicide reports in news media are selective, frequently underreport the relationship between suicide and mental illness, and focus frequently on the reporting of homicide suicides.[25–27] Repetitive reporting of suicide in the context of homicide may increase or contribute to maintaining the stigmatization of suicidal individuals and of those bereaved by suicide. Young people without past experiences of seeking professional help have been found to largely rely on inaccurate media stereotypes.[24] The discrepancies between the realities of suicide prevention and the reality portrayed in the mass media

therefore warrant attention in public education on suicide prevention.

Following the publication of Goethe's *The Sorrow of the Young Werther* in 1774,[28] several suicides by young men of similar age and with suicide motives like the protagonist in Goethe's novel were reported in the literature. There is strong evidence today that media portrayals of suicide can lead to additional suicides, the so-called Werther effect, but negative findings also continue to be reported.[29–32]

The evidence of copycat behavior is strongest following media coverage of a celebrity suicide, and for other types of repetitive, high-quantity reporting.[29,33,34] A recent meta-analysis[29] identified an average significant cumulative increase of 0.26 suicides per 100,000 people in the month following reporting on a celebrity suicide. The effect seemed to vary with the type of celebrity involved, with entertainers having the largest impact.[29] Effects have been shown to be most pronounced in subpopulations that resemble the portrayed suicide with regard to gender, age group, and selected suicide methods.[34,35]

Although most research has focused on the impact of news media reporting, some studies also have detected potential copycat behavior following fictional media programs.[36] For example, a fictional German TV series featuring the suicide of a teenager—which was produced in the 1980s with an aim to increase awareness of suicide—was associated with a strong increase in suicides among teenagers and young adults of similar age who used the same suicide method. An increase was witnessed again when the series was repeated later on.[37]

Most studies rely on aggregate data to analyze potential copycat behavior. These studies cannot account for whether those who died by suicide after the broadcast were actually exposed to the broadcast. Ecologic studies may also be subject to ecologic fallacy. There are only a limited number of individual-level studies available that support the negative influence of some sensationalist suicide reports on actual suicidal behavior.[31]

The consideration of potential copycat behavior and prevention thereof is essential in any public media discourse on suicide, including both media reporting on suicide and campaigns to increase awareness of the problem of suicide. Particularly with regard to news reporting, prevention efforts frequently involve the distribution of media recommendations for suicide reporting.

The U.S. recommendations were revised and released in 2012 by several national and international suicide prevention organizations in partnership with journalism and media representatives and are available at reportingonsuicide.org (see also nimh.nih.gov/health/topics/suicide-prevention/recommendations-for-reporting-on-suicide.shtml). Similar recommendations are available from the WHO.[38] There is some evidence that media recommendations have resulted in improved and less sensational media reporting about suicide[39–42] and may have even contributed to a decline in suicides.[42]

A suicide-protective effect of news articles featuring someone overcoming a suicidal crisis has been termed the Papageno effect—after the character in Mozart's opera *The Magic Flute*, who overcomes his suicidal crisis in the last minute because of three boys who remind him of alternative coping strategies.[32] Reporting on individual mastery of crises is recommended in media guidelines for reporting suicide. In an Austrian sample, these news articles turned out to lack the sensationalist characteristics that were common in some articles on completed suicide and suicide statistics.[32]

The problem of suicidal ideation and how to cope with it was raised in a responsible way in these articles, which may help reduce stigmatization of suicidal ideation and of individuals who suffer from suicidal thoughts. Moreover, publication of articles on coping with suicidal ideation was associated with a decrease in suicide rates in the area where they were widely distributed, suggesting that these articles may have a suicide-protective effect.

A potential explanation for a protective effect of these media reports may derive from the inherent social normative messages in media reports on mastery of crisis, which present help-seeking and constructive behaviors as the outcome of psychosocial crisis and may thereby manage to increase the psychological availability (sometimes referred to as "cognitive availability"[43]) of alternatives to suicide. Portrayals of ways on how to actively cope with suicidal ideation, emphasizing other options than suicide, may help to broaden the perspective in some individuals, particularly those in the psychological state of cognitive and affective constriction that has frequently been used to describe the dangerous tunneling and narrowing of the range of opportunities in suicidal individuals.[44,45]

Awareness Campaigns Using Mass Media as a Tool

Media awareness campaigns comprise a heterogeneous set of prevention efforts that pursue the goals of either decreasing the stigma of mental illness, raising awareness of the problem of suicide, increasing help-seeking, or, most frequently, a combination of several of these goals. Some of the campaigns focus primarily on mental illness (particularly depression), whereas others focus primarily on suicide. Accordingly, the campaign structures and

evaluation methods vary widely, but all of these efforts are based on the aspiration to ultimately help prevent suicide.

In general, broad awareness campaigns can be considered a type of social advertising,[46,47] which differs from conventional advertising by focusing on information that reminds people of their vulnerability and mortality, thereby triggering fear. Social advertising typically activates psychological defense mechanisms in the audience more so than conventional advertising, which may reduce the effectiveness of these messages.[48] Broad awareness campaigns may require additional components to effectively enhance learning and motivation in the target group to adopt the advertised behavior.

Many of the currently used awareness programs in suicide prevention apply a broad-scale approach. Yet, awareness campaigns that aim at increasing awareness or knowledge of suicide using media rarely apply the findings from media research. Moreover, studies on the effectiveness of awareness campaigns are currently scarce and provide mixed results, at best. In a review of 15 public campaigns about depression or suicide awareness between 1987 and 2007, Dumesnil and Verger[49] found only a modest improvement in public knowledge of and attitudes toward depression or suicide. Most studies did not assess the durability of the attitude changes, and none of these programs demonstrated an impact on help-seeking.[49]

For high-risk groups, such as individuals with major depression and suicidal ideation, no improvements in terms of attitudes toward treatment seeking and, more importantly, treatment-seeking behavior, were reported following an intensive community education program in Australia.[50] Furthermore, studies failed to demonstrate an effect on important primary outcome measures such as suicidal ideation or behavior.

A billboard study conducted by Klimes-Dougan et al. and the Suicide Awareness Voices of Education (SAVE) in 2009[5] indicated that when exposed to the public awareness message "Prevent suicide. Treat depression. See your doctor," adolescents most vulnerable to suicide, but not those with low vulnerability, had an increase in maladaptive coping behaviors. The findings of this study were largely replicated in a young adult population[6] and clearly suggest that caution is warranted when awareness campaigns are used to educate the public about suicidality.

Such campaigns may have unwanted backlash effects, or may not reach the most vulnerable populations. For example, in Austria, a 20-fold increase in utilization of a crisis hotline after the promotion of the crisis line telephone number on national television was reported, along with a tripling of clients at the crisis center. However, the proportion of suicidal individuals among clients decreased considerably after the campaign.[45] A significant increase of calls to an emergency mental health service was also reported following a mass media campaign in Cuyahoga County, Ohio.[51] This campaign adopted the message "Suicide is preventable. Its causes are treatable. For immediate help call (emergency number)."

Besides campaigns that primarily aim to increase knowledge of suicide risk or increase awareness of services, there are also examples of campaigns that focus directly on the stigma of mental illness with the aim of changing public attitudes to mental illness on a broader level.[19] However, there is little evidence that supports that public service announcements addressing the stigma of mental illness are effective in reducing prejudicial attitudes and discriminatory behaviors.[19]

For example, factsheets from the Royal College of Psychiatrists' Changing Minds campaign in the United Kingdom on stigmatizing attitudes of the general public toward schizophrenia or substance use disorders were largely ineffective in changing these attitudes in the study participants.[52] Another campaign targeting youth and young adults in British Columbia, Canada,[53] featured a prominent male sports figure talking about mental health issues and used online social media to convey its message. It resulted in an increase of campaign and website awareness, and those who were exposed to the campaign were significantly more likely to talk about and seek information relating to mental health issues. However, attitudes toward mental health issues did not change.[53] It has been noted that more evaluation of these types of campaigns is warranted, particularly regarding tangible positive impacts that go beyond the assessment of penetration in the population.[19]

There are also campaigns and initiatives that aim at improving attitudes toward treatment and health services. Help-seeking attitudes are thought to be a key barrier to service use for mental health problems. A meta-analysis of studies on help-seeking attitudes revealed an increasingly negative attitude toward help-seeking between 1968 and 2008,[54] which has been hypothesized as an unintended side effect of marketing biological therapies and medicalizing mental health problems.[54]

The evidence for the effectiveness of related campaigns that address attitudes toward mental health services is mixed.[54] For example, Jorm and colleagues[55] conducted an RCT to assess the effect of evidence-based consumer guides on effective treatment options for depression in a randomly selected community sample of individuals who screened positive for depression. The results showed

that attitudes to some treatment options improved. However, there were no increases in actual help-seeking.[55]

Multilevel Approaches

Multilevel approaches using individual-level strategies, such as gatekeeper training, to complement a campaign using media as a tool to distribute information to a smaller, well-defined audience has been used frequently in recent years, and some evaluations show promising results.[4] A Germany-based awareness campaign focusing on depression has involved physician training, information and awareness campaign for the broad public (e.g., movie spots, flyers); educational training for gatekeepers including teachers, priests, or geriatric care staff; as well as support of self-help-activities.[56,57]

There was a significant reduction of completed and attempted suicide combined following the program. Furthermore, there was some improvement in public knowledge of depression, which did not, however, include an improvement of negative attitudes toward antidepressant medication.[56,57] In Australia, a multimedia campaign promoting mental health literacy and help-seeking behavior increased awareness of suicide risk, depression, and other mental health issues and reduced the perceived barriers to seeking adequate help in youth.[9]

In the U.S., Boeke, Griffin, and Reidenberg[58] reported that, following a 6-month awareness campaign on suicide prevention in Minnesota, knowledge of how to help a depressed or suicidal person was good among individuals who participated in the evaluation. They identified a need to involve physicians and other healthcare providers in such campaigns. Physician and other gatekeeper trainings that might be used to complement media campaigns may occur in a variety of settings (e.g., schools, military installations, community settings). They have yielded partially positive findings regarding their effects on knowledge of suicide and attitudes toward suicide, intent to seek treatment, and referral behaviors.[4,59]

However, outcomes documenting behavioral changes are limited, particularly for the highest-risk individuals. Gatekeepers with professional responsibilities related to referral seem more likely to increase referral behaviors[60] and intent to seek treatment,[22] but it is not clear if their enhanced skills are sufficient to reach the individuals most in need of referral. Few programs have directly addressed the reduction of stigma as a goal.

A program in the U.S. Air Force that focused on decreasing the stigma of help-seeking included several components such as education of leadership and staff, guidelines for commanders on the use of mental health services, the establishment of trauma stress response teams, and surveillance measures.[61] An evaluation of this initiative indicated a statistically significant decline in suicide rates over time compared to baseline but did not include an evaluation of its impact on stigma associated with help-seeking.[61]

Future Research

Future research needs to focus on appropriate ways of providing information about suicidality in order to reduce stigma of suicidal ideation, mental illness, and stigmatization of those bereaved by suicide, to increase help-seeking behavior and referrals, and to ultimately reduce suicides. Awareness campaigns and multilevel intervention approaches, such as combinations of broad public health approaches using the mass media and individual-level approaches using gatekeeper training, need to be evaluated with regard to their overall effectiveness, and attempts should be made to identify which of the single components are most effective. Particular emphasis also needs to be placed on the evaluation of effects on individuals at risk for suicide.

Most researchers agree that audience characteristics, sender characteristics, and the actual media content influence media effects; therefore, a consideration of several factors that may determine media effects will help guide this research.

A paucity of research exists for individual audience characteristics, including risk status, which may impact media effects. A focus on these characteristics may shed light on the understanding of both protective and harmful media effects. For example, personal suicidal ideation may influence the reception and effects of media products. In a recent laboratory experiment, individuals with higher baseline suicidal ideation before watching a movie with suicidal content were more likely than audiences with lower suicidal ideation scores to get ideas about their own problem solving from the films.[62]

From a sender perspective, qualitative research on journalist perspectives has identified commercial competition, willingness to address social problems, and reading interest as main drives for suicide reporting.[63] Research on journalists' attitudes about reporting on suicide and the published media recommendations may assist in the successful dissemination, implementation, and adherence to media recommendations.

The question of how and what to report in order to reduce the stigma surrounding mental illness, suicidal ideation, and suicide decedents without promoting suicidal behavior, while still providing information on risk and protective factors and coping strategies, including treatment resources, remains the foremost public

health challenge regarding the media's role in suicide prevention and stigma reduction.

More evaluation work is needed to determine the impact of media recommendations on the quality of reporting and suicide rates.[42] Moreover, the specific recommendations require further scientific evaluation, as they are mainly based on expert opinions. Media recommendations also need some adaptation to meet the requirements of emergent media sources such as online news and social media.

More research needs to focus on the underlying mechanisms of media effects.[64] A recent review[65] has identified a clear lack of studies on the protective effects of media reporting whereas there are many on harmful effects. Because this research may open up new opportunities for awareness campaigns and reporting on suicidal ideation and suicide in news media, a stronger emphasis on protective effects seems necessary in future research endeavors.

For all types of media campaigns, including those that address public awareness of suicide risk, public awareness of services to prevent suicide, mental health issues on a broader level, or stigmatization of suicide and mental illness, more evaluation work is needed. The specific aims and objectives need to be defined well in advance, and predefined primary and secondary outcomes need to be evaluated.

In anti-stigma campaigns, the ultimate question is how to talk about suicide and reduce the stigmatization of suicidal ideation and mental illness without additional risk to vulnerable groups. Stigma associated with suicidal ideation and mental illness frequently hinders individual disclosure of mental health issues and adequate responses to suicidal communication and thereby hampers suicide prevention efforts. Stigma reduction efforts should therefore promote communication and disclosure of suicidal ideation. Guidelines on how to develop a stigma reduction initiative are available from the Substance Abuse and Mental Health Services Administration (SAMHSA) and may assist in the development of anti-stigma campaigns.[66]

Caution is needed to avoid normalizing the suicidal acts in these campaigns, which may have adverse effects. Research findings from media and communication studies need to be considered when developing awareness campaigns to reduce the risk of harm. In the short term, experimental studies that shed light on several core research questions related to the impact of the intervention need to be conducted before awareness campaigns on the community level are implemented. Some of these questions are outlined below.

Priority should be given to RCTs and well-planned controlled research designs, which are currently scarce.[4] Vignettes or other stimuli and cognitive interviewing could be used to identify potentially useful or iatrogenic content for stigma-reduction and help-seeking interventions. Quantitative and qualitative research as well as combinations of both will be necessary.

Some specific research questions may include the following: (1) What is the immediate impact of specific awareness/information messages (in news media or in awareness campaigns) in terms of actual help-seeking behavior? (2) What individual characteristics impact/mediate any immediate media effect? For example, do media effects vary with regard to age, gender, personality characteristics, and suicide risk status of the audience? (3) How are messages interpreted in relation to how they are intended, with a particular focus on those vulnerable to suicide? (4) What are the effects of media campaigns focusing primarily on suicide or suicide prevention as compared to campaigns that address mental health issues or their prevention in terms of outcomes relevant to suicide prevention? and (5) How do vulnerable individuals use media to obtain information related to suicide and suicide prevention?

Finally, owing to the documented shift in the media landscape from more traditional media types to online and other new forms of mass media, including social media,[67] differences between effects of awareness messages delivered online and via traditional media types require evaluation.

Social relationships based on trust and understanding are clearly established factors that facilitate help-seeking.[24,45] It is therefore necessary to investigate how individuals can best establish these relationships in times of need. Conflict resolution training, which includes problem recognition training in various settings such as schools but also via online media, may help to increase problem-solving skills.

Men and boys in particular need to be encouraged to express emotions in ways that are perceived as strength rather than weakness,[24] and research should focus on groups known to show more resistance toward help-seeking. Whether findings from such studies can be used to shape future media campaigns is an empirical question. Individual-level or multilevel strategies may be best suited to facilitate the enhancement of social relationships and problem-solving skills that underlie help-seeking behavior.

Multilevel interventions using several intervention approaches that may complement each other tend to show more promising results than single-level interventions and are increasingly used and recommended.[60,68] However, substantially more research is needed to determine the effectiveness of multilevel interventions. Promising multilevel programs that should be examined

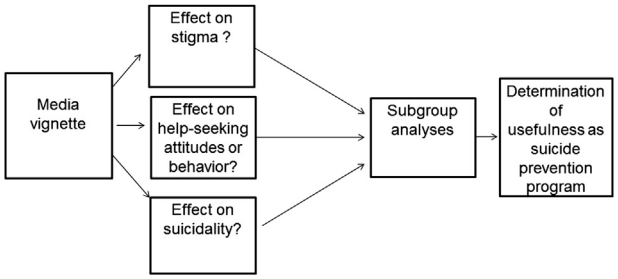

Figure 1. Proposed step-by-step research pathway for media research

further are educational programs that target the public and are combined with training of practitioners and primary care personnel in the diagnosis and treatment of depression and suicidality.[59,69]

Novel analytic strategies are needed to compare the potential benefits of individual-level interventions targeting high-risk groups with those of more mass media/public health approaches. Research is also needed to identify the optimal balance or combination of individual-level and public health–level approaches in order to achieve their maximum impact.

Depending on the aims and target group of an education program using media, researchers can select appropriate candidate media vignettes. For anti-stigma campaigns, examples of outreach materials are available from SAMHSA.[66] If the aim of the initiative is to encourage individuals to intervene if someone close to them is suicidal, the theory of planned behavior (TPB) has recently been proposed to guide the content of persuasive messages. The TPB posits that a person's behavior can be predicted by attitudes toward the behavior, subjective norms related to the behavior, the intention to perform that behavior, and control beliefs that describe beliefs about being able to perform the action based on the presence of skills, absence of obstacles, and other factors.[70] Salient relevant beliefs associated with the specific outcome can be assessed using open-ended interviews or focus group techiques.[70]

If the media campaign targets individuals at risk for suicide or if at-risk individuals are to be exposed to the campaign, the selected media vignette should be tested regarding their effect on self- or perceived stigma, help-seeking attitudes, and suicidality (Figure 1). The vignettes should be tested for different types of audiences within the target population (e.g., groups with different suicide risk status) to determine their appropriateness as a suicide prevention initiative. It is essential that evidence from different settings be combined to identify the most promising elements and complementary components for suicide prevention programs.

