A network outcome analysis of psychological risk factors driving suicide risk in emergency department patients

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Different theories of suicide propose somewhat different psychological factors that lead to suicidal thoughts and behaviors. For example, Beck's theory highlights hopelessness, while the interpersonal–psychological theory of suicide emphasizes burdensomeness, lack of belonging and fearlessness about death. Surprisingly, few studies have tested which theoretically proposed psychological factors are most predictive of suicidal thoughts and behaviors. We used network outcome analysis to disentangle the effects of these constructs in predicting suicidal ideation, suicide plans and attempts. Participants were 1,412 patients presenting to an emergency department with psychiatric complaints, with follow-up assessments one month and six months ($n = 938$) later. Here we showed that different psychological factors predicted different parts of the continuum of suicidal thoughts and behaviors. Lack of belongingness was most predictive of suicidal ideation (partial correlation (pcor) = 0.14), acquired capability for death (that is, fearlessness of death) was most predictive of suicide planning (pcor = 0.08), and hopelessness was most predictive of suicide attempts (pcor = 0.12). Individuals' explicit associations with death (that is, death = me) prospectively predicted all three outcomes (pcor = 0.13–0.23). The occurrence of suicidal thoughts and behaviors is best predicted using constructs from several different theories of suicide. Future theoretical and empirical work should integrate components of existing theories.

Suicide is among the leading causes of death[1], with rates in the United States increasing from 1999 through 2018 (ref. 2). Different theoretical frameworks have been proposed to explain the role of psychological factors (that is, cognitions, emotions) in the transition from suicidal ideation to suicide plans and suicide attempts. Initially, simple univariate theories, such as the hopelessness theory by Beck[3], pose that negative expectations for oneself in the future lead to suicidal behavior. Slightly more complex theories have emerged that contextualize a range of co-occurring psychological affective states in the prediction of suicide-related outcomes. Joiner's interpersonal theory of suicide[4,5] proposes that three key factors explain the emergence of suicidal behavior, hypothesizing that perceived burdensomeness only in combination with thwarted belongingness will lead to suicidal ideation, whereas fearlessness about injury/death predicts the transition from suicidal thought to behavior. The integrated motivational–volitional model of suicidal behavior[6] hypothesizes that specific psychological states, such as entrapment, predict suicidal ideation, and different volitional moderators, including fearlessness about death and impulsivity, predict suicidal behavior.

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Table 1 | Comparison of ideation and no-ideation groups at 6-month follow-up (*n*=938)

Measure	No ideation at 6-month follow-up	Ideation at 6-month follow-up	t	P	95% confidence interval	
	M (s.d.)	M (s.d.)			Lower	Upper
n	456	482				
Adverse psychological state						
IntEmo	3.93 (1.18)	4.23 (0.99)	−4.09	<0.01	−0.43	−0.15
Hopeless	2.98 (1.40)	3.8 (1.18)	−9.59	<0.01	−0.98	−0.65
TimeRunOut	3.07 (1.43)	3.76 (1.32)	−7.66	<0.01	−0.87	−0.51
TrappedProb	3.74 (1.32)	4.3 (1.00)	−7.37	<0.01	−0.72	−0.42
Anxious	3.52 (1.30)	4.1 (1.05)	−7.41	<0.01	−0.72	−0.42
LifeImpossible	3.09 (1.46)	3.76 (1.25)	−7.47	<0.01	−0.84	−0.49
Impulsive	3.08 (1.37)	3.54 (1.28)	−5.25	<0.01	−0.63	−0.29
Burden	2.92 (1.46)	3.77 (1.30)	−9.39	<0.01	−1.03	−0.67
NotBelong	3.10 (1.41)	4.04 (1.18)	−11.09	<0.01	−1.11	−0.78
NotAfraidDeath	2.84 (1.47)	3.33 (1.48)	−5.08	<0.01	−0.68	−0.30
NoSocSupport	2.32 (1.35)	2.67 (1.38)	−4.03	<0.01	−0.53	−0.18
NoPurpose	3.00 (1.33)	3.55 (1.32)	−6.29	<0.01	−0.71	−0.37
Explicit−implicit association						
ExplAssoDeath	34.56 (31.29)	56.33 (30.05)	−10.86	<0.01	−25.71	−17.84
IatDScore	−0.42 (0.32)	−0.35 (0.34)	−3.39	0.01	−0.12	−0.03

