

21 **Introduction**

22 “Suicide is painless, it brings on many changes, and I can take or leave it if I please.” This
23 chorus from the *M*A*S*H* theme song belies the reality of suicidal behavior. It’s not painless. It
24 exacts tolls on family, friends, community, and society, as well as the individual. Suicide is not a
25 simple matter of choice; it reflects a psychosocial cocktail that includes depression,
26 disillusionment, desperation, and despair as well as the influences of peers, families, and
27 communities. The changes caused by suicide are layered. There are financial costs for both
28 society and families as well as the profound emotional loss for those left behind. And, of course,
29 the changes at the individual level are the hard road to recovery or death.

30 More than 41,000 Americans die from suicide each year. It’s the tenth leading cause of death
31 in the United States and the second leading cause of death in youth (10 to 24 years of age) and
32 young adults (25 to 34 years of age), claiming the lives of 12,073 individuals in these age brackets
33 in 2014 (1). As pervasive as suicide is, it can be prevented. Risk factors (e.g., depression, mental
34 disorders, substance abuse, prior attempts, family history of suicide, family violence, exposure to
35 suicidal behavior, incarceration) and precipitating events (e.g., shame, loss, relationship
36 disruption) highlight the multiplicity of factors that contribute to suicidal behavior and reveal the
37 challenge of developing interventions to attack this enduring and growing public health concern.

38 Although daunting, the complexity of factors involved in suicide prevention are surmountable.
39 This complexity must be embraced to forge new research strategies. Many promising research
40 avenues are apparent, but they do not point toward a common focus. On March 29–30, 2016, the
41 National Institutes of Health convened a Pathways to Prevention Workshop on Advancing
42 Research to Prevent Youth Suicide. The overarching goal of the workshop was to optimize suicide
43 prevention efforts. The workshop encompassed a comprehensive evidence report by an Agency
44 for Healthcare Research and Quality Evidence-based Practice Center. After weighing evidence
45 from the evidence report, expert presentations, and public comments, an unbiased, independent
46 panel prepared a draft report that summarizes the workshop and identifies research gaps and

47 future research priorities, which are summarized in this report. This report provides a roadmap for
48 optimizing youth suicide prevention efforts by highlighting a number of directions for guiding the
49 next decade of research on youth suicide. These directions, which are summarized in Tables 1–
50 3, are organized around three larger issues: improving data systems, improving research design
51 and analysis, and strengthening the research and practice community.

52 **Improving Data Systems**

53 As noted in the evidence report, the availability of effective data systems for examining suicide
54 risk is limited. The authors conclude that only 6 of the 153 suicide prevention studies linked suicide
55 data from multiple sources, limiting researchers' capacity to study suicidal behaviors as outcomes.
56 The lack of data linkages impedes valid conclusions about suicidal behavior. Moreover, research
57 on youth suicide is typically underpowered, particularly when the multiple determinants,
58 mediators, and moderators are considered. Poor documentation of interventions (e.g., scarcity of
59 usable data dictionaries) compounds the problem of inadequate data systems. For example, the
60 U.S. Preventive Services Task Force concluded that there is insufficient evidence to assess the
61 balance of benefits and harms of screening for suicide risk in adolescents, adults, and older adults
62 in primary care. The lack of comprehensive, linked data resources makes it difficult to identify
63 those at risk of suicide.

64 A workshop speaker noted that the ability to understand the magnitude of the problem and
65 the factors influencing suicide and suicide attempts is hampered by not using cause-of-injury
66 codes in medical departments and on insurance claims. Not all states mandate the use of these
67 diagnostic codes. A complete picture of suicide and related factors would require federal
68 mandates for health care providers to use external cause-of-injury codes. Improved cause-of-
69 injury coding would enable researchers to conduct more accurate studies of suicide risk and
70 prevention.

71 Additional surveillance on suicides is clearly needed. The National Violent Death Reporting
72 System provides an example of a surveillance system that could yield insights into causes and
73 context of suicides by linking data from death certificates, law enforcement reports, crime
74 laboratories, and medical examiner reports. These data are not present in all states, and the
75 reporting only addresses deaths from suicide, not suicide attempts and related behaviors. Without
76 additional mandatory coding, it is not possible to differentiate if the death was a homicide, suicide,
77 or an accident. Implementing mandatory cause-of-death coding would enable public health

78 officials and researchers to capitalize on these data to identify means of suicide. This
79 recommendation is paramount as more than half of the reported suicides employ firearms as the
80 means, which supports our recommendation that a percentage of research, prevention, and
81 interventions focus on the means of suicide. Linking with existing surveillance and administrative
82 data also should be encouraged, but training is needed to help researchers identify and obtain
83 permission to use additional data sources found in school, municipal, state, and federal records
84 (e.g., making sure consent forms explicitly ask permission to link with other data sources).