Conclusions

Suicide is a significant public health problem for which all aspects should be addressed seriously, including awareness efforts. In this article, the authors have provided evidence for mass media as a powerful tool to address the stigma surrounding suicidal ideation and mental illness, although more research is needed before any definitive conclusions can be made about how this tool can best be used to increase help-seeking and prevent suicide, particularly in vulnerable populations. Recent findings such as the responsible reporting patterns in news articles on individual mastery of crisis, which were associated with a possible suicide-protective Papageno effect, provide an important basis for further research in the topic area.

All suicide preventive interventions should carefully consider the recommendations for reporting suicide when using media as a tool. Because of the omnipresence of mass media in everyday life and their use by even the most vulnerable populations, research on how to provide the best suicide prevention possible via mass media constitutes a high priority and timely topic area for suicide research and prevention.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

This work was funded by the Austrian Science Fund (FWF) (salary for Benedikt Till; grant number P-23659-B11).

No financial disclosures were reported by the authors of this paper.

References

1. Cummings JR, Lucas SM, Druss BG. Addressing public stigma and disparities among persons with mental illness: the role of federal policy. Am J Public Health 2013;103(5):781–5.
2. Clark W, Welch SN, Berry SH, et al. California's historic effort to reduce the stigma of mental illness: the Mental Health Services Act. Am J Public Health 2013;103(5):786–94.
3. WHO Health Report. Mental health: new understanding, new hope. Geneva: WHO, 2001.
4. Klimes-Dougan B, Klingbeil DA, Meller SJ. The impact of universal suicide-prevention programs on the help-seeking attitudes and behaviors of youths. Crisis 2013;34(2):82–97.
5. Klimes-Dougan B, Yuan C, Lee S, Houri AK. Suicide prevention with adolescents. Considering potential benefits and untoward effects of public service announcements. Crisis 2009;30(3):128–35.
6. Klimes-Dougan B, Lee CYS, in collaboration with Suicide Awareness Voices of Education. Suicide prevention public service announcements. Perceptions of young adults. Crisis 2010;31(5):247–54.

7. Rimal RN, Real K. Understanding the influence of perceived norms on behaviors. Commun Theory 2003;13(2):184–203.
8. Cialdini RB, Kallgren CA, Reno RR. A focus theory of normative conduct: recycling the concept of norms to reduce litter in public places. J Pers Soc Psychol 1990;58(6):1015–26.
9. Wright A, McGorry PD, Harris MG, Jorm AF, Pennell K. Development and evaluation of a youth mental health community awareness campaign—the compass strategy. BMC Public Health 2006;6:215.
10. Research!America. Mental health not given equal importance, Americans say. Alexandria VA: Research!America, 2006.
11. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
12. Cvinar JG. Do suicide survivors suffer social stigma: a review of the literature. Perspect Psychiatr Care 2005;41(1):14–21.
13. Guglielmi MC. The impact of stigma on the grief process of suicide survivors [dissertation]. Buffalo NY: State University of New York at Buffalo, 2008.
14. Gould MS, Greenberg T, Munfakh JLH, Kleinman M, Lubell K. Teenagers' attitudes about seeking help from telephone crisis services hotlines. Sui Life Threat Behav 2006;36(6):601–13.
15. Gould MS, Velting D, Kleinman M, Lucas C, Thomas JG, Chung M. Teenagers' attitudes about coping strategies and help-seeking behavior for suicidality. J Am Acad Child Adolesc Psychiatry 2004;43(9):1124–33.
16. Rickwood D, Thomas K. Conceptual measurement framework for help-seeking for mental health problems. Psychol Res Behav Manag 2012;5:173–83.
17. Batterham PJ, Calear AL, Christensen H. Correlates of suicide stigma and suicide literacy in the community. Sui Life Threat Behav 2013;43(4):406–17.
18. Ben-Zeev D, Corrigan PW, Britt TW, Langford L. Stigma of mental illness and service use in the military. J Ment Health 2012;21(3):264–73.
19. Corrigan PW. Where is the evidence supporting public service announcements to eliminate mental illness stigma? Psychiatr Serv 2012;63(1):79–82.
20. Batterham PJ, Calear AL, Christensen H. The stigma of suicide scale. Crisis 2013;34(1):13–21.
21. Gould MS, Munfakh J, Kleinman M, Lake AM. National Suicide Prevention Lifeline: enhancing mental health care for suicidal individuals and other people in crisis. Suicide Life Threat Behav 2012;42(1):22–35.
22. Stecker T, Fortney JC, Sherbourne CD. An intervention to increase mental health treatment engagement among OIF veterans: a pilot trial. Mil Med 2011;176(6):613–8.
23. Downs MF, Eisenberg D. Help seeking and treatment use among suicidal college students. J Am Coll Health 2012;60(2):104–14.
24. Rickwood D, Deane FP, Wilson CJ, Ciarrochi J. Young people's help-seeking for mental health problems. Australian e-J Adv Ment Health 2005;4(3):1–34.
25. Niederkrotenthaler T, Till B, Herberth A, et al. The gap between suicide characteristics in the print media and in the population. Eur J Public Health 2009;19(4):361–4.
26. Au JS, Yip PS, Chan CL, Law YW. Newspaper reporting of suicide cases in Hong Kong. Crisis 2004;25(4):161–8.
27. Fu KW, Chan YY, Yip PS. Newspaper reporting of suicides in Hong Kong, Taiwan and Guangzhou: compliance with WHO media guidelines and epidemiological comparisons. J Epidemiol Commun Health 2011;65(10):928–33.
28. Goethe JW. The sorrows of the young Werther. Sawtry: Dedalus, 1988.
29. Niederkrotenthaler T, Fu KW, Yip P, et al. Changes in suicide rates following media reports on celebrity suicides: a meta-analysis. J Epidemiol Commun Health 2012;66(11):1037–42.
30. Phillips DP. The influence of suggestion on suicide: substantive and theoretical implications of the Werther effect. Am Sociol Rev 1974;39(3):340–54.
31. Pirkis J, Blood W. Suicide and the news and information media: a critical review, 2010. www.mindframe-media.info/__data/assets/pdf_file/0016/5164/Pirkis-and-Blood-2010,-Suicide-and-the-news-and-information-media.pdf.
32. Niederkrotenthaler T, Voracek M, Herberth A, et al. The role of media reports in completed and prevented suicide—Werther versus Papageno effects. Br J Psychiatry 2010;197(3):234–43.
33. Pirkis JE, Burgess PM, Francis C, Blood RW, Jolley DJ. The relationship between media reporting of suicide and actual suicide in Australia. Soc Sci Med 2006;62(11):2874–86.
34. Niederkrotenthaler T, Till B, Voracek M, Dervic K, Kapusta ND, Sonneck G. Copycat effects after media reports on suicide: a population-based ecologic study. Soc Sci Med 2009;69(7):1085–90.
35. Fu KW, Yip PS. Estimating the risk for suicide following the suicide deaths of three Asian entertainment celebrities: a meta-analysis approach. J Clin Psychiatry 2009;70(6):869e78.
36. Pirkis J, Blood W. Suicide and the media. Part II: portrayal in fictional media. Crisis 2001;22(4):155–62.
37. Schmidtke A, Häfner H. The Werther effect after television films: new evidence for an old hypothesis. Psychol Med 1988;18(3):665–76.
38. WHO. Preventing suicide. A resource for media professionals. Geneva: WHO, 2008.
39. Pirkis J, Dare AR, Blood W, et al. Changes in media reporting of suicide in Australia between 2000/01 and 2006/07. Crisis 2009;30(1):25–33.
40. Michel K, Frey C, Schlaepfer E, Valach L. Suicide reporting in the Swiss print media. Frequency, form and content of articles. Eur J Public Health 1995;5:199–203.
41. Etzersdorfer E, Sonneck G. Preventing suicide by influencing mass-media reporting. The Viennese experience 1980–1996. Arch Suicide Res 1998;4:67–74.
42. Niederkrotenthaler T, Sonneck G. Assessing the impact of media guidelines for reporting on suicides in Austria: interrupted time-series analysis. Aust N Z J Psychiatry 2007;41(5):419–28.
43. Florentine JB, Crane C. Suicide prevention by limiting access to methods: a review of theory and practice. Soc Sci Med 2010;70(10):1626–32.
44. Shneidman ES. A psychological approach to suicide. In: Van den Bos GR, Bryant BK, eds. Cataclysms, crises and catastrophes: psychology in action. Washington DC: American Psychological Association, 1987.
45. Sonneck G, Kapusta N, Tomandl G, Voracek M, eds. Krisenintervention und Suizidverhütung [Crisis intervention and suicide prevention]. Wien: UTB facultas.wuv, 2012.
46. Hassan LM, Walsh G, Shiu E, Hastings G, Harris F. Modeling persuasion in social advertising: a study of responsible thinking in antismoking promotion in eight eastern EU Member States. J Advert 2007;36:15–31.
47. Andreasen A. Social marketing: its definition and domain. J Public Policy Mark 1994;13:108–14.
48. Hastings G, Stead M, Webb J. Fear appeals in social marketing: strategic and ethical reasons for concern. Psychol Market 2004;21:961–86.
49. Dumesnil H, Verger P. Public awareness campaigns about depression and suicide: a review. Psychiatr Serv 2009;60(9):1203–13.
50. Chamberlain PN, Goldney RD, Taylor AW, Eckert KA. Have mental health education programs influenced the mental health literacy of those with major depression and suicidal ideation? A comparison between 1998 and 2008 in South Australia. Sui Life Threat Behav 2012;42:525–40.
51. Oliver RJ, Spilsbury JC, Osiecki SS, Denihan WM, Zureick JL, Friedman S. Preliminary results of a suicide awareness mass media campaign in Cuyahoga County, Ohio. Suicide Life Threat Behav 2008;28:245–9.

52. Luty J, Umoh O, Sessay M, Sarkhel A. Effectiveness of Changing Minds campaign factsheets in reducing stigmatized attitudes towards mental illness. Psychiatr Bull 2007;31:377–81.
53. Livingston JD, Tugwell A, Korf-Uzan K, Cianfrone M, Coniglio C. Evaluation of a campaign to improve awareness and attitudes of young people towards mental health issues. Soc Psychiatry Psychiatr Epidemiol 2013;48(6):965–73.
54. Mackenzie CS, Erickson J, Deane FP, Wright M. Changes in attitudes toward seeking mental health services: a 40-year cross-temporal meta-analysis. Clin Psychol Rev 2014;34(2):99–106.
55. Jorm AF, Griffiths KM, Christensen H, Korten AE, Parslow RA, Rodgers B. Providing information about the effectiveness of treatment options to depressed people in the community: a randomized controlled trial of effects on mental health literacy, help-seeking and symptoms. Psychol Med 2003;33(6):1071–9.
56. Hegerl U, Althaus D, Schmidtke A, Niklewski G. The alliance against depression: 2-year evaluation of a community-based intervention to reduce suicidality. Psychol Med 2006;36(9):1225–33.
57. Hegerl U, Althaus D, Stefanek J. Public attitudes towards treatment of depression: effects of an information campaign. Pharmacopsychiatry 2003;36(6):288–91.
58. Boeke M, Griffin T, Reidenberg DJ. The physician's role in suicide prevention: lessons learned from a public awareness campaign. Minn Med 2011;94(1):44–6.
59. Isaac M, Elias B, Katz LY, Belik SL, Deane FP, Penns MW. Swampy Cree Suicide Prevention Team. Gatekeeper training as a preventative intervention for suicide: a systematic review. Can J Psychiatr 2009; 54(4):260–8.
60. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
61. Knox KL, Pflanz S, Talcott GW, et al. The U.S. Air Force suicide prevention program: implications for public health policy. Am J Public Health 2010;100(12):2457–63.
62. Till B, Vitouch P, Herberth A, Sonneck G, Niederkrotenthaler T. Personal suicidality in reception and identification with suicidal film characters. Death Stud 2013;37(4):383–92.
63. Cheng Q, Fu KW, Caine E, Yip PSF. Why do we report suicides and how can we facilitate suicide prevention efforts? Perspectives of Hong Kong media professionals. Crisis 2014;35(2):74–81.
64. Blood RW, Pirkis J. Suicide and the media. Part III: theoretical issues. Crisis 2001;22(4):163–9.
65. Sisask M, Värnik A. Media roles in suicide prevention: a systematic review. Int J Environ Res Public Health 2012;9(1):123–38.
66. Substance Abuse and Mental Health Services Administration (SAMHSA). Developing a stigma reduction initiative. Rockville MD: Center for Mental Health Services, SAMHSA, 2006. SAMHSA Pub No. SMA-4176.
67. Collings S, Niederkrotenthaler T. Suicide prevention and emergent media: surfing the opportunity. Crisis 2012;33(1):1–4.
68. CDC. Youth suicide prevention: a resource guide. Atlanta GA: CDC, 1992.
69. Rutz W, Knorring L, Walinder J. Long-term effects of an educational program for general practitioners given by the Swedish Committee for the Prevention and Treatment of Depression. Acta Psychiatr Scand 1992;85(1):83–8.
70. Shemanski Aldrich R, Cerel J. The development of effective message content for suicide prevention. Crisis 2009;30(4):174–9.

Suicide Later in Life

Challenges and Priorities for Prevention

Yeates Conwell, MD

Suicide in later life is a major public health concern in the U.S., where more than 6,000 older adults take their own lives every year. Suicide prevention in this age group is made challenging by the high lethality of older adults' suicidal behavior; few survive their first attempt to harm themselves. Research has revealed that factors in each of five domains place older adults at increased risk for suicide—psychiatric illness, personality traits and coping styles, medical illness, life stressors and social disconnectedness, and functional impairment. Little research has examined the effectiveness of interventions to reduce the toll of suicide in older adulthood.

The study of strategies to decrease suicide deaths in later life should emphasize four areas. First is approaches to early detection of older people at risk through improved understanding of multidimensional determinants and their interactions. Second is research on the impact of general health promotion that optimizes well-being and independent functioning for older adults on suicide outcomes. Third concerns the study of approaches to the provision of mental health care that is evidence-based, accessible, affordable, acceptable, and integrated with other aspects of care. The fourth area of high priority for research is approaches to improvement of social connectedness and its impact on suicide in older adults.

(Am J Prev Med 2014;47(3S2):S244–S250)

Introduction

Although rates of suicide among older adults, as in other groups, vary over time and place, they have historically been among the highest of any age group, particularly for older men both in the U.S.[1] (Figure 1) and worldwide. In 2011, the first wave of 75 million people born in the years 1946–1964 (the "baby boom" cohort) reached age 65 years. Demographers estimate that by 2030, more than 71 million Americans will be aged 65 years and older, or 20% of the population.[2] In some regions of the world, rates of late-life suicide have decreased in recent years; however, the expanding population of elders raises the possibility that the absolute number of older adults who will die by suicide in coming decades will rise. An aggressive and comprehensive strategy for preventing late-life suicide is indicated.

Developed as a resource for the National Action Alliance for Suicide Prevention's (Action Alliance) Research Prioritization Task Force (RPTF), this paper addresses Aspirational Goal 11—to identify clear targets for intervention through better understanding of risk and protective factors. Its focus is on suicide prevention in later life. Emphasizing a public health perspective, the following sections provide an overview of current knowledge concerning factors that increase and mitigate risk for suicide in older people.

On that basis, the paper then outlines priorities for prevention research and programming at the individual, service system, and community levels. Ultimately, the most effective prevention approach to reducing late-life suicides will be one that incorporates evidence-based suicide preventive interventions of a variety of types across settings in which older adults live their lives.

Current Knowledge

Pre-Intervention Research

An extensive body of research conducted worldwide has examined factors associated with risk for suicide in older adults. As this literature is too large to review here, the reader is referred to recent publications for background.[3,4] Figure 2 depicts a framework, adapted from Blumethal and Kupfer,[5] which serves as a useful means with which to organize current knowledge about risk factors for late-life suicide into five domains or "axes."

From the School of Medicine and Dentistry, University of Rochester Medical Center, Rochester, New York

Address correspondence to: Yeates Conwell, MD, University of Rochester Medical Center, 300 Crittenden Blvd., Rochester NY 14642. E-mail: yeates_conwell@urmc.rochester.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.040

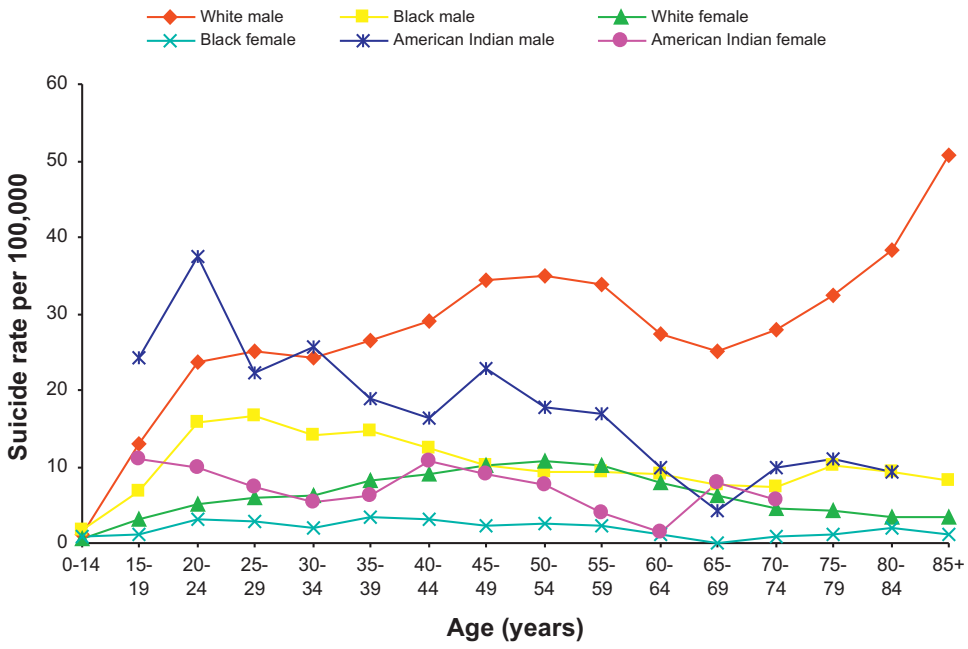

Figure 1. Rates of suicide by age, sex, and race, U.S., 2010
From the CDC, Web-based Injury Statistics Query and Reporting System (WISQARS), cdc.gov/injury/wisqars/index.htm.