The 95% confidence interval is for the difference in means between the two groups. Two-sided *t* tests were conducted without corrections for multiple comparisons. Different adverse psychological states are abbreviated as follows (Supplementary Table 1): IntEmo, intensity of emotions/emotional reactivity (I feel emotions very intensely); Hopeless, hopelessness (I feel hopeless about the future); TimeRunOut, despair/entrapment (time is running out for me); TrappedProb, feeling trapped (I feel trapped by my problems); Anxious, anxiety (I am constantly anxious and on edge); LifeImpossible, desperation (life is impossible if things don't change); Impulsive, impulsivity (I often act without thinking when I am upset); Burden, burdensomeness (I am a burden to others); NotBelong, lack of belongingness (I feel like I don't belong); NotAfraidDeath, acquired capability for death (I am not afraid of death or injury); No SocSupport, social support (I have no social support); NoPurpose, purposefulness (I do not have a sense of direction and purpose in life). All group differences were significant at the ≤0.01 level. Standard deviations are reported in parentheses. All psychological state items range from 1 to 5. The explicit association with death score (ExplAssoDeath) ranges on a scale from 0 to 100, and the IAT D score (IatDScore) ranges from −2 to 2.

Most current theories of suicide do not specifically articulate why these factors (for example, hopelessness, lack of belongingness) lead to suicide rather than other behaviors that might serve the same function as suicide such as escaping from aversive psychological states, through alcohol or substance use or other forms of self-injury. One theoretical model proposes that one's identification with specific behaviors (for example, suicide, alcohol use) may predispose people toward engaging in these specific behaviors when in distress[7]. Such identification can be measured via implicit association tests[8] or explicit self-reports of such associations (for example, single-item measure: 'To what extent do you think of death as being like you versus not like you?'). Implicit death association tests measure the extent to which individuals associate the concept 'death' (as opposed to 'life') with the self. Such computerized reaction-time-based tests (detailed description in Methods) were designed to assess implicit biases, which some have described as more automatic/less controllable than explicit biases[9,10]. Implicit biases represent markers of vulnerability for suicide attempts[11] that may overcome challenges with self-reported suicide risk assessment. Such challenges include deliberate faking, reluctance to disclose suicidal ideation, unawareness of the true extent of suicide risk and the transient nature of suicidal thoughts, where an individual might accurately report no suicidal thoughts at one moment, only to experience them again soon after[12]. Although no formal theory has been developed or specifically added implicit biases into their models of suicide, Nock[13] has proposed that alternative methods such as the Death/Suicide Implicit Association Test (IAT)[11,14] might provide insight into markers of vulnerability for suicide risk[11].

Previous studies have demonstrated that implicit and explicit associations with the concepts of suicide and non-suicidal self-injury are specifically predictive of engagement in these behaviors both concurrently and prospectively (that is, over 6–12 months)[15,16].

However, surprisingly few studies have examined psychological factors from different theories together to examine which are most predictive of suicidal outcomes. Contemporary theories of suicide integrate many intercorrelated and overlapping factors representing adverse psychological states[17]. Meehl[18] further described this problem of inter-correlation among many variables of interest ('crud factor') when using standard statistical approaches for theory testing. Thus, there is a need to better understand the unique contribution of different cognitive, social and affective predictors across theories.

In the past decade, network analysis has been proposed as a statistical toolbox[19,20] for identifying conditional (that is, partial) associations between a range of variables. Network models consist of nodes (that is, variables) that are connected through edges (that is, pairwise conditional associations). The present study uses a novel network analysis approach, namely network outcome analysis[21], to examine predictive associations between a range of different psychological factors and the development of suicidal ideation, suicide plans, and suicide attempts. A crucial benefit of network analysis concerns the separation of direct effects (for example, edge between impulsivity and suicidal ideation) and indirect effects (for example, association between impulsivity and suicidal ideation through other cognitions)[21]. Based on prior research, we predicted that hopelessness, burdensomeness, lack of belongingness, entrapment, and identification with death would be the strongest proximate predictors of suicide-related outcomes.