85 Policies at the state and community levels also have a role in improving our ability to
86 understand suicide and suicide attempts. State all-payer claims databases could provide
87 communities with local data about suicide and suicide attempts. Under the Affordable Care Act,
88 accountable care organizations or health information exchanges could serve this same role in
89 providing local communities with population data. States have the opportunity to be innovative
90 with syndromic surveillance data, which could be used to identify patients in need of improved
91 care management, or used by communities to help target interventions.

92 A number of policy and practice issues are perhaps the most difficult of the problems to rectify
93 due to social stigma, governance, conflicting legal goals, silos of isolated research teams, and
94 unique data systems. For example, we will not have accurate reporting until we both recognize
95 the pervasive impact of stigmatization, and destigmatize suicide and mental health issues.
96 Reporting and tracking suicidal behavior and its precursors are hampered by disincentives
97 embedded in policies and practices from the federal to the local level. Families and medical
98 providers often are reluctant to label events as suicide or suicide attempts for a number of
99 reasons, including legal concerns, cultural issues, and community referral patterns.

100 **Table 1. Recommendations for Improving Data Systems**

1. Improve the ability to identify persons at risk for suicide events.	
	A. Implement standardized measures to identify those at high risk for suicide.
	B. Use external cause of injury codes so that suicides and suicide attempts that require medical attention can be identified.
2. Improve the ability to understand protective and risk factors of suicide.	
	A. Expand surveillance of suicide and suicide attempts by linking data from multiple sources (e.g., state all-payer databases, syndromic emergency room data, electronic health records data, health information exchanges, accountable care organizations, research data).
	B. Encourage and facilitate efforts to document implementation and measurement details (e.g., code books, data dictionaries).
	C. Use broad measurement strategies to capture all of the levels of influence (e.g., improve measurement of ecometrics and psychometrics).

101 **Improving Research Design and Analysis**

102 Researchers studying suicide underutilize advances in research design and analysis for
103 complex systems. Descriptions of several innovative and promising techniques follow.

104 **Levels of measurement.** An especially ripe area for improving data systems in the realm of
105 suicide prevention research pertains to measurement. Measuring risk and protective processes
106 at multiple levels—including the individual, family, peer group, school, and community—facilitates
107 investigating and understanding the complex set of factors central to suicide risk across diverse
108 populations. Beginning with the lowest measurement level, information on biomarkers and
109 biological processes is important for advancing the continuum of suicide research, from
110 surveillance to basic research to prevention studies.

111 Novel ways of integrating neurobiological measures into the science of suicide prevention
112 research are needed. One workshop speaker presented research that connects head injuries to
113 later risks for depression. It could be beneficial for school systems to collect electronic data on
114 student head injuries and link these to school and health records to enhance identification of youth
115 at increased risk for suicide. Biological measures may improve the effectiveness of evaluation
116 research. Evidence for the protective effects of mindfulness and meditation practices, mentioned
117 by suicide survivors at the workshop and supported by numerous studies, is strengthened by the
118 inclusion of measures of biological mechanisms, such as reduced cortisol. Incorporating biological
119 measures into studies of suicide risk and prevention will help identify potential treatment
120 approaches for ameliorating the adverse impacts that trauma and stress have on youth suicide
121 risk.

122 Psychological and developmental processes also play key roles in suicide risk and prevention.
123 Speakers noted the need for psychometric work addressing the measurement of (a) personal
124 characteristics such as sexual orientation and identity and (b) processes that have universal
125 prominence as well as culture- and context-specific importance across diverse populations.

126 Rather than adapting existing measures to new cultural contexts, direct development of
127 theoretically informed measures for a given cultural context is warranted.