Axis 1: major psychiatric illness. Carefully conducted psychological autopsy studies indicate that major affective illness is the factor associated with the highest population-attributable risk for suicide in later life. Other Axis 1 conditions linked to older adult suicide in some (but not all) controlled studies include non-affective psychoses, anxiety disorders, and substance use disorders. The evidence for association with dementia is weak.

Axis 2: personality traits. Although personality disorder diagnosis has not been extensively examined, personality traits of neuroticism, rigid coping, and anxious and obsessive features have been repeatedly linked to late-life suicide as well.

Axis 3: physical illness. Physical conditions including malignancies and diseases of the cardiovascular,

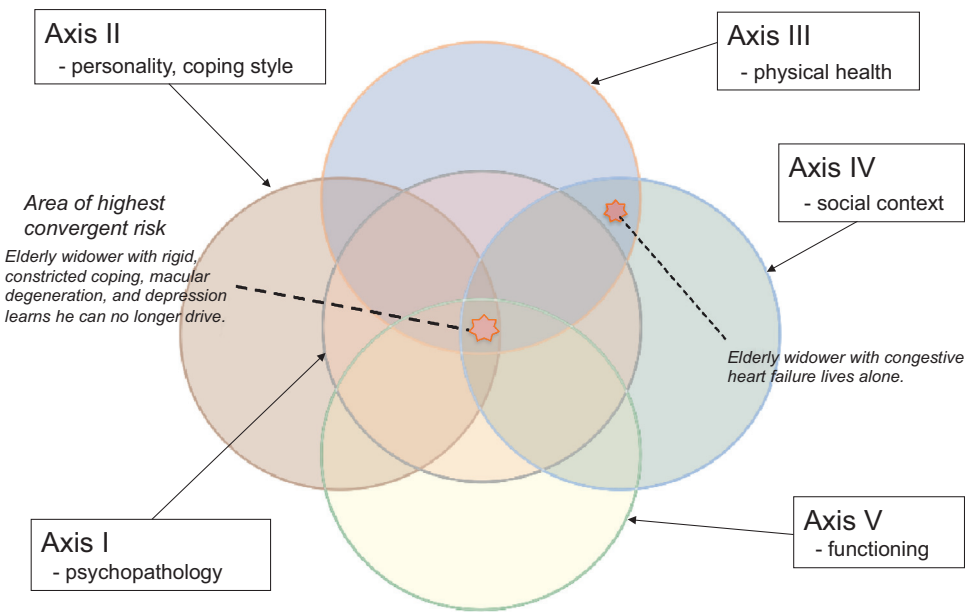

Figure 2. Axes of risk for suicide in older adults

Table 1. Driver diagram—research priorities for development and testing of late-life suicide preventive interventions

Primary outcome	Primary drivers	Secondary drivers: Individual	Secondary drivers: Service system	Secondary drivers: Community
Decrease suicide in older adults	1. Early detection of older adults with depression at risk for suicide owing to other more distal factors	1. Identify cognitive vulnerabilities associated with impaired decision making 2. Identify family-, neighborhood-, and community-level risk and protective factors 3. Understand relative risk associated with combinations and sequences of risk factors	1. Systematic, multidimensional screening in PC 2. Risk stratification with multiple factors from all levels	1. Gatekeeper training
	2. General health promotion to minimize physical and mental morbidity and optimize functioning	1. Empowerment of patients and families as partners in care 2. Provision of routine preventive care 3. Promotion of healthy behaviors	1. Use of in-home technologies (e.g., remote monitoring) to support patient/family engagement in care 2. Access to rehabilitation services 3. Aggressive pain control 4. Access to quality palliative and end-of-life care	1. Education about, and promotion of, healthy behaviors 2. Elder-friendly communities 3. Access to community-based long-term-care services and supports to optimize independent functioning
	3. Provide MH care that is evidence-based accessible affordable acceptable fully integrated with PC and community services and supports	1. Education of patients, families, and providers about benefits of treatment of mental disorders 2. Tailor treatments to patient preferences	1. Collaborative, stepped care approaches to PC-based MH care 2. Use of evidence-based care transitions interventions—hospital to home, rehabilitation, residential care 3. Integration of PC, MH, and community-based aging services	1. Implementation of parity laws 2. Other payment system reforms to ensure affordable, high-quality MH care
	4. Increase social connectedness	1. Psychosocial interventions to increase social networks and supports (e.g., IPT, PST) 2. Adaptation of interventions to address family-level dysfunction and adaptation to challenges of aging	1. Link aging services network agencies to healthcare delivery systems for coordination of care	1. Volunteer opportunities for older adults (RSVP) 2. Congregate living opportunities (NORCs) 3. Adaptation and dissemination of information and communication technologies to support social networking for homebound elders

IPT, interpersonal therapy; MH, mental health; NORC, naturally occurring retirement community; PC, primary care; PST, problem-solving therapy; RSVP, Retired & Senior Volunteer Program

pulmonary, gastrointestinal, and central nervous systems have been implicated. Chronic pain syndromes also are associated with increased risk of suicide.

Axis 4: social context. Stressors common to later life such as family discord, social isolation, and bereavement distinguish older adults suicides from controls in numerous studies. All share the common themes of social and psychological disconnectedness.

Axis 5: functioning. The relationships between physical illness, mental disorders, social context, and impaired

functioning are complex. It is clear, however, that each may result in disability, and that disability is in turn associated with suicide in later life.

The fact that suicide is associated with risk factors on multiple axes implies that if we are able to reduce risk factors on any one, we may be able to alter an individual's trajectory toward death. Each of these factors alone, however, has insufficient predictive power to be useful in identifying a person at risk for suicide. Almost no studies to date have included sample sizes large enough to examine risk and protective factors in multivariate models, limiting our understanding of the role played by each. Although study of individual variables in each domain must go on, equally or more important will be studies adequately powered to test hypotheses about how combinations of factors within and across axes influence suicide risk. Research is needed to test interactions commonly found in older adults, such as those depicted in Figure 2.

Although numerous studies over the past decade have raised intriguing questions about the neurobiological basis of suicidal behavior,[6] little work has focused specifically on older adults. Isolated findings using structural neuroimaging and cognitive testing require further study. Promising work by Dombrovski and colleagues[7] has highlighted the potential importance of neurocognitive deficits, suggesting that older adults who attempt suicide overemphasize present reward/punishment contingencies to the exclusion of past experiences.

Aging-related neurobiological processes, possibly superimposed on innate (e.g., affect regulation deficits) or acquired (e.g., stress axis abnormalities due to early life trauma) vulnerabilities may contribute to the dramatic rise in rates of suicide with age for both men and women worldwide.[8] Studies of the neural circuitry governing affect and aggression, and the changes that they are likely to undergo with aging, are particularly important to pursue.

In addition, research that combines functional neuroimaging with neurocognitive studies of decision-making processes is a promising avenue by which to elucidate who in later life is at risk for becoming suicidal in the face of stressors, and by what basic neurobiological mechanism.[9] At this stage, however, these lines of research do not translate directly to the design or implementation of prevention strategies.

Preventive Intervention Research

Although evidence has accumulated about risk and protective factors, relatively little research has examined translation of that knowledge into preventive interventions for which the specific target is late life suicidal ideation and behavior (review published elsewhere[3,4]). Notable exceptions include tests of primary care–based, collaborative depression care management interventions in the U.S.,[10,11] a community-based program to provide in-home support for isolated, frail elders in Italy,[12] and multilevel interventions in rural Japan that incorporated systematic depression screening and clinical referral with patient education and community-based services and supports.[13] Although all these studies provide indications of effectiveness, each has methodologic limitations and additional research is needed.

The paucity of preventive interventions research in late-life suicide prevention is due to several barriers. One barrier to progress in developing effective approaches to detection of older people at increased risk for suicide is our inability to reliably measure, and make nuanced distinctions between, ideation that is indicative of suicide risk and thoughts of death that are a normal aspect of aging.[14] Insufficient research has addressed this issue, yet it is important for several reasons. If research uses imprecise outcome measures (e.g., conflating normal and pathologic thoughts of death), results will be less likely to find meaningful solutions and be of limited relevance to the study of completed suicide. Furthermore, they may lead to diversion of precious prevention resources to interventions where none are warranted, with costs both for the older person and society.

Additionally, suicide has a low base rate and, unlike at younger ages when relatively higher rates of suicidal ideation and attempts make them potentially useful proxies for suicide in treatment and outcomes research, at older ages, rates of ideation and attempts are also very low. Studies estimate that there are as many as 200 attempts for each completed suicide in some adolescent and young adult samples, and a ratio of perhaps 20 attempts that come to medical attention for each suicide in the general population. In later life, however, there are as few as 2–4 attempts for each suicide death.[4]

The greater lethality of suicidal behavior in later life may be accounted for in part by the greater frailty of older adults who, therefore, may be more likely to die with any self-injurious act. Second, older adults in suicidal crises tend to be more isolated than younger people in our society, making them less subject to rescue or detection by others as being at risk. Importantly, older adults tend to use more immediately lethal means than younger people to take their own lives. In 2010 in the U.S., 46.7% of suicides among those under age 65 years were by firearm compared to 71.4% of older adults.[1]

These observations have important implications for setting priorities for preventive interventions research. Because recognition of the suicidal state and prevention

of suicide death are more difficult in older adults, the most effective interventions are likely to be those that target individuals and groups with characteristics that place them at risk, but prior to the development of suicidal states (selective preventive intervention; e.g., social connections for those isolated by disability), or entire populations irrespective of any individual's or subgroup's risk status (universal preventive intervention; e.g., restriction of access to lethal means.)

When considered in this light, many interventions shown effective at reducing outcomes known to be "distal" risk factors for suicide (those factors that have remote or indirect causal influence on suicide, such as physical illness or social isolation) are likely to be important elements of the late-life suicide prevention armamentarium. However, they have not been tested with regard to impact on suicidal ideation or behavior per se. For example, optimal management of chronic pain or engagement of older adults in social networks may be potent selective suicide-preventive interventions, but data are lacking to test such hypotheses. Large-scale studies of interventions that address distal risk factors for suicide should be encouraged to include more "proximal" outcome measures (e.g., suicidal ideation, death ideation, hopelessness) as well, to demonstrate their relevance to comprehensive late-life suicide prevention (see Knox et al.[15] for a discussion of application of the public health approach to suicide prevention).

Mental health settings are far less salient to suicide prevention in older adults than in younger and middle-aged populations.[16] Rather, emphasis must be on other settings where older adults receive care who may develop suicidal states as a result of being depressed, medically ill or disabled, or socially disconnected. These venues include primary and specialty medical care, pharmacies, home health care, and aging services network agencies that provide community-based long-term services and supports. All serve potentially important roles in the detection of older adults at risk of suicide and implementation of preventive interventions.

A Framework for Preventive Interventions Research

Table 1 specifies a framework with which to establish priorities for research on preventive interventions. The proposed target interventions for study are based on the special considerations required for late-life suicide prevention, existing knowledge and promising early research findings on factors that place older adults at risk for suicide on each of the five axes, and lessons learned from intervention studies conducted to date that have targeted suicidal ideation and behavior in later life.

The framework takes the form of a driver diagram—a device used to conceptualize an issue, determine its system components, and thereby create a pathway to achieve a desired outcome. Driver diagrams are particularly useful in situations in which the desired outcome is relatively farther "downstream" from the point of intervention, and is difficult to measure, as for late-life suicide.

The "primary outcome" in our driver diagram is a reduction in suicide among older adults. "Primary drivers" represent the first-level objectives to be addressed in order to reach that outcome. Each primary driver is associated with a series of activities that must be undertaken to reach the objective; these activities are called "secondary drivers." Because suicide prevention activities can take place at multiple levels of organization, we specify secondary drivers as occurring at the individual, service system, and community levels. The driver diagram for reduction in late-life suicide delineates four primary drivers, each of which is linked with five to ten secondary drivers according to the existing knowledge and knowledge gaps referenced above and reviewed in detail elsewhere.[3,4] These drivers should be the subject of research.

Early Detection

The first primary driver of reduced suicide deaths in later life is early detection of individuals at risk and therefore is linked explicitly to the factors on all axes depicted in Figure 2. We emphasize detection of older adults with depression (Axis 1) because of the well-demonstrated and close association of mood disorders and late-life suicide. However, as not all older adults who die by suicide are clinically depressed, and because the predictive value of a depression diagnosis alone is low, additional research is needed on assessment of risk factors on each of the other four axes, and their interactions, in detecting who requires intervention.

Secondary drivers leading to early detection then can be conceptualized at the individual, service system, and community levels. At the individual level, priorities for research should be placed on studies of (1) cognitive vulnerabilities associated with impaired decision making; (2) family-, neighborhood-, and community-level risks and protective factors influencing detection of the individual; and (3) the relative risk associated with a combination or sequence of risk factors—the areas of overlap depicted in Figure 2.

At the service system level of improved early detection, secondary drivers for study include (1) systematic multidimensional screening in primary care and (2) applying risk stratification to inform design of service delivery,

suggesting the need for studies of how to make systems of care more effective in detecting and treating those at risk.

Finally, research needed at the community level should focus on the institution of gatekeeper training for all who may have access to older people in trouble and, thus, the opportunity to detect their risk and mobilize a helpful response.

General Health Promotion

The next primary driver of late-life suicide suggested by previous research is general health promotion to minimize mental (Axis 1 in Figure 2) and physical morbidity (Axis 3) and to optimize functioning (Axis 5). Consistent with observations described above about the lethal nature of suicidal states in older adults, the special emphasis here is on research into the primary prevention of illness and its progression once established. Although studies of detection and treatment of acute conditions that are more proximal to suicide are needed, research on more distal risk factors and their amelioration should be pursued as well.

At the individual level, secondary drivers for which study is needed include (1) provision of routine preventive care; (2) promotion of healthy behaviors in older people; and (3) empowerment of patients and families as partners in their own care, a central tenet of chronic disease management.[17] At the service system level, secondary drivers recommended for study include (1) use of in-home technologies, including monitoring devices that provide real-time assessment of pertinent outcomes and technologies to reduce isolation and engage patients and their caregivers in their health care; (2) easy access to rehabilitation services; (3) pain control; and (4) palliative and end-of-life care.

At the community level, secondary drivers of general health promotion for study should include (1) community-wide education about the need for an active lifestyle and other adaptive health behaviors for older adults; (2) creation of elder-friendly communities through environmental and policy interventions to improve access of older people, for example, to exercise opportunities, optimal nutrition, and recreation; and (3) easy, affordable access to community-based long-term-care services and supports to optimize independent functioning.

Mental Health Care

Mental disorders are common in later life and closely associated with suicide (Axis 1), yet only a small proportion of older adults in need of mental health care receive adequate treatment. The third primary driver to reducing suicide in older people, therefore, is the provision of mental health care that is evidence-based, accessible, affordable, acceptable to the older consumer, and well coordinated with other aspects of their care.

Thus, research needed on secondary drivers of improving care delivery at the individual level includes (1) education of patients and families about the need for, and benefits of, treatment for mental disorders and (2) ensuring that treatments are tailored to their preferences (patient- and family-centered care). At the service system level, secondary drivers for which research is needed include (1) use of integrated mental healthcare approaches in primary care settings according to established practice guidelines for collaborative mental healthcare management; (2) seamless transitions in care; and (3) integration of primary and mental health care with social services expertise in the multidisciplinary care team. At the community level, targets of study include (1) implementation of parity laws and (2) alignment of provider payment with quality, patient outcomes, and value.

Social Connectedness

A large body of risk factor research[3,4] indicates that the fourth primary driver of late-life suicide is social disconnectedness (Axis 4). There is a compelling literature about the health effects of social connections and adverse consequences of social disconnections, including those among older people.[3,18]

Therefore, secondary drivers of reduced late-life suicide that warrant study at the individual level are (1) interventions to enrich social networks and increase social supports, including through psychosocial treatments such as interpersonal and problem-solving therapies, and (2) other interventions to address family dysfunction and the individual's adaptation to age-related challenges.

At the service system level, it is particularly important that studies target linkage of aging service network agencies to healthcare delivery and other approaches to integration of biological, psychological, and social/environmental care. Secondary drivers for study at the community level might include (1) offering opportunities to volunteer one's time to others (a source of meaning in life for many older adults); (2) affordable congregate living options such as naturally occurring retirement communities; and (3) for homebound elders, the use of information and communication technologies to decrease social isolation.

Conclusions

Suicide in later life is complex and multidetermined. This complexity poses challenges to prevention but also indicates a wide range of possible avenues to intervene

that, in combination and over time, can be expected to reduce the rate of suicide in older adults.

There is no debate that additional studies of factors that place older adults at risk for suicide are indicated in order to refine our ability to target interventions to those most in need. Neither is there doubt about the importance of continuing to study interventions that target older people at imminent risk. However, the highly lethal nature of suicidal behavior in later life also indicates that study of more distal risk factors and approaches to their mitigation and prevention will be necessary if a substantial reduction in the number of older adults taking their own lives is to be achieved.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

This work was supported in part by USDHHS/PHS/CDC Award 1 R49 CE002093: Injury Control Research Center for Suicide Prevention. Drs. Katalin Szanto, Eric Lenze, Gary Epstein-Lubow, Margda Waern, Pal Duberstein, Eric Caine, and Martha Bruce also collaborated in the development of the ideas expressed herein.

No financial disclosures were reported by the author of this paper.

References

1. CDC. Web-based Injury Statistics Query and Reporting System (WISQARS). cdc.gov/injury/wisqars/index.html.
2. CDC. The state of aging and health in America. Witehouse Station NJ: CDC, 2007.
3. Conwell Y, Van Orden K, Caine ED. Suicide in older adults. Psychiatr Clin North Am 2011;34(2):451–68.
4. Conwell Y. Suicide and suicide prevention in later life. Focus 2013;11(1): 39–47.
5. Blumenthal SJ, Kupfer DJ. Generalizable treatment strategies for suicidal behavior. Ann NY Acad Sci 1986;487:327–40.
6. Ernst C, Mechawar N, Turecki G. Suicide neurobiology. Prog Neurobiol 2009;89(4):315–33.
7. Dombrovski AY, Siegle GJ, Szanto K, Clark L, Reynolds CF, Aizenstein H. The temptation of suicide: striatal gray matter, discounting of delayed rewards, and suicide attempts in late-life depression. Psychol Med 2012;42(6):1203–15.
8. WHO. Mental Health: Suicide Prevention (SUPRE). who.int/mental_health/prevention/suicide/suicideprevent/en/.
9. Szanto K, Lenze E, Waern M, et al. Research to reduce the suicide rate in older adults: methodology roadblocks and candidate paradigms. Psychiatr Serv 2013;64(6):586–9.
10. Unutzer J, Tang L, Oishi S, et al. Reducing suicidal ideation in depressed older primary care patients. J Am Geriatr Soc 2006;54(10): 1550–6.
11. Bruce ML, Ten Have T, Reynolds CF III, et al. Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA 2004;291(9): 1081–91.
12. De Leo D, Dello Buono M, Dwyer J. Suicide among the elderly: the long-term impact of a telephone support and assessment intervention in northern Italy. Br J Psychiatry 2002;181:226–9.
13. Oyama H, Sakashita T, Ono Y, Goto M, Fujita M, Koida J. Effect of community-based intervention using depression screening on elderly suicide risk: a meta-analysis of the evidence from Japan. Community Ment Health J 2008;44(5):311–20.
14. Van Orden KA, Simning A, Conwell Y, Skoog I, Waern M. Characteristics and comorbid symptoms of older adults reporting death ideation. Am J Geriatr Psychiatry 2013;21(8):803–10.
15. Knox KL, Conwell Y, Caine ED. If suicide is a public health problem, what are we doing to prevent it? Am J Public Health 2004;94(1):37–45.
16. Luoma JB, Martin CE, Pearson JL. Contact with mental health and primary care providers before suicide: a review of the evidence. Am J Psychiatry 2002;159(6):909–16.
17. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. Milbank Q 1996;74(4):511–44.
18. Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. PLoS Med 2010;7(7): e1000316.

Developmental Approach to Prevent Adolescent Suicides

Research Pathways to Effective Upstream Preventive Interventions

Peter A. Wyman, PhD

The 2012 National Strategy for Suicide Prevention expands the current suicide prevention paradigm by including a strategic direction aimed at promoting healthy populations. Childhood and adolescence are key suicide prevention window periods, yet knowledge of suicide prevention pathways through universal interventions is limited (Aspirational Goal 11). Epidemiologic evidence suggests that prevention programs in normative social systems such as schools are needed for broad suicide prevention impact. Prevention trial results show that current universal prevention programs for children and young adolescents are effective in reducing adolescent emotional and behavioral problems that are risk factors for suicidal behavior, and in the case of the Good Behavior Game, suicide attempts. A developmentally sequenced upstream suicide prevention approach is proposed: (1) childhood programs to strengthen a broad set of self-regulation skills through family and school-based programs, followed by (2) adolescent programs that leverage social influences to prevent emerging risk behaviors such as substance abuse and strengthen relationships and skills. Key knowledge breakthroughs needed are evidence linking specific intervention strategies to reduced suicidal behaviors and mortality and their mechanisms of action. Short- and long-term objectives to achieve these breakthroughs include combining evidence from completed prevention trials, increasing motivators for prevention researchers to assess suicide-related outcome, and conducting new trials of upstream interventions in populations using efficient designs acceptable to communities. In conclusion, effective upstream prevention programs have been identified that modify risk and protective factors for adolescent suicide, and key knowledge breakthroughs can jump-start progress in realizing the suicide prevention potential of specific strategies.

(Am J Prev Med 2014;47(3S2):S251–S256)

Introduction

This manuscript offers a developmentally informed approach to prevent the emergence of suicidal behavior during adolescence, and research pathways to identify effective interventions. By focusing "upstream"—on factors that influence the likelihood a young person will become suicidal—this manuscript addresses Aspirational Goal 11 of the Prioritized Research Agenda for Suicide Prevention,[1] namely, to identify clear targets and strategies for prevention programs that will reduce suicides by promoting resilience and health in broad-based populations.

From the Department of Psychiatry, University of Rochester School of Medicine and Dentistry, Rochester, New York

Address correspondence to: Peter A. Wyman, PhD, 300 Crittenden Blvd., University of Rochester Medical Center, Rochester NY 14642. E-mail: peter_wyman@urmc.rochester.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.039

Importance of Initiating Suicide Prevention during Childhood and Adolescence

Childhood and adolescence are key suicide "prevention window" periods. Approximately one half of emotional and behavioral disorders that are well-defined risk factors for suicide have onset of symptoms by age 14 years.[2] Many effective programs for children and adolescents prevent or reduce the severity of these mental, emotional, and behavioral problems, according to a recent National Academy of Sciences review.[2] In addition to being a critical period for preventing disorders, childhood and early adolescence are important periods for preventing the onset of suicidal behaviors. Adolescence is the age period of the highest rates of attempted suicide, and each attempt increases risk for future attempts and death due to suicide.[3]

Need to Expand Suicide Prevention Focus Upstream Prior to Suicidal Behavior

The 2012 National Strategy for Suicide Prevention (NSSP) expands the paradigm for suicide prevention by

including a strategic direction aimed at promoting the general health of broad populations to reduce the risk for suicidal behaviors and related problems such as substance abuse and depression (Strategic Direction 1).[4] This expanded focus on modifying "upstream" risk and protective processes—before the emergence of suicidal behavior—stands in contrast to current youth suicide prevention programming focused on identifying and treating individuals who are already suicidal or at high risk by training adult gatekeepers[5] and screening.[6]

Although efforts to identify and address the needs of high-risk youth should continue and be improved, expanding the suicide prevention paradigm to modify upstream processes is essential to reduce suicide rates. The population impact of strategies that identify and treat high-risk youth is limited by the following: (1) a reliance on referrals to the mental health system that might not suit many communities' ability to provide accessible, effective services; (2) limited ability to identify specific individuals who will die by suicide; and (3) even where treatment services are available, limited evidence that use of usual mental health treatment services will reduce suicide risk.[7]

Which Prevention Targets and Strategies Will Reduce Youth Suicides in the Population?

The following considerations, drawn from epidemiologic and prevention science perspectives, guided selection of the most promising prevention targets and research pathways.

Interventions delivered in social systems are needed for broad impact. Children develop through interactions within social systems (e.g., families, schools), and interventions in these systems can influence emotional and behavioral developmental processes of large youth populations essential to reduce suicide rates. *Normative* social systems—such as public schools, community youth organizations—are settings for universal interventions and serve the broadest populations. Interventions delivered universally have the greatest theoretic potential for reducing suicide mortality, if such interventions can address needs and priorities to make them attractive to social systems.

Reparative social systems—such as juvenile justice—are important settings to reach high-risk youth through selective and indicated interventions, which should be a part of a comprehensive, integrated suicide prevention strategy. However, programs in reparative social systems alone will not reach many youth who will die by suicide. For example, although youth in juvenile justice facilities have a suicide rate that is approximately three times higher than that of the general population, only 0.25% of youth are in justice facilities at any given time in the U.S.[8]

Interventions that reduce common, multiple risk factors will maximize impact. Scientific evidence suggests that the potential for large population reductions in suicide may be as great or greater for approaches that target more common, lower-risk conditions compared to rarer, high-risk conditions.[9,10] For example, preventing new instances of substance abuse problems would have a substantial impact on reducing suicides because substance use problems are highly prevalent, even though the relative risk for suicide from substance problems is lower than that for depression. It is also the case that interventions that modify multiple, rather than single, risk factors have the potential for largest population impact on reducing suicide rates.

Leveraging system-level influences will maximize prevention impact. System-level interventions modify social-ecologic contexts, which have risk-protective effects above and beyond individual factors. The Good Behavior Game (GBG) program that reduces aggressive–antisocial behavior leverages the influence of teacher practices and students across the classroom to promote behavioral control and classroom norms.[11]

Testing interventions to build more robust models for suicide prevention. Current models guiding suicide prevention are based primarily on observational studies linking suicidal behaviors to risk and protective factors, few of which have been established as "causal" factors.[12] Rigorous experimental designs involving randomization are the most potent methods for establishing causal pathways and building stronger conceptual models. Understandably, many communities are reluctant to participate in randomized trials in which they might get no intervention. Designs such as those that randomly assign groups (e.g., communities) to begin interventions at different time phases have been acceptable for communities to test suicide prevention programs.[13]

Proposed Prevention Targets and Intervention Strategies to Reduce Suicide Rates

Table 1 outlines a developmentally sequenced approach for preventing adolescent suicide:

(1) childhood programs to strengthen a broad set of self-regulation processes (i.e., behavioral and emotional self-control) through family and school-based programs, followed by (2) adolescent programs that leverage system-level influences (e.g., peer norms) to prevent emerging risk behaviors (e.g., substance abuse) and strengthen relationships and skills that are protective (e.g., coping).

Table 1. Developmental-sequenced upstream approach for preventing adolescent suicide: demonstrated impact by adolescence of illustrative programs

	Childhood programs strengthen self-regulation of behavior and emotions		Adolescent programs target differentiated risk and protective processes	
Social system	**Specific target**	**Illustrative program** *Impact in adolescence*	**Specific target**	**Illustrative program** *Impact in adolescence*
Family	Parenting skills for children under family stress	New Beginnings Program[14] *MEB, substance use*	Parenting skills for adolescent risk behaviors	Iowa Strengthening Families Program[15] *Substance use*
School	Strengthen classroom behavior, reduce aggression	Good Behavior Game[11] *Suicide attempts* *MEB, substance use*	Bullying Substance use	Olweus Bullying Program[16] *Bullying schoolwide* Life Skills[17] *Substance use*
Peers			Peer norms in social networks	Sources of Strength[18] *Coping* *Connectedness*
Community			Community-wide prevention system	Communities that Care[19] *MEB, substance use*

MEB, mental, emotional, or behavioral problems

The suicide prevention potential of selected programs is summarized regarding demonstrated impact on risk and protective processes upstream to suicidal behavior. For a population of children, optimal suicide prevention impact would be expected when they are exposed to effective childhood programs (e.g., strengthen classroom behavior) that prepare them to enter adolescence as behaviorally and emotionally competent, and then they are exposed to effective programs that address specific adolescent risk and protective processes such as substance abuse.

Strengthen Self-Regulation of Behavior and Emotions in Children

Increasing self-regulation, which encompasses behavior, emotions, and cognitive processes, is a key indicator of healthy childhood development according to evidence from diverse fields ranging from developmental psychopathology[20] to developmental neuroscience.[21] These self-regulatory processes are first learned within parent–child dyads and are embedded over time in broader systems including classrooms and peer relationships. Failures in self-regulatory processes are conceptualized as a key mechanism through which biological, social, and psychological influences lead to more differentiated and stable mental, emotional, and behavior disorders.[20]

Aggressive school behaviors are salient prevention targets because these problems are moderately stable and magnify risk for cascading problems, including delinquency and substance abuse. Dysregulation of emotions frequently co-occurs with early aggressive behavior, is associated with suicidal ideation during childhood,[22] and if persisting into adolescence is a specific risk factor for attempting suicide.[23] Self-regulation also extends to executive-cognitive functions, which continue to mature into early adulthood,[24] and normative delays in these functions are linked to adolescent impulsivity and susceptibility to suicide contagion effects.[25]

Seminal research findings that the GBG implemented in first- or second-grade urban classrooms reduced suicidal behavior 15 years later demonstrates the potential suicide prevention impact from enhancing self-regulatory processes through universal interventions. Training teachers to promote positive student classroom behavior, the GBG evaluated through a rigorous RCT, decreased substance use, antisocial and risky sexual behaviors,[11] and self-reported suicidal ideation and attempts occurring by age 19–21 years by one half (Table 1).[26] Less-rigorous GBG implementation in a second cohort had a directionally similar, but non-significant, impact on reducing suicidal behaviors, indicating the need to replicate and determine how to achieve high-quality implementation needed for suicide prevention impact.

Findings from a randomized trial testing the New Beginnings Program (NBP) for divorcing families[14] is an illustrative example of the prevention potential of strengthening protective processes, including self-regulation, through family-based programs. Promoting

parenting and child skills for coping, the NBP reduced adolescent mental health disorders, substance use, and behavioral problems, and the positive preventive effects increased over time. However, as with nearly all prevention programs for youth, the impact of NBP on suicidal behaviors was not assessed.

Leverage Peer and Family Influences to Reduce Adolescent Substance Use and Bullying and Increase Healthy Coping and Connectedness

Parent–youth relationships and norms generated through peers exert a potent influence on specific emerging risk factors for suicide. System-level interventions that leverage these influences have become state of the art. Examples of promising system-level interventions during adolescence and their demonstrated impact on risk/protective factors for adolescent suicide (Table 1) are as follows. Substance use initiation is reduced by the universal Life Skills curriculum that strengthens resistance to peer influences[17]; by interventions delivered through schools to strengthen family functioning (e.g., Iowa Strengthening Families Program)[15]; and by programs assisting communities to implement evidence-based programs (e.g., Communities that Care).[19]

By modifying schoolwide practices including student perceptions regarding acceptable behavior, the Olweus program reduces schoolwide bullying.[16] Training for high school student peer leaders to prepare them to modify norms through their natural social networks (Sources of Strength) has increased schoolwide help-seeking acceptability, coping norms, and engagement of adults to help suicidal peers.[18]

As with nearly all other prevention programs, with the exception of the GBG, the impact on reducing suicidal behaviors of these adolescent programs is largely unknown. To date, few RCTs evaluating these interventions have incorporated suicidal behaviors as an outcome or have sufficient power to assess impact on suicide attempts or mortality.

Proposed Step-by-Step Research Pathways

Breakthroughs in the following areas would jump-start progress in realizing the suicide prevention potential of upstream approaches: (1) establishing causal links between specific intervention strategies and programs (e.g., classroom interventions; substance abuse prevention) and reductions in adolescent suicidal behaviors, beginning with suicide attempts and medically serious attempts; (2) identifying intervention mediators and pathways (e.g., reduced adolescent substance use) to reduced suicidal behaviors; and (3) providing evidence that specific interventions, or combinations of interventions, implemented in broad populations lead to reduced suicide rates (long-term objective). To achieve these breakthroughs, the following research pathways are proposed.

Short-Term Research Objectives and Potential Barriers (4–8 Years)

By capitalizing on completed trials of preventive interventions and strategically chosen new trials, the following objectives can significantly advance knowledge within 4–8 years. First, data should be leveraged from the large number of preventive intervention trials with youth already completed to identify intervention strategies that reduce suicidal behaviors, including deaths (e.g., linking to the National Death Index). This first short-term objective may be accomplished by utilizing new methods for synthesizing data across multiple trials, even if different measures of similar constructs are used.[27]

Second, in selecting specific programs for data synthesis, universal and selective programs should be prioritized by targeting self-regulation processes such as classroom behavior and emotion self-regulation, programs for adolescent substance use and bullying prevention, and interventions that strengthen norms for coping with stress and increase youth–adult connections. By synthesizing data from multiple programs that affect common proximal outcomes (e.g., reduced aggressive behavior; delayed onset of alcohol use), and identifying valid indicators of suicidal behavior (e.g., from depression scale items), we can achieve the potential to identify which strategies and outcomes are most promising.

Third, a specific priority should be to combine follow-up data from multiple implementations of GBG. Fourth, many school-based interventions have been, or could be, adapted to reparative systems (e.g., juvenile justice), with similar testing for suicide prevention impact by aggregating groups of institutions. Fifth, estimates of reductions in suicidal behavior and mortality associated with changes in targeted behaviors should be developed. A potential barrier is that few trials may have assessed suicidal behavior, although more will have suicidal ideation, which could be used to estimate impact on suicidal behaviors.

Efforts should be made to increase the number of prevention researchers in fields such as substance abuse, bullying, and parenting that incorporate high-quality measures of suicidal behavior in their work. To that end, tools should be developed and researchers should be encouraged to include valid and reliable measures of suicidal behavior in follow-up evaluations of prevention programs through the following: (1) creating and distributing protocols and expertise on accessing resources (e.g., National Suicide Prevention Hotline) to respond to trial participants identified as suicidal to reduce ethical and pragmatic concerns;

(2) creating consensus lists of high-quality measures for assessing suicidal behavior for youth of different ages, including those that can be deployed in population-based studies, and potential modifications needed for specific populations (ethnic, race, and cultural differences); and (3) developing new approaches for conducting follow-ups of subjects in prevention trials such as using Internet-based surveys for brief, rapid assessments of suicidal behaviors,[28] which could be de-identified to protect confidentiality. Potential barriers include the need to address "silo" priorities in prevention, including funding agency priorities, to encourage collaboration so that alcohol prevention researchers, for example, are motivated to incorporate measures of suicidal behavior.

Finally, researchers should determine whether combining interventions targeting multiple preventive targets (e.g., substance abuse, bullying, youth–adult connectedness) may have greater impact on suicide prevention. Combinations of programs and choices may provide better "fit" with community needs, using models such as Communities that Care,[19] to help communities identify needs and select evidence-based programs across the full prevention continuum (universal, selected, indicated).

Use of trial designs that randomize communities to receive intervention at different phases[13] may increase acceptability and participation. RCTs should incorporate program implementation research to identify levels of implementation quality necessary for suicide prevention impact and utilize social network tools to determine diffusion of intervention impact and which practices reach highest risk youth.