128 For individuals identifying as sexual and gender minorities, measures of behaviors and
129 attitudes important to gender identity and sexual orientation can help to better identify these
130 correlates of suicide risk. Research indicates higher rates of suicide among transgendered youth
131 than among gay or lesbian youth. General methodological improvements in measurement, such
132 as using visual analog scales, computerized adaptive testing, and multiform questionnaire
133 protocols to collect planned missing data would increase the reliability and validity of the research
134 findings.

135 Perhaps the least extensively investigated domain of measurement concerns measuring the
136 settings and contexts beyond the individual and family levels. Ecometrics, the measurement of
137 environmental contexts, is essential to accommodate the multilevel analytic approaches needed
138 for this field of research. Innovation in this area includes direct assessment of constructs such as
139 climate and aggregate indicators that can come from linkable administrative data.

140 **Developmental and longitudinal change.** Despite the importance of dynamic change
141 processes in youth suicidal behavior, few studies have addressed how changes and reciprocal
142 influences among risk and protective factors influence youth's suicidal behaviors across multiple
143 time scales (short- and long-term changes). Our capacity to design interventions aimed at
144 preventing suicide depends on longitudinal research that can better capture the complex interplay
145 between imminent and long-term factors in predicting suicide ideation and attempts.

146 By incorporating a broader repertoire of predictors into a longitudinal context—whether in a
147 single study or through the use of linked studies (see below)—we are better positioned to
148 understand the mediating, moderating, and reciprocal mechanisms underlying suicidal behavior.
149 Studies will then be better able to optimize the timing and maximize the impact of suicide
150 prevention efforts. For example, children who question their gender identity may experience

151 rejection from parents, teachers, or peers; rejection, in turn, may increase a child's social isolation
152 and depressive symptoms that can further escalate rejecting behaviors.

153 Measurement and design strategies that facilitate the study of changes over time will help
154 inform the timing and targets for interventions that can interrupt the recursive cycle of negative
155 social interaction. Relatedly, a growing body of evidence points to the potentially powerful effects
156 of short-term predictors (e.g., insomnia, exposure to coping or self-regulation skills, peer support,
157 intervening efforts from teachers, real-time sharing for care management) on longer-term suicidal
158 prevention processes. Such cascading, multiple time scale effects offer a renewed way of
159 conceptualizing and testing mediation and moderation, often at much lower long-term costs. To
160 evaluate the long-term effects of intervention programs, we recommend that researchers collect
161 and integrate measurements from multiple time scales, including measures of likely mechanisms
162 of change. Integrating evidenced-based results with theory and methods will help ensure high-
163 quality and effective suicide prevention efforts.

164 All of these modeling efforts are enhanced by using latent variable approaches to test critical
165 assumptions, such as the psychometric equivalence of constructs across time and subgroups,
166 and to correct important estimates for various sources of measurement and sampling error.
167 Finally, at the level of groups and networks, powerful methods exist for modeling important effects
168 such as diffusion, contagion, selection, and socialization as well as propagation of risk or
169 protective factors and associated processes.

170 **Multilevel structure.** In addition to multiple time scales, compelling evidence exists for the
171 multilevel nature of factors and processes tied to youth risk of suicidal behavior. Research rarely
172 assesses and analyzes the interrelated and nested social processes and structures tied to suicide
173 risk, particularly at higher levels of influence such as school, neighborhood, and community.
174 Settings at a higher, more distal level (e.g., community), can have a cascade of effects on youth
175 suicide risk by shaping family and individual functioning. Studies of multilevel effects on suicide
176 risk suggest that interventions addressing factors at the community and family levels may impact

177 large numbers of individuals to a greater extent than typical individual-level interventions alone.
178 Multilevel analytic techniques help adjust for issues of known clustering (e.g., families nested in
179 communities) and thereby can capture the heterogeneity across multiple levels and cross-level
180 mediation or moderation effects. Several methodological challenges must be addressed to
181 estimate multilevel effects on youth suicide risk. As mentioned above, these challenges also
182 manifest in the measurement and design needs to represent adequately the different levels of a
183 multilevel structure.

184 **Known and unknown subgroups.** Subgroups and subpopulations contribute to the
185 heterogeneity of study cohorts. These subgroups can have differential effects and patterns of
186 change. Methods to model both known and unknown heterogeneity can identify and explicitly
187 model these differential effects. When such groups are known (e.g., groups defined by gender
188 identity and orientation), the group membership can be represented as fixed effects to control for
189 their influence. The groups also can be explicitly compared as multiple groups to examine various
190 influences, including moderation by group membership. When subgroups are not explicitly known,
191 the different at-risk subgroups and subpopulations that are often embedded in universal programs
192 can be estimated. Specifically, using mixture modeling allows identification of subgroups of
193 individuals for whom an intervention may have differential influences. Predictors and outcomes of
194 group membership can inform the differential impacts and outcomes of suicide prevention
195 research.