The use of "roll out" designs[29] can also increase the impact in large population-based trials needed to identify interventions that reduce suicide mortality. Roll-out designs enroll multiple cohorts over the years and modify content or implementation to account for what is learned in early cohorts—an approach that can increase responsiveness to community needs. Determining how to best engage schools to implement universal programs while having multiple competing demands is an important barrier to address.

Long-Term Objectives and Potential Barriers (12–20 Years)

Ultimately, the most robust data and knowledge needed to identify strategies to reduce suicide rates will come from large-population randomized trials of promising interventions, or combinations of interventions, with long-term follow-up. The following are recommended as strategies to maximize knowledge gains from such RCTs: (1) prioritizing both rural communities and other regions with high suicide rates (western U.S. states), which can enhance efficiency and statistical power to detect impact on suicide mortality; (2) using ongoing surveillance (e.g., Youth Risk Behavior Surveillance System) that may provide efficient and relatively inexpensive means of testing intermediate outcomes and suicidal behavior impact in large regions.

Potential barriers include long waiting periods for child populations to reach periods of elevated suicidal behavior needed to determine intervention impacts. However, when using designs that randomize large community segments to implement programs at different phases over 3–4-year periods, intermediate effects can be detected, and large cohorts of youth followed for suicide prevention impact.

Conclusions

Upstream interventions delivered through social systems in childhood and early adolescence have the potential for reducing population-level suicide rates by decreasing the number of adolescents with mental emotional and behavioral problems, as well as creating social environments that expose adolescents to positive coping norms, increase youth–adult connections, and reduce adverse experiences such as bullying. Effective prevention programs already have been identified across childhood and adolescence prevention window periods that modify multiple risk and protective factors for adolescent suicide and can reach large populations of youth.

Key research gaps must be addressed to identify specific strategies and programs with greatest suicide prevention potential. School-based interventions have been highlighted in this manuscript based on prior work identifying promising interventions and the potential for reaching population groups. Prenatal and early childhood programs shown to reduce adolescent antisocial behaviors and other problems[30] may also have suicide prevention potential, particularly if implementation is expanded to reach broader population segments. In the future, other intervention strategies and settings may emerge as promising, such as interventions aimed at modifying adolescent norms for behavior through social media networks or that provide "option-rich" alternatives that can be adapted to address individual needs (e.g., individuals choose modules to suit specific emotional, behavioral, or life-context needs).[23]

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

The author thanks Anthony R. Pisani, PhD, for valuable feedback on the manuscript, and C. Hendricks Brown, colleagues from the University of Rochester Center for Study and Prevention of Suicide (CSPS), and the Upstream Suicide Prevention Expert Panel for informative discussions on suicide prevention. The author also thanks the National Institute of Mental Health for support under grant RO1MH091452.

No financial disclosures were reported by the author of this paper.

References

1. National Action Alliance for Suicide Prevention: Research Prioritization Task Force. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
2. O'Connell ME, Boat T, Warner KE. Preventing mental, emotional, and behavioral disorders among young people: progress and possibilities. Washington DC: National Academies Press, 2009.
3. CDC. Trends in suicide rates among persons ages 10 years and older, by sex, U.S., 1991–2009. Web-based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Reports. cdc.gov/injury/wisqars/index.html.
4. USDHHS Office of the Surgeon General and National Action Alliance for Suicide Prevention. 2012 National Strategy for Suicide Prevention: Goals and Objectives for Action. Washington, DC: HHS, September 2012. http://www.surgeongeneral.gov/library/reports/national-strategy-suicide-prevention/full-report.pdf.
5. Wyman PA, Brown CH, Inman J, et al. Randomized trial of a gatekeeper program for suicide prevention: 1-year impact on secondary school staff. J Consult Clin Psychol 2008;76(1):104–15.
6. Gould MS, Marrocco FA, Kleinman M, Thomas JG, Mostkoff K, Cote J. Evaluating iatrogenic risk of youth suicide screening programs: a randomized controlled trial. JAMA 2005;293(13):1635–43.
7. Wyman P. "Upstream" youth suicide prevention: need for a national commitment. Summary report from the Upstream Youth Suicide Prevention Expert Panel. American Association of Suicidology Annual Conference; 2012 April 25; Baltimore MD, 2012.
8. Gallagher CA, Dobrin A. Deaths in juvenile justice residential facilities. J Adolesc Health 2006;38(6):662–8.
9. Brown CH. Designs to evaluate high-risk and population-based suicide prevention programs: maximizing our potential for reducing completed suicide: Washington DC: IOM, 2001.
10. Rose G. Sick individuals and sick populations. Int J Epidemiol 1985;14(1):32–8.
11. Kellam SG, Brown CH, Poduska J, et al. Effects of a universal classroom behavior management program in first and second grades on young adult behavioral, psychiatric, and social outcomes. Drug Alcohol Depend 2008;95(1S):S5.
12. Caine ED. Forging an agenda for suicide prevention in the U.S. Am J Public Health 2013;103(5):822–9.
13. Brown CH, Wyman PA, Guo J, Peña J. Dynamic wait-listed designs for randomized trials: new designs for prevention of youth suicide. Clin Trials 2006;3(3):259–71.
14. Wolchik SA, Sandler IN, Millsap RE, et al. Six-year follow-up of preventive interventions for children of divorce. JAMA 2002;288(15):1874–81.
15. Spoth RL, Redmond C, Shin C. Randomized trial of brief family interventions for general populations: adolescent substance use outcomes 4 years following baseline. J Consult Clin Psychol 2001;69(4):627–42.
16. Olweus D. Bullying at school: basic facts and effects of a school based intervention program. J Child Psychol Psychiatry 1994;35(7):1171–90.
17. Botvin GJ, Griffin KW, Diaz T, Scheier LM, Williams C, Epstein JA. Preventing illicit drug use in adolescents: long-term follow-up data from a randomized control trial of a school population. Addict Behav 2000;25(5):769–74.
18. Wyman PA, Brown CH, LoMurray M, et al. An outcome evaluation of the Sources of Strength suicide prevention program delivered by adolescent peer leaders in high schools. Am J Public Health 2010;100(9):1653–61.
19. Hawkins JD, Oesterle S, Brown EC, et al. Results of a type 2 translational research trial to prevent adolescent drug use and delinquency: a test of Communities That Care. Arch Pediatr Adolesc Med 2009;163(9):789–98.
20. Calkins SD, Keane SP. Developmental origins of early antisocial behavior. Dev Psychopathol 2009;21(4):1095.
21. Tucker DM, Phan L, Pibram KH. Social and emotional self-regulation. Ann N Y Acad Sci 1995;769(1):213–40.
22. Wyman PA, Gaudieri PA, Schmeelk-Cone K, et al. Emotional triggers and psychopathology associated with suicidal ideation in urban children with elevated aggressive-disruptive behavior. J Abnorm Child Psychol 2009;37(7):917–28.
23. Pisani AR, Wyman PA, Petrova M, et al. Emotion regulation difficulties, youth–adult relationships, and suicide attempts among high school students in underserved communities. J Youth Adolesc 2013;42(6):807–20.
24. Giedd JN, Blumenthal J, Jeffries NO, et al. Brain development during childhood and adolescence: a longitudinal MRI study. Nat Neurosci 1999;2(10):861–3.
25. Insel BJ, Gould MS. Impact of modeling on adolescent suicidal behavior. Psychiatr Clin North Am 2008;31(2):293–316.
26. Wilcox HC, Kellam SG, Brown CH, et al. The impact of two universal randomized first- and second-grade classroom interventions on young adult suicide ideation and attempts. Drug Alcohol Depend 2008;95(1S):S60–S73.
27. Brown CH, Sloboda Z, Faggiano F, et al. Methods for synthesizing findings on moderation effects across multiple randomized trials. Prev Sci 2013;14(2):144–56.
28. Gibbons RD, Hooker G, Finkelman M, et al. The CAD MDD: A computerized adaptive diagnostic screening tool for depression. J Clin Psychiatry 2013;74(7):669–74.
29. Brown CH, Ten Have TR, Jo B, et al. Adaptive designs for randomized trials in public health. Annu Rev Public Health 2009;30:1–25.
30. Olds DL, Eckenrode J, Henderson CR, et al. Long-term effects of home visitation on maternal life course and child abuse and neglect. JAMA 1997;278(8):637–43.

Promising Strategies for Advancement in Knowledge of Suicide Risk Factors and Prevention

Jitender Sareen, MD, Corinne Isaak, MSc, Laurence Y. Katz, MD, James Bolton, MD, Murray W. Enns, MD, Murray B. Stein, MD, MPH

Suicide is an important public health problem. Although there have been advances in our knowledge of suicide, gaps remain in knowledge about suicide risk factors and prevention. Here, we discuss research pathways that have the potential to rapidly advance knowledge in suicide risk assessment and reduction of suicide deaths over the next decade. We provide a concise overview of the methodologic approaches that have the capacity to rapidly increase knowledge and change practice, which have been successful in past work in psychiatry and other areas of medicine. We suggest three specific pathways to advance knowledge of suicide risk factors and prevention. First, analysis of large-scale epidemiologic surveys and administrative data sets can advance the understanding of suicide. Second, given the low base rate of suicide, there is a need for networks/consortia of investigators in the field of suicide prevention. Such consortia have the capacity to analyze existing epidemiologic data sets, create multi-site cohort studies of high-risk groups to increase knowledge of biological and other risk factors, and create a platform for multi-site clinical trials. Third, partnerships with policymakers and researchers would facilitate careful scientific evaluation of policies and programs aimed at reducing suicide. Suicide intervention policies are often multi-faceted, expensive, and rarely evaluated. Using quasi-experimental methods or sophisticated analytic strategies such as propensity score-matching techniques, the impact of large-scale interventions on suicide can be evaluated. Furthermore, such partnerships between policymakers and researchers can lead to the design and support of prospective RCTs (e.g., cluster randomized trials, stepped wedge designs, waiting list designs) in high-risk groups (e.g., people with a history of suicide attempts, multi-axial comorbidity, and offspring of people who have died by suicide). These research pathways could lead to rapid knowledge uptake between communities and have the strong potential to reduce suicide.

(Am J Prev Med 2014;47(3S2):S257–S263)

Introduction

Suicide is an important cause of death throughout the world.[1] Suicide rates in the U.S. have increased rather than decreased in the last decade.[2] There is an urgent need for research that rapidly advances knowledge and has rapid uptake by policymakers and clinicians to reduce suicide deaths.

One of the major challenges in advancing knowledge around suicide prevention is that deaths by suicide are relatively infrequent events. Although the gold standard test of an intervention is an RCT, conducting RCTs that are powered for detecting impact on suicides are expensive, difficult to coordinate, and require long periods of follow-up.[3] Here, we discuss three key research pathways (analysis of existing data sets that include suicide variables, networks and consortia focused on suicide prevention, and researchers working with policymakers to address important questions related to suicide) that we believe can advance the field of suicide prevention in a manner that will reduce suicides over the next 10 years. To guide the current discussion, we list the well-established suicide risk factors[4] and prevention strategies

From the Department of Psychiatry (Sareen, Isaak, Katz, Bolton, Enns), Department of Psychology (Sareen, Bolton), and Department of Community Health Sciences (Sareen, Bolton, Enns), University of Manitoba, Winnipeg, Manitoba, Canada; and the Departments of Psychiatry and Family and Preventive Medicine (Stein), University of California, and Veterans Affairs San Diego Healthcare System, San Diego, California

Address correspondence to: Jitender Sareen, MD, Departments of Psychiatry, Psychology, and Community Health Sciences, University of Manitoba, PZ430-771 Bannatyne Ave., Winnipeg, Manitoba, Canada R3E 3N4. E-mail: sareen@cc.umanitoba.ca.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2014.05.041

Table 1. Selected suicide risk factors and interventions: individual, family, and community levels

Risk factors	Interventions
Individual level	
• Sex/gender • Occupation • History of suicide attempts • Mental disorder (anxiety, mood) • Addictions • Physical illness • Financial stress • Personality disorders/impulsivity/aggression • Legal problems • Lack of religious affiliation	• Timely access to evidence-based interventions in various settings: college, workplace, justice, primary care, organized faith settings, specialty care (S/I) • Postdischarge follow-up contact for patients hospitalized for suicidal behavior (I)
Family level	
• Childhood maltreatment • Intimate partner violence • Addictions, mental disorders, suicide in family members	• Positive parenting programs (U/S) • Family-based interventions (U/S) • Peer support for young mothers (S) • Support for the bereaved (S)
Community level	
• Suicide in peers • Sensational media reporting of suicide • Specific cultural factors (e.g., Native Americans, immigrants, refugees) • Access to lethal means: guns, pesticides	• School-based evidence based programs (U) • Media education of safe reporting (U) • Culturally grounded interventions (U/I/S) • Means restriction (U) • Crisis lines (U)

Note: IOM-defined prevention programs: I, indicated; S, selective; U, universal.
I programs target groups that have already developed the disease and aim to reduce severe problems.
S programs target groups at high risk for the outcome or disease.
U programs include all people in a certain community in the intervention.

at the individual, family, and community levels (Table 1) and describe the limitations of the current knowledge in these areas.

Limitations of the Current State of Knowledge on Suicide Risk Factors

Suicide is, fortunately, a relatively rare event. Unfortunately, this makes it hard to study for a variety of reasons.[4] First, empirical data on optimal screening and prediction tools for suicide are lacking.[5] Many suicide risk assessment tools (e.g., SAD PERSONS scale) have good sensitivity but poor positive predictive value in their ability to forecast future suicide attempts.[5,6]

Second, there is a lack of understanding of suicide risk in vulnerable groups (e.g., military personnel, ethnic minorities, socially deprived individuals). For example, depending on the group studied, social markers such as income and marital status have been shown to be both suicide risk and protective factors.[7,8]

Third, with the recent increase in use of social media, information is lacking on the impact of exposure to suicide in social media on suicide contagion. Fourth, although there has been an increase in prevalence of non-suicidal self-injury,[9] the longitudinal course and risk for death by suicide among people with non-suicidal self-injury remains unknown. Fifth, most epidemiologic studies of suicidal ideation and attempts have been cross-sectional, may be affected by recall bias, and are not generalizable to death by suicide.

Limitations of Evidence in Suicide Prevention

Although a wide range of suicide prevention strategies are suggested in guidelines worldwide (Table 1), it is important to underscore that most of the suicide prevention strategies, with the exception of means restriction policies,[10] training of physicians in treating depression,[11] and postcards after hospitalization for suicide attempts,[12] lack strong empirical evidence for reducing suicidal behavior. There is, therefore, an urgent need to rigorously test promising suicide prevention strategies.

Owing to the low base rate phenomenon of suicide, extremely large sample sizes (thousands of people) often followed over relatively long periods of time are required to test whether interventions are effective. The most-cited studies in the field of suicide prevention to date are quasi-experimental designs in high-risk adult groups (e.g., Air Force personnel,[13] regions of Hungary[14]) where

improving/increasing gatekeeper training for suicide and treatment of depression by primary care physicians reduced suicide rates.

Furthermore, large-scale clinical trials for mental disorders often exclude people with a high risk of suicidal behavior. Thus, there is little information available from RCTs regarding effective interventions in high-risk adults. Even less data are available for optimal methods of intervention in culturally diverse groups.[15] Finally, given the complex multifactorial and heterogeneous etiology of suicide, large-scale public health interventions may be expensive and typically have small effect sizes.[16] In the context of limited funding for research, investigators often face significant obstacles in designing fundable studies.

Suggested Research Pathways

In order to advance knowledge of suicide risk factors and evaluate suicide prevention strategies, the following three main research pathways are suggested (Table 2).

Pathway 1: Analyses of Existing Epidemiologic, Clinical, and Administrative Data

Although there has been a large increase in knowledge around risk factors for suicide, existing large, longitudinal mental health surveys and clinical trial databases are publicly available and can be analyzed to further increase our understanding of risk factors for suicide and suicide attempts.[17] There is also a need for developing predictive algorithms for suicide similar to those developed in the Framingham Heart study[18] for development of a core set of predictors for cardiovascular disease. This would require identifying a select group of key, potentially modifiable risk factors that could be targeted among individuals at high suicide risk. However, such large-scale intervention studies are time consuming and costly.

In the medical field, there has been an increase in the use of propensity score-matching analysis to determine if certain interventions (e.g., pharmacotherapy) have impact on outcomes.[19,20] Although these types of observational methodologies may not entirely remove residual confounding issues, they are economically feasible and overcome the ethical concerns about randomization of high-risk groups.[21] Propensity score-matching analyses have been used, for example, to understand the impact of antidepressants during pregnancy on fetal and neonatal outcomes where randomization is clearly not acceptable because of ethical issues.[22]

The analysis of large-scale epidemiologic surveys and administrative databases has been instrumental in increasing our understanding of suicide risk. Much of our understanding of risk factors for suicide attempts

Table 2. Strengths and limitations of proposed research pathways

Research pathways	Strengths	Limitations
1. Analysis of existing epidemiologic samples and clinical trial databases	Data already collected	Limited by what is already collected in data sets
	Inexpensive to conduct analysis	Observational studies, causal inferences cannot be made
	Large sample size	
2. Networks and consortia of researchers	Multi-site prospective cohorts (history of suicide attempts, family history of suicide)	Large infrastructure support required
	Sufficient sample sizes to examine biomarkers, genetics, and imaging work to understand biological factors related to suicide	Observational studies
	Understand the natural trajectory of suicidal behavior	Substantial effort to create the network and develop partnerships
3. Evaluation of current or new policies and programs	Creates partnerships between policymakers and researchers in suicide	Large-scale policies are heterogeneous and it may be difficult to discern which parts of the policies are associated with reductions in suicide
	Bidirectional knowledge exchange leads to rapid uptake of new knowledge in suicide prevention	Quasi-experimental designs preclude causal inferences
	Careful evaluation of large-scale policies leads to an understanding of which suicide policies have an impact on suicide	
	Multi-site clinical trials with high-risk samples	Ethical issues of conducting RCTs in high-risk groups
	Sufficient sample size to detect impact of interventions on suicide attempts or deaths	

comes from cross-sectional and longitudinal epidemiologic surveys, whereas understanding of suicide deaths comes from administrative database studies from the U.S., Europe, and Canada. Examples of secondary analysis of existing data sets includes the examination of controversial topics such as the relationship between anxiety disorders and risk of suicidal behavior among adults.[23] Based on a series of studies using several epidemiologic data sets, there has been an expansion of the understanding of the importance of anxiety,[24] specifically posttraumatic stress disorder and panic disorder, as triggers for suicide attempts.[23]

Administrative data sets that link vital statistics databases with de-identified health information (e.g., physician contacts, prescription drug use) have rapidly advanced the understanding of suicide risk factors suicide.[25] They also provide the opportunity to objectively assess factors such as treatment seeking and overcoming the recall bias inherent in survey data. Using this method, Olfson et al.[26] have shown the gaps in follow-up care of patients after they present to emergency departments for suicide attempts.

This strategy is relatively inexpensive and can rapidly yield novel findings. However, observational studies (the use of techniques such as propensity matching notwithstanding) do not provide the same strength of evidence for cause and effect as data obtained in randomized trials.

Pathway 2: Need for Networks and Consortia

Given the low base rate phenomenon of suicide, a consortium of researchers across multiple sites is needed to generate findings backed by sufficient statistical power. These team endeavors also have the advantage of bringing together a diverse, highly expert group of researchers. This strategy enhances knowledge transfer opportunities both within the consortium and more broadly with the scientific community and public stakeholders, given the greater number of connections inherent in a larger team. Together, these factors enhance the potential for both rapid knowledge advancement and dissemination, increasing the likelihood of uptake in clinical and policy domains. Similar consortia have been necessary and successful in the field of genetics[27] where large sample sizes and diverse research expertise are also needed.

In suicide research, networks of researchers are needed to overcome the lack of understanding of the neurobiology and genetics of suicide. We suggest that networks could rapidly advance knowledge in suicide prevention by using longitudinal epidemiologic studies of high-risk samples. Prospective cohorts are required, where data on family history of suicides or previous suicide attempts, as well as multiple mental and physical illnesses, can be "concentrated" for the highest likelihood of attempting suicide.

Weissman[28] discussed the concept of *translational epidemiology*, where population-based samples are recruited and their biological factors are examined (genetics and biomarkers) to increase knowledge of the biological underpinnings of suicidal behavior. Such efforts are essential in advancing the understanding of suicide biomarkers that have the potential to transform suicide risk assessment and personalized treatments.

Owing to the increase in suicide rates in the U.S. military in the mid to late part of the past decade, U.S. government agencies have funded consortia such as the Military Suicide Research Consortium (msrc.fsu.edu) and the Army Study to Assess Risk and Resilience in Service members (Army STARRS; armystarrs.org).[29] These consortia bring together a large group of investigators to conduct a series of studies to rapidly increase the knowledge of suicide risk factors among service members. In civilian samples, there are also examples of these networks on suicide prevention in Europe and Canada. Each network often has a particular focus. For example, some networks focus on genetics, whereas others, like our team in Manitoba, have focused on cultural factors related to suicide risk and culturally grounded universal suicide prevention strategies.[15]

We encourage the development and funding of more suicide prevention networks across civilian populations. Lessons learned include the fact that it can take months to years for a consortium to coalesce in terms of policies and procedures; hence, any investment in such an entity must have a long-term perspective. Once up and running, however, the ability to harness the brainpower and person-power of a large co-operative group of committed researchers focused on a problem can jump-start the generation of new knowledge. In addition, networks that engage policymakers can have important collaborative efforts in creating new knowledge on suicide prevention (see Pathway 3 below).

The strengths of this approach are that there can be a synergy in creating new knowledge, with the potential for multi-site intervention studies and collection of high-risk cohorts that are sufficiently powered to test the impact of interventions on suicide attempts and deaths. However, limitations of this approach include the need for substantial funding to create such a consortium, combined with the challenge of coordinating large research groups. Moreover, a large team of researchers can lead to synergistic efforts, but in some cases may inhibit the individuals within a team to innovate and create novel

strategies or approaches to suicide prevention that are not agreed upon by the leaders of the network.

Pathway 3: Researchers and Policymakers Working Together to Evaluate Policies of Suicide Prevention Programs

All too frequently, governments implement far-reaching and, at times, very expensive policy changes intended to have specific effects (e.g., reduction of suicide deaths) but fail to put in place in advance the means to evaluate such interventions. Collaboration between policymakers and researchers, prior to the implementation of the intervention, can facilitate the optimal evaluation of suicide prevention programs. We argue that there is a need for further work on examining policies using existing administrative data, quasi-experimental designs, or RCTs if possible.

There are several examples of high-quality evaluations of suicide policies using observational studies. Similar efforts are needed across different countries, health systems, and cultural contexts. A seminal paper[13] in the field of suicide prevention demonstrated the impact of policy changes in suicide prevention for U.S. Air Force personnel. The authors used a quasi-experimental design to demonstrate a reduction in suicides associated with a multi-layered program implemented in a cohort of more than 5 million U.S. Air Force personnel.

Similarly, in a high-risk region in Hungary,[14] education of primary care providers in the treatment of depression was associated with a reduction in suicides in the intervention area compared to surrounding regions that did not receive the intervention. Recently, While and colleagues[30] examined the impact of several suicide policies in the United Kingdom and found that certain policies were associated with reduction in suicides (e.g., 24-hour crisis lines, multi-disciplinary review of suicides) whereas other policies were not.

Finally, healthcare reform is currently an enormous public health concern in the U.S. Sommers et al.[31] examined the impact of expansion of Medicaid in certain U.S. states using a quasi-experimental design and demonstrated that the states with expanded Medicaid coverage had an associated decrease in mortality. Similar methods could be used to examine the impact of Medicaid expansion (or other broad policy changes) on suicide rates.

In addition, with the recent gun violence in the U.S., there has been increasing concern about the need for stronger policies on firearm regulations. Analysis of U.S. state data showed an association between higher state-level regulations of firearms and a lower likelihood of suicides and homicides.[32] Although these types of ecologic data preclude inferences about causality, this recent paper suggests that means restriction policies may have the capacity to reduce suicides. Rapid analysis of policy-relevant questions could be conducted efficiently with these types of administrative data analyses.

To overcome the limitations of the quasi-experimental designs of the aforementioned studies, it would be ideal to conduct RCTs (e.g., cluster randomization, waiting list designs) when governments initiate new suicide prevention programs that have not been previously tested in RCTs. The Canadian government has, for example, partnered with researchers to implement a large-scale pragmatic RCT of Housing First consisting of case management for more than 2,000 homeless individuals with mental illness. This trial provided the opportunity to evaluate a promising intervention across five cities in Canada and engaged policymakers throughout the process.[33]

Our team is also working with policymakers to facilitate the evaluation of promising suicide prevention programs that are being implemented (gatekeeper training) in Canada. Gatekeeper training involves coaching people (adults and youth) in the community who have primary contact with those at risk for suicide in identifying and assisting them in getting care.[34] Similar clinical trials are required for testing interventions among individuals at high risk for suicide (i.e., previous suicide attempters, those with multi-axial comorbidities, and offspring of people who have died by suicide).

Systematic evaluation of large-scale public health interventions has the potential to show an impact on relatively infrequent outcomes such as suicide and suicide attempts. Researchers benefit from this approach because they do not need to acquire funding for or deliver the expensive large-scale interventions (governments are already funding the roll-out of these untested programs).

Instead, researchers can focus on acquisition of funding to conduct thoughtful evaluation of the interventions. Policymakers can benefit from working with researchers who evaluate the interventions on suicide to ensure that programs and funding are doing what they are supposed to do (i.e., reducing suicides). However, strong partnerships between government and researchers are required to ensure clear roles and effective administration of both the intervention and evaluation of the program.

As many suicide prevention strategies are multi-layered, it may be difficult to discern the effective "ingredient" of the intervention. Also, evaluation of the process of policy implementation is essential in large-scale studies to ensure fidelity to the intervention. Although cluster randomization would be ideal, it may not be possible given that governments may be reluctant to "withhold" a potentially helpful intervention from a given community. Although this is politically

understandable, from a scientific perspective it is equally unjustified to subject a community to an unproven intervention that could do harm.

Thus, although quasi-experimental designs have been used to evaluate policies, these designs preclude strong causal inferences. Randomization may be more acceptable if a "proven" treatment is compared against a new, potentially better treatment. Finally, governments might not wish to evaluate the implemented programs because of fear of finding that the program is ineffective, which may lead to negative media attention and other political hazards.

Conclusions

In conclusion, we suggest three specific and complementary pathways to rapidly advance knowledge in suicide risk and reduce suicides: (1) increasing the analysis of existing databases to further our knowledge of risk and protective mechanisms in suicide; (2) creation of networks and consortia that have the platform for cross-site studies in suicide risk and suicide intervention; and (3) forging of partnerships between policymakers and researchers to rapidly test the impact of current and new policies in suicide prevention.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

Preparation of this article was supported by a Canadian Institutes of Health Research grant (No. 273657) and a Manitoba Health Research Council Chair award to Dr. Sareen.

No financial disclosures were reported by the authors of this paper.

References

1. Nock MK, Borges G, Bromet EJ, Cha CB, Kessler RC, Lee S. Suicide and suicidal behavior. Epidemiol Rev 2008;30(1):133–54.
2. Rockett IR, Regier MD, Kapusta ND, et al. Leading causes of unintentional and intentional injury mortality: U.S., 2000–2009. Am J Public Health 2012;102(11):e84–e92.
3. Brown CH, Wyman PA, Guo J, Pena J. Dynamic wait-listed designs for randomized trials: new designs for prevention of youth suicide. Clin Trials 2006;3(3):259–71.
4. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. JAMA 2005;294(16):2064–74.
5. Randall JR, Colman I, Rowe BH. A systematic review of psychometric assessment of self-harm risk in the emergency department. J Affect Disord 2011;134(1–3):348–55.
6. Bolton JM, Spiwak R, Sareen J. Predicting suicide attempts with the SAD PERSONS scale: a longitudinal analysis. J Clin Psychiatry 2012;73(6):e735–e741.
7. Sareen J, Afifi TO, McMillan KA, Asmundson GJ. Relationship between household income and mental disorders: findings from a population-based longitudinal study. Arch Gen Psychiatry 2011;68(4):419–27.
8. Agerbo E. High income, employment, postgraduate education, and marriage: a suicidal cocktail among psychiatric patients. Arch Gen Psychiatry 2007;64(12):1377–84.
9. Hawton K, Bergen H, Mahadevan S, Casey D, Simkin S. Suicide and deliberate self-harm in Oxford University students over a 30-year period. Soc Psychiatry Psychiatr Epidemiol 2012;47(1):43–51.
10. Yip PS, Caine E, Yousuf S, Chang SS, Wu KC, Chen YY. Means restriction for suicide prevention. Lancet 2012;379(9834):2393–9.
11. Rutz W, von Knorring L, Walinder J. Frequency of suicide on Gotland after systematic postgraduate education of general practitioners. Acta Psychiatr Scand 1989;80(2):151–4.
12. Carter GL, Clover K, Whyte IM, Dawson AH, D'Este C. Postcards from the EDge project: randomised controlled trial of an intervention using postcards to reduce repetition of hospital treated deliberate self poisoning. BMJ 2005;331(7520):805.
13. Knox KL, Litts DA, Talcott GW, Feig JC, Caine ED. Risk of suicide and related adverse outcomes after exposure to a suicide prevention programme in the U.S. Air Force: cohort study. BMJ 2003;327:1376–8.
14. Szanto K, Kalmar S, Hendin H, Rihmer Z, Mann JJ. A suicide prevention program in a region with a very high suicide rate. Arch Gen Psychiatry 2007;64(8):914–20.
15. Katz LY, Elias B, O'Neil J, et al. Aboriginal suicidal behaviour research: from risk factors to culturally-sensitive interventions. J Can Acad Child Adolesc Psychiatry 2006;15(4):159–67.
16. Streiner DL. The 2 "Es" of research: efficacy and effectiveness trials. Can J Psychiatry 2002;47(6):552–6.
17. Kessler RC, Berglund P, Borges G, Nock M, Wang PS. Trends in suicide ideation, plans, gestures, and attempts in the U.S., 1990–1992 to 2001–2003. JAMA 2005;293(20):2487–95.
18. Benjamin EJ, Levy D, Vaziri SM, D'Agostino RB, Belanger AJ, Wolf PA. Independent risk factors for atrial fibrillation in a population-based cohort: the Framingham Heart Study. JAMA 1994;271(11):840–4.
19. Wang PS, Schneeweiss S, Avorn J, et al. Risk of death in elderly users of conventional vs. atypical antipsychotic medications. N Engl J Med 2005;353(22):2335–41.
20. Patorno E, Bohn RL, Wahl PM, et al. Anticonvulsant medications and the risk of suicide, attempted suicide, or violent death. JAMA 2010;303(14):1401–9.
21. Streiner DL, Norman GR. The pros and cons of propensity scores. Chest 2012;142(6):1380–2.
22. Stephansson O, Kieler H, Haglund B, et al. Selective serotonin reuptake inhibitors during pregnancy and risk of stillbirth and infant mortality. JAMA 2013;309(1):48–54.
23. Sareen J. Anxiety disorders and risk for suicide: why such controversy? Depress Anxiety 2011;28(11):941–5.
24. Sareen J, Cox BJ, Afifi TO, et al. Anxiety disorders and risk for suicidal ideation and suicide attempts: a population-based longitudinal study of adults. Arch Gen Psychiatry 2005;62:1249–57.
25. Bolton JM, Au W, Leslie WD, et al. Parents bereaved by offspring suicide: a population-based longitudinal case-control study. JAMA Psychiatry 2013;70(2):158–67.
26. Olfson M, Marcus SC, Bridge JA. Emergency treatment of deliberate self-harm. Arch Gen Psychiatry 2012;69(1):80–8.

27. Pauls DL. The genetics of obsessive compulsive disorder: a review of the evidence. Am J Med Genet C Semin Med Genet 2008;148C(2):133–9.
28. Weissman MM, Brown AS, Talati A. Translational epidemiology in psychiatry: linking population to clinical and basic sciences. Arch Gen Psychiatry 2011;68(6):600–8.
29. Nock MK, Stein MB, Heeringa SG, et al. Prevalence and correlates of suicidal behavior among soldiers: results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). JAMA Psychiatry 2014;71(5):514–22.
30. While D, Bickley H, Roscoe A, et al. Implementation of mental health service recommendations in England and Wales and suicide rates, 1997–2006: a cross-sectional and before-and-after observational study. Lancet 2012;379(9820):1005–12.
31. Sommers BD, Baicker K, Epstein AM. Mortality and access to care among adults after state Medicaid expansions. N Engl J Med 2012;367(11):1025–34.
32. Fleegler EW, Lee LK, Monuteaux MC, Hemenway D, Mannix R. Firearm legislation and firearm-related fatalities in the U.S. JAMA Intern Med 2013;173(9):732–40.
33. Goering PN, Streiner DL, Adair C, et al. The At Home/Chez Soi trial protocol: a pragmatic, multi-site, randomised controlled trial of a Housing First intervention for homeless individuals with mental illness in five Canadian cities. BMJ Open 2011;1(2):e000323.
34. Isaac M, Elias B, Katz LY, et al. Gatekeeper training as a preventative intervention for suicide: a systematic review. Can J Psychiatry 2009;54(4):260–8.

Reducing a Suicidal Person's Access to Lethal Means of Suicide

A Research Agenda

Catherine W. Barber, MPA, Matthew J. Miller, MD, ScD

Reducing the availability of highly lethal and commonly used suicide methods has been associated with declines in suicide rates of as much as 30%–50% in other countries. The theory and evidence underlying means restriction is outlined. Most evidence of its efficacy comes from population-level interventions and natural experiments. In the U.S., where 51% of suicides are completed with firearms and household firearm ownership is common and likely to remain so, reducing a suicidal person's access to firearms will usually be accomplished not by fiat or other legislative initiative but rather by appealing to individual decision, for example, by counseling at-risk people and their families to temporarily store household firearms away from home or otherwise making household firearms inaccessible to the at-risk person until they have recovered. Providers, gatekeepers, and gun owner groups are important partners in this work. Research is needed in a number of areas: communications research to identify effective messages and messengers for "lethal means counseling," clinical trials to identify effective interventions, translational research to ensure broad uptake of these interventions across clinical and community settings, and foundational research to better understand method choice and substitution. Approaches to suicide methods other than firearms are discussed. Means restriction is one of the few empirically based strategies to substantially reduce the number of suicide deaths.

(Am J Prev Med 2014;47(3S2):S264–S272)

Introduction

The National Action Alliance for Suicide Prevention established the Research Prioritization Task Force in 2010 to identify interventions capable of reducing the suicide rate by 20% over a 5-year period. Twelve goals emerged. We discuss the 12th: "reduce access to lethal means that people use to attempt suicide" (briefly, means restriction or means reduction).

A suicidal person's access to highly lethal means, or methods, of suicide can be reduced through (1) physically impeding access (e.g., using gun locks and bridge barriers); (2) reducing the lethality or toxicity of a given method (e.g., reducing carbon monoxide [CO] content of motor vehicle exhaust); or (3) reducing "cognitive access,"[1] that is, reducing a particular method's appeal or cognitive salience (e.g., discouraging media coverage of an emerging suicide method). We focus here largely on the first two approaches.

From the Harvard Injury Control Research Center, Harvard School of Public Health, Boston, Massachusetts

Address correspondence to: Catherine W. Barber, MPA, Harvard School of Public Health, 677 Huntington Avenue, 3rd floor, Boston MA 02115. E-mail: cbarber@hsph.harvard.edu.