196 **Integrative and linked data across studies.** Another recommendation involves coordinating
197 efforts in the broader research community. Integrative data analysis uses a set of common
198 measures across two or more studies to link the data. These linked studies can be combined as
199 an integrated data set that allows greater overall power to identify hard-to-detect mediating and
200 moderating mechanisms, as well as greater representation of suicides, which are infrequent in
201 any given study or setting. Including common measures and linking items across projects,
202 coupled with principled treatment of the missing data, would expand the power and validity of the

203 larger research portfolio sponsored by funding agencies. The data archive of the National Institute
204 of Mental Health is an important sharing platform for integrative data analysis, but the linking
205 information must be coordinated and highlighted (<http://rdocdb.nimh.nih.gov>).

206 **Valid inference strategies.** Randomized controlled trials (RCTs) have long been regarded
207 as the “gold standard” through which valid inference can be accomplished. Although promising
208 under some conditions, many RCTs are characterized by strict exclusion criteria that limit their
209 generalizability. Recent methodological advances offer alternative methods to strengthen valid
210 interpretations from non-RCT data. Propensity score methods can be used to study group
211 differences, probe for unmeasured confounding effects, and infer aggregate effects in studies
212 where random assignment is not possible. These methods also can be used to address selection
213 effects inherent in mediator analyses in studies where the mediating mechanisms are not
214 randomly assigned. Similarly, quasi-experimental designs such as the regression discontinuity
215 design may be used and further expanded to deduce the effects of interventions. Cross-design
216 synthesis also can be used to help combine RCT data and observational data. These designs
217 facilitate valid inference based on targeted variables and can account for the effects of moderators
218 across the range of studies. Importantly, multidisciplinary collaborations can integrate across the
219 strengths from multiple techniques to overcome weaknesses and the restrictive assumptions of
220 any single technique or study.

221 Meta-analysis is another powerful tool to help aggregate the effects of intervention programs
222 across multiple studies. Results from meta-analysis not only help identify intervention components
223 that are effective at the “average population level,” but also allow more effective quantification of
224 the extent of uncertainty from one implementation to another—that is, for whom, to what extent,
225 and for how long does an intervention program work. Meta-analysis can quantify the differences
226 in cost-to-benefit ratios and can be used to identify the ways in which universal and selective
227 intervention components can be adapted to improve intervention efforts.

Table 2. Recommendations for Improving Design and Analysis

3. Design studies to ensure adequate coverage of data at multiple levels (e.g., family, school, community) and longitudinally (across time and the life course).	
	A. Use analytic methods to represent effects over multiple levels.
	B. Use appropriate analytic methods to study cross-level moderation and mediation.
	C. Utilize longitudinal methods to study dynamic and potentially reciprocal effects over multiple time scales (e.g., short- and long-term effects).
	D. Incorporate person-centered methods to identify and model unknown heterogeneity in risk and protective factors and processes over time.
	E. Represent known heterogeneity explicitly (e.g., as fixed effects, multiple groups).
	F. Utilize latent variable approaches to test critical assumptions (e.g., measurement equivalence) and consolidate measures.
4. Design “bridging studies” or primary data collection efforts to facilitate data integration, linking, and pooling data across multiple studies.	
	A. Include a subset of common measures or linking items to integrate and pool data across studies.
	B. Link data from multiple sources (e.g., administrative and surveillance data).
	C. Incorporate information from multiple sources (e.g., teachers, schools, families, peers).
5. Use principled, valid, and current missing data techniques (e.g., full information maximum likelihood, multiple imputation) to adjust for the effects of missing data mechanisms.	
	A. Design studies to ensure adequate coverage of baseline variables that may predict unplanned missing data.
	B. Use planned missingness designs as a cost-effective way to ensure adequate sampling and measurement coverage.
6. Broaden methods for drawing valid conclusions to inform policy and practice.	
	A. Integrate information from RCTs and observational data (bias-adjusted models such as cross-design synthesis).
	B. Use techniques that improve the robustness and scientific rigor of studies in which randomization is not possible (e.g., modifications and extensions of quasi-experimental designs such as regression discontinuity and interrupted time-series designs; propensity score methods).
	C. Use meta-analysis to consolidate the strengths and identify the limitations of current intervention programs or implementation efforts.
	D. Use network and related methods to better understand group effects (e.g., diffusion, contagion, selection, socialization) as well as propagation of risk or protective factors and associated processes.

229 **Building and Strengthening the Research and Practice Community**

230 Building and strengthening collaborative efforts among researchers, methodologists, and
231 practitioners are needed to advance the field. Building a coordinated research and practice
232 community would foster data linking. Coordination in the research community would need to occur
233 at different phases, including in requests for proposals, in pre-award discussions with program
234 officers, and in cross-project sharing among the various principal investigators of the funded
235 research. Coordination also would need to occur in the coupling of administrative data from the
236 practice community.

237 Interdisciplinary collaboration is critical to identify those at highest risk for inclusion in targeted
238 prevention efforts. Youth who commit suicide may not have had prior contact with mental health
239 providers; however, they may have been seen by educators, medical providers, coaches, and
240 other community members. Similarly, population-based efforts can and should draw on cross-
241 sector collaborations (e.g., schools, law enforcement, parks and recreation departments, faith-
242 based organizations) to strengthen protective factors in individuals, families, and communities.
243 Recognizing the broader costs and impact of youth suicide is a critical policy agenda that can be
244 addressed only by strengthening the larger community of researchers, practitioners, and
245 stakeholders.

246 Finally, education and training opportunities and participation in them are needed to build and
247 expand the research and practice community. Education of providers, agencies, families, and
248 communities is needed to highlight the importance of removing the stigma associated with suicide.
249 Training in the various advanced design and analysis techniques described above needs to be
250 made readily available, and all members of collaborative teams should be given access to these
251 training opportunities. Broadening the understanding of the merits of using the recommended
252 procedures highlighted by presenters at this Pathways to Prevention workshop is critical to
253 bringing these procedures into the realm of standard practice.

254 **Table 3. Recommendations for Building and Strengthening the Research and Practice**
 255 **Community**

7. Encourage cross-sector collaboration—communication and the exchange of information, for example, among researchers, public health professionals, health care providers, law enforcement, policymakers, community organizations, and educators.	
	A. Increase research into policy and other approaches that restrict access to means of suicide (e.g., laws regarding open carry of firearms, state waiting periods and background checks before gun purchase, gun safety locks).
	B. Increase research into policy guidelines restricting access to suicide events (e.g., Health Insurance Portability and Accountability Act, Family Educational Rights and Privacy Act).
	C. Facilitate practitioners' ability to identify effective programs by creating a menu of evidence-based suicide prevention programs.
	D. Disseminate information on what works, what doesn't, to what extent, and in what context.
	E. Disseminate aggregated data for use in community prevention planning and evaluation.
8. Provide education and training.	
	A. Promote awareness and understanding to reduce stigma associated with suicide.
	B. Educate health care professionals, parents, educators, and others who work with youth.
	C. Encourage collaborative efforts among researchers, methodologists, and practitioners.
	D. Provide training opportunities for researchers and practitioners interested in using advanced methods to test theories.

256 **Conclusion**

257 Researchers and practitioners must unite to stop suicide, and thereby circumvent the
258 economic costs and the devastating pain and suffering it causes. They must build and strengthen
259 both coordination and collaboration among all members of the larger policy, practice, and
260 research communities. They must improve and coordinate the numerous surveillance and
261 administrative data systems across these sectors. They must also elevate the level of rigor and
262 breadth of methods directed to studies of suicidal behavior. Adherence to the recommendations
263 summarized herein provides us with a roadmap directed to our ultimate goal: eliminate suicide.

- 264 1. Ten Leading Causes of Death by Age Group, United States – 2014. Accessed at
265 Centers for Disease Control and Prevention at [http://www.cdc.gov/injury/images/lc-](http://www.cdc.gov/injury/images/lc-charts/leading_causes_of_death_age_group_2014_1050w760h.gif)
266 [charts/leading_causes_of_death_age_group_2014_1050w760h.gif](http://www.cdc.gov/injury/images/lc-charts/leading_causes_of_death_age_group_2014_1050w760h.gif) on March 28, 2016.