0749-3797/$36.00

http://dx.doi.org/10.1016/j.amepre.2014.05.028

Reducing access to lethal means saves lives when people who cannot readily obtain a highly lethal method either attempt with a method less likely to prove fatal or do not attempt at all (Figure 1). The rationale rests on four well-established observations. First, many suicidal crises are short-lived. A survey of people who had seriously considered suicide in the past year found that for about 30%, the suicidal period lasted under an hour.[2] Surveys of attempters have found that the interval between deciding on suicide and actually attempting was 10 minutes or less for 24%–74% of attempters (with the lower end of the range reported by a study of those nearly dying in their attempt).[3–5]

Second, the method people use in suicidal acts depends, to a non-trivial extent, on its ready availability.[6,7] Third, the proportion of attempts that result in death (case fatality ratio) varies dramatically across methods, ranging from a high of 85%–90% for firearms to a low of 1%–2% for the methods most commonly used in attempts—medication overdoses and sharp instrument wounds.[8] The lethality of the method readily available during a suicidal crisis therefore plays an important role in whether the person survives an attempt; intent matters, but means also matter.

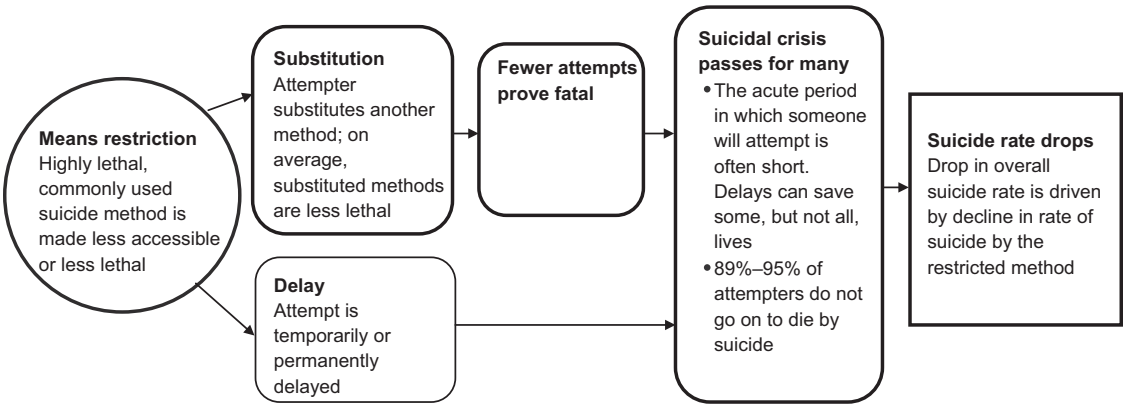

Figure 1. Conceptual model of how reducing access to a highly lethal and commonly used suicide method saves lives at the population level

Note: When the restriction is effectuated by making a highly lethal method less lethal at the population level (e.g., reducing carbon monoxide content of motor vehicle exhaust), the substitution is passive. That is, people attempting suicide with the method are unaware that, in effect, a less lethal method has been substituted for a more lethal method.

Fourth, approximately 90% of attempters who survive a nonfatal attempt will not go on to die by suicide thereafter,[9] a finding that holds true even in studies focusing only on medically serious attempts, such as jumping in front of a train.[10] Therefore, helping people survive periods of acute suicidal risk by reducing their access to highly lethal methods is likely to help many people survive in both the short and long term.

Reducing access to lethal means saves lives if the methods available for substitution, on balance, are less likely to prove lethal. Firearms account for more than half of suicides in the U.S. and have the highest case fatality ratio. A number of factors are theorized to influence the lethality of a given method. The first is inherent deadliness. For example, car exhaust with a high CO level will be more deadly than car exhaust with a low CO level. The second is ease of use. A method that requires technical knowledge is less accessible than one that does not.

The third is accessibility. Given the brief duration of some suicidal crises, a lethal dose of pills in the nightstand poses a greater danger than a prescription that must be hoarded over months to accumulate a lethal dose. Similarly, a gun in the closet poses a greater risk than a very high bridge 5 miles away, even if both methods have equal lethality if used. The fourth is ability to abort mid-attempt. More people start an attempt and abort it than carry it through[2]; therefore, methods that can be interrupted without harm mid-attempt—such as overdose, cutting, CO poisoning, and hanging/suffocation—offer a window of opportunity for rescue or change of heart that guns and jumps do not. The fifth factor is acceptability to the attempter. Although fire, for example, is universally accessible, it is rarely used in the U.S. for suicide.

At the population level, no measurable impact of means restriction on overall suicide rates is likely to be observed (even if, on balance, lives are saved) if the restricted method constitutes a very small proportion of all suicides or if the restricted method is of low lethality. If all sharp instruments magically disappeared, for example, in spite of their frequent use in suicide attempts there would be little measurable impact on suicide deaths, given their low case fatality ratio (sharps constitute only 2% of suicide deaths). Importantly, a possible, though unsubstantiated, unintended impact of reducing access to popular low-lethality methods may be an increase in suicide risk if attempters substitute more lethal methods.

Research Evidence on Means Restriction

Population-Level Natural Experiments

Before 1960, the leading suicide method in the United Kingdom was inhalation of domestic gas. Following discovery of a cheaper, nontoxic source of natural gas in the North Sea, gas suicides fell to nearly zero. Suicides by other methods increased somewhat, but, importantly, the net result was a drop of approximately 30% in the overall suicide rate.[11,12] These findings held in other countries where domestic gas was a leading method,[13,14] but not in those where gas accounted for a small proportion of total suicides.[15–17]

Natural experiments involving decreased toxicity of motor vehicle exhaust and reduced accessibility of barbiturates, firearms, and analgesics (as well as some population-level interventions described below) also illustrate that method-specific suicide rates drop when a method becomes less available or less lethal; however, whether the overall suicide rate drops is equivocal when the method is not commonly used or is of low lethality.[1,18–24]

Population-Level Interventions

Pesticides are the leading suicide method in Sri Lanka. In the 1990s, the Sri Lankan government placed restrictions on sales of the most highly human-toxic agents, following which overall suicide rates dropped by 50%.[25] Nearly 20,000 fewer suicides occurred in the 10 years following restrictions compared with the 10 previous years. The decline in suicide was driven by a decline in poisoning suicides; non-poisoning suicides did not decline, nor did nonfatal poisonings. The underlying behavior (swallowing pesticides in a suicide attempt) did not appear to change, but thousands of lives were saved because the lethality of the behavior diminished.

Pesticide poisoning was a highly lethal, common method of suicide prior to the policy changes. Its lethality dropped following changes; therefore, the overall suicide rate in Sri Lanka dropped driven exclusively by a drop in the pesticide suicide rate. A similarly dramatic drop in suicides was observed in Western Samoa when the pesticide paraquat became less available.[26]

Most studies in the United Kingdom on the impact that limiting access to the pain relievers co-proxamol (via market withdrawal)[27] and paracetamol (via pack size limits)[28] had on poisoning suicides found a significant decline in poisoning deaths by these agents without compensatory increase in other lethal poisonings. Given the small proportion of suicides overall that the two medications comprised, these studies did not look at impact on overall suicide deaths. However, Bateman's review concluded that pack size restrictions did not reduce paracetamol deaths.[29]

Jumping from a very great height is a highly lethal but uncommonly employed method in the U.S. Barriers have been installed at some popular jump sites, such as tall bridges. Most[30,31] (but importantly not all[32]) studies of the impact of these barriers have found that fewer suicides occurred at the protected site without evidence of a compensatory increase in jumping suicides from other sites. Most have not assessed impact on rates overall, given the small proportion that jumps typically constitute of suicides overall.

An intervention that found a net effect on overall suicide rates, albeit in a small population (i.e., 28 suicides annually on average pre-intervention), involved the Israeli Defense Force.[33] Soldier suicides occurred disproportionately on weekends and 90% involved firearms. A 2006 policy aimed at preventing suicide required soldiers to leave their weapons on base during weekend leave. The suicide rate decreased by 40%; weekend firearm suicides dropped significantly, with no significant change in weekday suicides, and no change in non-firearm suicides.

Firearms and Suicide in the U.S.

In the U.S., more suicides are completed with a firearm than by all other methods combined. About one in three homes contain firearms and 51% of all suicides involve firearms.[34] Miller et al.[34] have provided a review of U.S. firearm suicides. All U.S. case-control studies that have examined the issue[35–39] have found that the risk of suicide is two- to five-fold higher in gun-owning homes for all household members, with relative risk being especially high for youth and people without known psychopathology. The higher suicide risk is driven by a higher risk of firearm suicide, with no difference in non-gun suicides. Most studies, but not all, find that among gun households, suicide risk is lower when firearms are stored unloaded, locked, and separate from ammunition.[40]

A cohort study found that handgun purchasers in California were more than twice as likely to die by suicide as were their age/sex-matched peers throughout the 6-year study period, with the increase in risk attributable to an excess risk of firearm suicide.[41] Several ecologic studies in the U.S. bolster findings from the individual-level studies.[42] Time-series[43] and cross-sectional studies that have measured firearm prevalence in relation to suicide risk have consistently found a strong association between household firearm ownership rates and rates of overall and firearm suicide (and no significant association between household firearm prevalence and non-firearm suicide).

These findings do not appear to be accounted for by differences in underlying suicide risk among persons living in homes with guns. People living in homes with (versus without) guns, for example, are no more likely to screen positive for psychopathology or suicidal ideation, or to report having attempted suicide.[44–47] Importantly, the heightened risk of suicide associated with the presence of a household firearm applies not only to the gun owner but to all household members.[38,48] In aggregate, the literature on the firearm–suicide connection indicates that access to firearms does not serve as a proxy for an unmeasured third variable that drives suicide risk, but rather increases suicide risk by making it more likely that suicidal acts will involve guns and therefore, on average, prove fatal.

Applying the Lessons of Means Restriction to the U.S.

Suicide rates can be substantially reduced—without necessarily changing underlying mental illness or suicidal behavior—by making it more difficult to die in an act of

deliberate self-harm. Despite evidence across studies (including targeted interventions, natural experiments, case control, cohort, and ecologic studies) of its potential to save lives, means restriction historically has not been prioritized in the U.S.

One reason may be the misperception that reducing access requires embracing gun control, a politically polarizing issue. It need not. There are a variety of non-legislative approaches that respectfully engage the gun-owning community as partners in suicide prevention. Prime among them is "lethal means counseling"—advising people at risk for suicide, and their friends and family, to keep firearms away from the at-risk person until the person recovers. Below, we highlight suicide methods that may be useful targets for means restriction.

Firearms have several characteristics that make them particularly suitable targets: They are the leading suicide method in the U.S. (approximately 19,000 deaths a year)[49]; they are the most lethal[50] (substituted methods will be less likely to kill); they are both accessible and cognitively acceptable in U.S. culture; and an attempt with a gun once initiated cannot be reversed (unlike attempts with nearly every other method except jumping). If under an ideal scenario means restriction counseling reached all relevant households (households in which there is a gun and a suicidal person), and if counseling had modest results (one quarter of the households effectively kept the guns from the suicidal person), based on findings from case-control and ecologic studies, an estimated 3,600–3,900 lives would be saved in 1 year.[51] This approach is especially promising for youth, whose firearm suicides typically involve a family member's gun.[52]

Medication overdoses are by far the leading method of suicide attempt, with hundreds of thousands occurring each year.[53] Although the overall case fatality ratio for medications is below 2%, some medications are markedly more lethal than others, and overdoses account for more than 5,000 deaths annually in the U.S.[49] Interventions that reduce the medication load available to at-risk persons to a level that, even when taken all at once, will not pose a severe danger, may prevent deaths and reduce the severity of attempts. Because some of the more-lethal medications also are addictive (e.g., opioids and benzodiazepines), other advantages may accrue from reducing access.

The drop in deaths associated with motor vehicle exhaust suicides following wider use of catalytic converters suggests that more savings could be realized with further engineering changes.[21] Barriers at popular jumping sites, such as the Golden Gate Bridge—particularly when no sites nearby offer comparable acceptability and lethality—will likely save lives. At 700–800 jumping suicides annually in the U.S.,[49] and about the same number from motor vehicle exhaust, these approaches may save lives but their impact on overall suicide rates may not be apparent given their small numbers.[54] Examples of interventions and the mechanisms by which they could save lives are illustrated in Table 1.

Hanging/suffocation is the second-leading mechanism of suicide death in the U.S. and its use has increased in recent years.[49] This method is not amenable to physical means restriction techniques, except in controlled settings like prisons and hospitals. Because it still ranks relatively low among ideators as a planned method,[2] means restriction theory suggests that "cognitive access" might be reduced if efforts are made to avoid publicizing this method in traditional and social media. Similarly, care should be taken not to inadvertently increase acceptability of emerging suicide methods (such as highly lethal poisons or drug combinations) by publicizing them in traditional and social media.

Research Needs

The body of evidence on means reduction comes from studies examining changes in exposure to suicide methods resulting from natural experiments and interventions at the population level. Individual-level interventions are far more complex. They require identifying at-risk groups, learning the right messages to deliver, finding the right messengers to deliver them, and learning how to change behavior—not insignificant challenges. They also require changing practice among providers, healthcare/social service systems, families, and community organizations.

A small body of literature on parents of youth with psychiatric problems suggests that families who were counseled to reduce access to firearms and medications at home were more likely to do so than those not receiving such counseling.[55,58,59] This is encouraging, but more intervention research is needed in three broad categories: (1) communications research to identify and test the messages; (2) intervention evaluations to rigorously test the impact of selected interventions; and (3) translation and dissemination work to extend and adapt effective interventions to a variety of populations and settings. In addition, continued foundational research is needed to understand the dynamics governing method choice and planning and to develop a stronger surveillance infrastructure.

Communications Research

Communications research with at-risk individuals and their families and friends. Communications research should examine the attitudes and knowledge that at-risk

Table 1. Operational logic model: examples of means restriction interventions

Inputs	Outputs	Outcomes (at population level)		
		Short	Medium	Long
Train providers and gatekeepers on lethal means counseling[55,56]	Providers and gatekeepers counsel at-risk individuals and their families to make household guns inaccessible to at-risk person	Families take action (e.g., store guns with a friend or at a gun club)	At-risk individualsattempt with less lethal method or crisis passes before alternate attempt is made	Fewer suicides overall, driven by fewer firearm suicides
Train providers and gatekeepers on lethal means counseling	Physicians monitor prescriptions of at-risk individuals to keep total supply below toxic dose, advise families to dispose of unused medications, and substitute less toxic for more toxic medications when possible	Fewer pills on hand at home	Low-planned attempts occur with fewer pills	Lower severity of overdoses
Educate insurance companies on dangers of mandatory 90-day prescription policies	Amend 90-day prescription policies to allow opt-out for at-risk patients	At-risk patients continue receiving smaller quantities at each refill	Low-planned attempts occur with fewer pills	Lower severity of overdoses
Collaborate with gun-owning groups on suicide prevention and means restriction	Gun owner groups incorporate message in firearm safety training classes, brochures, and websites (sample message: Store all guns locked and unloaded; consider temporarily storing firearms offsite if a household member is at risk of suicide)	Families take action	At-risk individuals attempt with less lethal method or delay attempt; for many, crisis passes	Fewer suicides overall, driven by fewer firearm suicides
Induce motor vehicle manufacturers to make engineering changes	Reduce toxicity of motor vehicle exhaust; install carbon monoxide–sensing gadgets that shut off idling engines when highly toxic levels accumulate	Attempts with motor vehicle exhaust less likely to prove fatal	For many thwarted attempters, crisis passes	Fewer carbon monoxide suicides
Induce civil engineers to make engineering changes	Bridge barriers erected at targeted jump sites	Barriers prevent attempts by jumping	Most methods substituted for jumping are less lethal	Fewer jumping suicides
Educate hospital administrators about environmental changes to reduce inpatient suicides	Hospitals install collapsible curtain and shower rails and reduce other points of ligature in psychiatric wards[57]	Changes prevent attempts by hanging	Most other methods are unavailable in inpatient rooms	Fewer inpatient suicides overall, driven by fewer hanging suicides

individuals and their families hold regarding means restriction and evaluate the acceptability of various strategies, particularly regarding firearms, the method for which reduced access is likely to save the greatest number of lives.[60] Examples of useful research questions to pursue via focus groups, surveys, and other methodologies include the following:

1. Which specific messages and messengers on safe firearm storage are persuasive to people at risk of suicide and their families, and does the acceptability of the messages vary by reasons for gun ownership (e.g., self-defense, hunting, sport) and by other socioeconomic factors (e.g., political views, education level)?
2. Do mistaken assumptions about suicide (e.g., once suicidal, a person remains so; most attempts are well planned long in advance; one method is about as likely to kill as another) pose a barrier to means restriction? Does education on these issues increase families' safe storage behavior?
3. With whom, if anyone, are at-risk persons likely to feel most comfortable temporarily storing their firearms (e.g., a relative, Army buddy, storage facility, or police department)?
4. For whom is secure in-home locking (with another person holding the key) a more acceptable solution to off-site storage?
5. How should firearm safety messages be tailored when the suicidal person is a minor versus an adult, the gun

owner versus non-owning member of a gun household, a crisis line caller versus inpatient, or a person at acute versus chronic risk?

6. Regarding medication safety, is the protective effect of limiting a patient with an active overdose history to shorter prescription refills (e.g., weekly rather than monthly refills) outweighed by the deleterious consequences of poorer medication compliance? Would a lockable, electronic pill-dispensing machine prove more viable?

Communications research with providers and gatekeepers. A number of studies have indicated that behavioral health and medical providers do not routinely conduct lethal means counseling with at-risk groups.[61,62] Research aimed at remedying this should (1) identify attitudinal and informational barriers that impede and facilitate routine use of lethal means counseling by providers; and (2) evaluate training programs in lethal means counseling to identify the most effective approaches.

Messaging on firearms safety should be developed in partnership with a broad spectrum of invested parties including, importantly, gun owners, to ensure that messaging is relevant and helpful. Because many suicidal people do not explicitly seek help for their suicidal feelings, non-healthcare–related venues where suicidal people intersect with the system should be identified. The suicide risk of a person who has just been arrested on his third drunk driving charge may be as high as a patient who has been hospitalized for depression. Therefore, defense attorneys and others who see people in trouble (e.g., clergy, batterers' counselors, social service personnel, probation/parole officers, marriage counselors, divorce attorneys) may be useful "gatekeepers" to refer people at risk and convey firearm safety messages.

Communications research with gun owner groups. Gun owner groups such as gun shops, shooting and hunting clubs, firearm rights groups, gun magazines, and firearm training classes offer an environment in which to deliver a basic rule of firearm safety: Be alert to signs of suicide in household members and keep guns from them until they recover.[63] Gun owner groups typically have a strong safety culture focused on preventing the 600 unintentional firearm deaths that occur annually in the U.S.; expanding that focus to prevent the 19,000 firearm suicides is a natural next step.[49]

Communications research with these groups could (1) identify facilitators and barriers to gun owner organizations embracing the role of reducing the misuse of firearms in suicide; (2) collaborate with gun owner groups to develop communications tools such as brochures, posters, training modules, and sample newsletter blurbs; and (3) test "uptake" of these communications tools (the extent to which groups use the tools when provided).

The ultimate goal of communications research is to develop an interdisciplinary approach that will make reducing a suicidal person's ready access to firearms as "normative" in 10 years as the "friends don't let friends drive drunk" message[64] is today. In addition to messaging research outlined above, research is needed to clarify whether broad-scale media campaigns that raise awareness about suicide and warn families to keep guns from those at risk exert a protective, neutral, or harmful effect (the latter by normalizing suicide).[65]

Intervention Outcomes Research

Controlled clinical trials. As effective messages are developed, rigorous studies are needed to test the impact of lethal means counseling. Although these necessarily will be on a small scale as protocols are tested,[55] ideally, they will be tested in populations large enough (e.g., Veterans Affairs, military, large healthcare network) to detect changes in suicide outcomes. In smaller populations, impact on individuals' self-reported storage of guns and medications should be tested as interim outcome measures. Because these studies are conducted with suicidal individuals, researchers must attend carefully to human subjects considerations to protect study subjects.

Other outcomes research. At the same time, evaluations aimed at other approaches should be undertaken, including (1) technical interventions (e.g., locked electronic pill dispensers, algorithms to flag potentially dangerous prescribing in electronic medical records, personalized firearms that can only be fired by the gun owner); (2) policy interventions (e.g., amend insurance companies' mandatory 90-day prescription policies to exempt patients at risk of overdose); and (3) outreach interventions (e.g., incorporate suicide awareness/means restriction messages in firearm safety materials).

Translation/Dissemination Research

The next step after effective methods of lethal means counseling (and other interventions) are identified, is institutionalizing these practices in standard clinical care among medical and behavioral health providers, and among non-traditional groups like firearm safety instructors and defense attorneys. Translation research will help identify the most effective strategies to promote implementation of effective interventions. As lethal means

counseling becomes more widespread, it will be necessary to find safe storage and disposal options for firearms and toxic medications.

Foundational Research

In concert with developing, testing, and disseminating interventions, we must deepen our understanding of the factors that govern method choice and deliberation in suicidal behavior, and incorporate what is learned, iteratively, into ongoing interventions. Unanswered questions include the following:

1. When a suicidal person's access to a lethal method is blocked, what determines whether he or she substitutes a more lethal versus less lethal method, or abandons an attempt entirely?
2. Under what conditions might blocking access to a low-lethality method (e.g., locking the medicine cabinet) have an unintended harmful effect of leading attempters to substitute more lethal methods?
3. What role do online and personal social networks play in method choice and technical knowledge?
4. Have method-specific case fatality ratios changed over time as the capacity for greater technical knowledge of methods increases and medical interventions change?
5. Have prescribing practices affected the severity of attempts?
6. How do gun storage practices affect suicide risk to the gun owner and household members by age and sex?
7. Among youth who die by firearm suicide, does the source of the firearm (e.g., parent's gun, youth's gun acquired illegally) vary across racial/ethnic/socioeconomic groups?

Foundational research relies upon the existence of accessible, current, and valid data. The National Violent Death Reporting System provides detailed information on suicide deaths and should be expanded from its current 18 states to all 50.[66] The Behavioral Risk Factor Surveillance System has supplied valuable information on state- and national-level gun ownership rates and storage practices; however, its gun items have not been asked since 2004 and should be repeated every 2–3 years.[67] Linked hospital, pharmacy, and death certificate data will enable researchers to examine the impact of prescribing and method switching.

Changing the Paradigm

Currently, the suicide prevention field focuses on identifying people at risk and getting them into treatment. A challenge facing the field is to shift the paradigm such that researchers, practitioners, patients, and the broader population understand that reducing a suicidal person's access to lethal means also has important life-saving potential. A first step is educating researchers and practitioners during training and continuing education about the evidence base.

Reducing the availability of highly lethal and commonly used suicide methods has been associated with declines in suicide rates of as much as 30%–50% in other countries. Research on how to apply these lessons to the U.S.—including communications research to identify effective messages and messengers, clinical trials and other intervention research to identify effective interventions, and translational research to ensure broad uptake of these interventions—has the potential to substantially reduce the number of suicide deaths.

Publication of this article was supported by the Centers for Disease Control and Prevention, the National Institutes of Health Office of Behavioral and Social Sciences, and the National Institutes of Health Office of Disease Prevention. This support was provided as part of the National Institute of Mental Health-staffed Research Prioritization Task Force of the National Action Alliance for Suicide Prevention.

This work was funded with support from the Joyce Foundation and Bohnett Foundation.

No financial disclosures were reported by the authors of this paper.

References

1. Florentine JB, Crane C. Suicide prevention by limiting access to methods: a review of theory and practice. Soc Sci Med 2010;70(10):1626–32.
2. Drum D, Brownson C, Denmark A, Smith S. New data on the nature of suicidal crises in college students: shifting the paradigm. Prof Psychol Res Pract 2009;40(3):213–22.
3. Williams CL, Davidson JA, Montgomery I. Impulsive suicidal behavior. J Clin Psychol 1980;36(1):90–4.
4. Simon OR, Swann AC, Powell KE, Potter LB, Kresnow MJ, O'Carroll PW. Characteristics of impulsive suicide attempts and attempters. Suicide Life Threat Behav 2001;32(1S):S49–S59.
5. Deisenhammer EA, Ing CM, Strauss R, Kemmler G, Hinterhuber H, Weiss EM. The duration of the suicidal process: how much time is left for intervention between consideration and accomplishment of a suicide attempt? J Clin Psychiatry 2009;70(1):19–24.
6. Eddleston M, Karunaratne A, Weerakoon M, et al. Choice of poison for intentional self-poisoning in rural Sri Lanka. Clin Toxicol (Phila) 2006;44(3):283–6.
7. Skopek MA, Perkins R. Deliberate exposure to motor vehicle exhaust gas: the psychosocial profile of attempted suicide. Aust N Z J Psychiatry 1998;32(6):830–8.
8. Spicer RS, Miller TR. Suicide acts in 8 states: incidence and case fatality rates by demographics and method. Am J Public Health 2000;90(12):1885–91.
9. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. Br J Psychiatry 2002;181:193–9.
10. O'Donnell I, Arthur AJ, Farmer RD. A follow-up study of attempted railway suicides. Soc Sci Med 1994;38(3):437–42.

11. Kreitman N. The coal gas story. United Kingdom suicide rates, 1960–1971. Br J Prev Soc Med 1976;30(2):86–93.
12. Gunnell D, Middleton N, Frankel S. Method availability and the prevention of suicide—a re-analysis of secular trends in England and Wales 1950–1975. Soc Psychiatry Psychiatr Epidemiol 2000;35(10):437–43.
13. Curran PS, Lester D. Trends in the methods used for suicide in Northern Ireland. Ulster Med J 1991;60(1):58–62.
14. Lester D. The effect of the detoxification of domestic gas in Switzerland on the suicide rate. Acta Psychiatr Scand 1990;82(5):383–4.
15. Lester D. The effects of detoxification of domestic gas on suicide in the U.S. Am J Public Health 1990;80(1):80–1.
16. Lester D, Abe K. The effect of restricting access to lethal methods for suicide: a study of suicide by domestic gas in Japan. Acta Psychiatr Scand 1989;80(2):180–2.
17. Lester D. Effects of detoxification of domestic gas on suicide in The Netherlands. Psychol Rep 1991;68(1):202.
18. Hawton K. Restricting access to methods of suicide. Crisis 2007;28(1S):S4–S9.
19. Nordentoft M, Qin P, Helweg-Larsen K, Juel K. Restrictions in means for suicide: an effective tool in preventing suicide: the Danish experience. Suicide Life Threat Behav 2007;37(6):688–97.
20. Daigle MS. Suicide prevention through means restriction: assessing the risk of substitution. A critical review and synthesis. Accid Anal Prev 2005;37(4):625–32.
21. Studdert DM, Gurrin LC, Jatkar U, Pirkis J. Relationship between vehicle emissions laws and incidence of suicide by motor vehicle exhaust gas in Australia, 2001–2006: an ecological analysis. PLoS Med 2010;7(1):e1000210.
22. Yip PS, Caine E, Yousuf S, Chang SS, Wu KC, Chen YY. Means restriction for suicide prevention. Lancet 2012;379(9834):2393–9.
23. Amos T, Appleby L, Kiernan K. Changes in rates of suicide by car exhaust asphyxiation in England and Wales. Psychol Med 2001;31(5):935–9.
24. Reisch T, Steffen T, Habenstein A, Tschacher W. Change in suicide rates in Switzerland before and after firearm restriction resulting from the 2003 "Army XXI" reform. Am J Psychiatry 2013;170(9):977–84.
25. Gunnell D, Fernando R, Hewagama M, Priyangika WD, Konradsen F, Eddleston M. The impact of pesticide regulations on suicide in Sri Lanka. Int J Epidemiol 2007;36(6):1235–42.
26. Bowles JR. Suicide in Western Samoa: an example of a suicide prevention program in a developing country. In: Diekstra RFW, ed. Preventive strategies on suicide. Leiden: E.J. Brill, 1995.
27. Hawton K, Bergen H, Simkin S, Wells C, Kapur N, Gunnell D. Six-year follow-up of impact of co-proxamol withdrawal in England and Wales on prescribing and deaths: time-series study. PLoS Med 2012;9(5):e1001213.
28. Hawton K, Bergen H, Simkin S, et al. Long term effect of reduced pack sizes of paracetamol on poisoning deaths and liver transplant activity in England and Wales: interrupted time series analyses. BMJ 2013;346:f403.
29. Bateman DN. Limiting paracetamol pack size: has it worked in the UK? Clin Toxicol (Phila) 2009;47(6):536–41.
30. Pirkis J, Spittal MJ, Cox G, Robinson J, Cheung YT, Studdert D. The effectiveness of structural interventions at suicide hotspots: a meta-analysis. Int J Epidemiol 2013;42(2):541–8.
31. Gunnell D, Miller M. Strategies to prevent suicide. BMJ 2008;341:c3054.
32. Sinyor M, Levitt AJ. Effect of a barrier at Bloor Street Viaduct on suicide rates in Toronto: natural experiment. BMJ 2010;341:c2884.
33. Lubin G, Werbeloff N, Halperin D, Shmushkevitch M, Weiser M, Knobler HY. Decrease in suicide rates after a change of policy reducing access to firearms in adolescents: a naturalistic epidemiological study. Suicide Life Threat Behav 2010;40(5):421–4.
34. Miller M, Azrael D, Barber C. Suicide mortality in the U.S.: the importance of attending to method in understanding population-level disparities in the burden of suicide. Annu Rev Public Health 2012;33:393–408.
35. Brent DA. Firearms and suicide. Ann NY Acad Sci 2001;932:225–39; discussion 239–40.
36. Kung HC, Pearson JL, Liu X. Risk factors for male and female suicide decedents ages 15–64 in the U.S. Results from the 1993 National Mortality Followback Survey. Soc Psychiatry Psychiatr Epidemiol 2003;38(8):419–26.
37. Conwell Y, Duberstein PR, Connor K, Eberly S, Cox C, Caine ED. Access to firearms and risk for suicide in middle-aged and older adults. Am J Geriatr Psychiatry 2002;10(4):407–16.
38. Kellermann AL, Rivara FP, Somes G, et al. Suicide in the home in relation to gun ownership. N Engl J Med 1992;327(7):467–72.
39. Brent DA, Perper JA, Allman CJ, Moritz GM, Wartella ME, Zelenak JP. The presence and accessibility of firearms in the homes of adolescent suicides: a case-control study. JAMA 1991;266(21):2989–95.
40. Grossman DC, Mueller BA, Riedy C, et al. Gun storage practices and risk of youth suicide and unintentional firearm injuries. JAMA 2005;293(6):707–14.
41. Wintemute GJ, Parham CA, Beaumont JJ, Wright M, Drake C. Mortality among recent purchasers of handguns. N Engl J Med 1999;341(21):1583–9.
42. Miller M, Lippmann S, Azrael D, Hemenway D. Household firearm ownership and rates of suicide across the 50 U.S. J Trauma 2007;62(4):1029–34; discussion 1034–5.
43. Miller M, Azrael D, Hepburn L, Hemenway D, Lippmann SJ. The association between changes in household firearm ownership and rates of suicide in the U.S., 1981–2002. Inj Prev 2006;12(3):178–82.
44. Sorenson SB, Vittes KA. Mental health and firearms in community-based surveys: implications for suicide prevention. Eval Rev 2008;32(3):239–56.
45. Betz ME, Barber C, Miller M. Suicidal behavior and firearm access: results from the second injury control and risk survey. Suicide Life Threat Behav 2011;41(4):384–91.
46. Miller M, Barber C, Azrael D, Hemenway D, Molnar BE. Recent psychopathology, suicidal thoughts and suicide attempts in households with and without firearms: findings from the National Comorbidity Study Replication. Inj Prev 2009;15(3):183–7.
47. Ilgen MA, Zivin K, McCammon RJ, Valenstein M. Mental illness, previous suicidality, and access to guns in the U.S. Psychiatr Serv 2008;59(2):198–200.
48. Dahlberg LL, Ikeda RM, Kresnow MJ. Guns in the home and risk of a violent death in the home: findings from a national study. Am J Epidemiol 2004;160(10):929–36.
49. CDC. Compressed Mortality File 1999-2010 on CDC WONDER Online Database. Data are compiled from Compressed Mortality File 1999-2010 Series 20 No. 2P; http://wonder.cdc.gov/cmf-icd10.html. Accessed April 2013.
50. Vyrostek SB, Annest JL, Ryan GW. Surveillance for fatal and nonfatal injuries–U.S., 2001. MMWR Surveill Summ 2004;53(7):1–57.
51. Barber C, Miller M. Model for estimating reduction in U.S. suicide deaths following a reduction in suicidal adult persons' access to firearms. In: National Action Alliance for Suicide Prevention Research Prioritization Task Force, ed. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.
52. Johnson RM, Barber C, Azrael D, Clark DE, Hemenway D. Who are the owners of firearms used in adolescent suicides? Suicide Life Threat Behav 2011;40(6):609–11.
53. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUPnet). hcupnet.ahrq.gov/.
54. Barber C, Miller M. Model for estimating reduction in U.S. suicide deaths from carbon monoxide poisoning in vehicles. In: National Action Alliance for Suicide Prevention Research Prioritization Task Force, ed. A prioritized research agenda for suicide prevention: an action plan to save lives. Rockville MD: National Institute of Mental Health and Research Prioritization Task Force, 2014.

55. Kruesi MJ, Grossman J, Pennington JM, Woodward PJ, Duda D, Hirsch JG. Suicide and violence prevention: parent education in the emergency department. J Am Acad Child Adolesc Psychiatry 1999; 38(3):250–5.
56. Johnson RM, Frank EM, Ciocca M, Barber CW. Training mental healthcare providers to reduce at-risk patients' access to lethal means of suicide: evaluation of the CALM Project. Arch Suicide Res 2011;15 (3):259–64.
57. Gunnell D, Bennewith O, Hawton K, Simkin S, Kapur N. The epidemiology and prevention of suicide by hanging: a systematic review. Int J Epidemiol 2005;34(2):433–42.
58. Brent DA, Baugher M, Birmaher B, Kolko DJ, Bridge J. Compliance with recommendations to remove firearms in families participating in a clinical trial for adolescent depression. J Am Acad Child Adolesc Psychiatry 2000;39(10):1220–6.
59. McManus BL, Kruesi MJ, Dontes AE, Defazio CR, Piotrowski JT, Woodward PJ. Child and adolescent suicide attempts: an opportunity for emergency departments to provide injury prevention education. Am J Emerg Med 1997;15(4):357–60.
60. Walters H, Kulkarni M, Forman J, Roeder K, Travis J, Valenstein M. Feasibility and acceptability of interventions to delay gun access in VA mental health settings. Gen Hosp Psychiatry 2012;34(6):692–8.
61. Betz ME, Miller M, Barber C, et al. Lethal means restriction for suicide prevention: beliefs and behaviors of emergency department providers. Depress Anxiety 2013;30(10):1013–20.
62. Giggie MA, Olvera RL, Joshi MN. Screening for risk factors associated with violence in pediatric patients presenting to a psychiatric emergency department. J Psychiatr Pract 2007;13(4):246–52.
63. Vriniotis M, Barber C, Frank E, Demicco R, and the NH Firearm Safety Coalition. A suicide prevention campaign for firearm dealers in New Hampshire. Suicide and Life-Threatening Behavior 2014. In press.
64. Ad Council. Drunk Driving Prevention, 1983-Present. http://www.adcouncil.org/Our-Work/The-Classics/Drunk-Driving-Prevention. Accessed May 29, 2014.
65. Niederkrotenthaler T, Voracek M, Herberth A, et al. Role of media reports in completed and prevented suicide: Werther v. Papageno effects. Br J Psychiatry 2010;197(3):234–43.
66. Barber C, Azrael D, Hemenway D. A truly national National Violent Death Reporting System. Inj Prev 2013;19(4):225–6.
67. Okoro CA, Nelson DE, Mercy JA, Balluz LS, Crosby AE, Mokdad AH. Prevalence of household firearms and firearm-storage practices in the 50 states and the District of Columbia: findings from the Behavioral Risk Factor Surveillance System, 2002. Pediatrics 2005;116(3): e370–e376.