Results
Sample characteristics and group comparison
Participants were patients presenting to the Massachusetts General Hospital Emergency Department (ED) between February 2015 and March 2017 due to severe psychiatric distress. There were two follow-up surveys conducted over the telephone or email, 1 month and 6 months
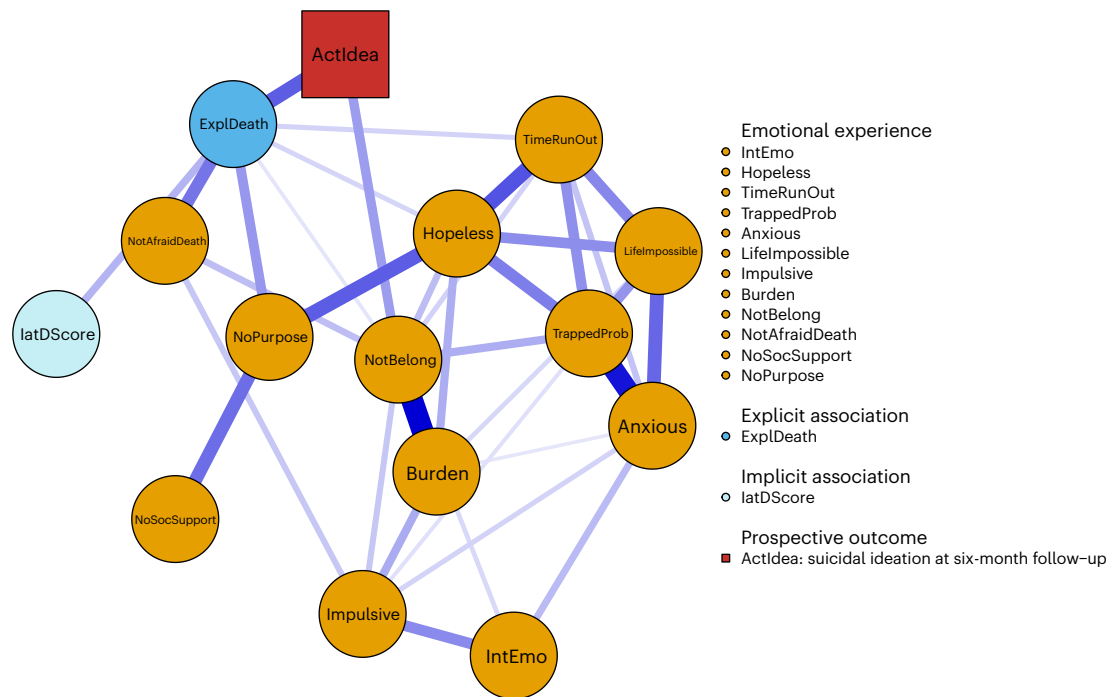
Fig. 1 | Symptom network with suicidal ideation at 6-month follow-up (hyperparameter = 0.25). The connections (positive edges shown in blue) represent conditional associations. The thickness of each line describes the strength of the association. All edge weights (strengths of associations) can be found in Supplementary Tables 7–9. The red square indicates the suicide-related outcome (suicidal ideation) assessed at the 6-month follow-up; all other variables have been assessed at baseline.

after the baseline visit. All psychological factors (description in Methods) were evaluated at baseline, while all suicide-related outcomes (that is, ideation, suicide plan, attempt) were assessed during both follow-up surveys. The sample at baseline ($n = 1,412$) was predominantly male (54.32%; female, 43.96%; transgender, 1.72%), young ($M = 34.95$, s.d. = 13.57) and relatively diverse with respect to ethnicity and race (non-Hispanic white, 68.0%; non-Hispanic African American, 7.22%; Hispanic other, 7.15%; non-Hispanic other, 6.22%; Hispanic white, 5.79%; non-Hispanic Asian, 3.86%; and other race or ethnicity, 1.76%). At the 1-month follow-up survey, there were complete data for reports of suicidal ideation for 900 participants (63.74%). By the 6-month follow-up, 938 participants (66.43%) completed reports on measures of suicidal ideation. A supplemental analysis (Supplementary Table 3) showed that older age, female gender, lower income and a lifetime history of a suicide attempt were significantly associated with slight increases in the likelihood of dropout.

Table 1 describes participants' responses to assessments about psychological factors as well as their explicit and implicit association with death. We examined group differences in the mean level on the basis of whether individuals reported suicidal ideation (Table 1), suicide plan (Supplementary Table 5) and a suicide attempt (Supplementary Table 6) at the 6-month follow-up. Participants with suicidal ideation, suicide plans and suicide attempts at 6-month follow-up reported generally more adverse psychological states and a stronger explicit association with death compared with individuals who did not report any of these suicide-related outcomes at 6-month follow-up. Participants' implicit association with death is stronger in individuals experiencing suicidal ideation; however, there were no significant group differences in this implicit score for the comparison by suicide plans ($P = 0.29$) and suicide attempts ($P = 0.52$).

Network outcome analysis
The network outcome analysis consistently identified direct predictive associations between explicit association with death at baseline and

all suicide-related outcomes (suicidal ideation 100% retrieved, suicide plan 99% retrieved, suicide attempt 65% retrieved) at the 6-month follow-up. We present all network models with the 1-month follow-up outcomes in Supplementary Figs. 1–3. These direct associations with explicit association with death also hold at the 1-month follow-up, except for suicide attempt.

Figure 1 displays the network model with suicidal ideation at the 6-month follow-up. Importantly, lack of belongingness constitutes the single adverse psychological state that shows predictive associations (retrieved in 95% of bootstraps) with suicidal ideation at the 6-month follow-up visit. Lack of belongingness is strongly associated with feelings of burdensomeness (100% retrieved). Implicit associations with death and several adverse psychological states, including the acquired capability for death, lack of belongingness ('I feel like I don't belong') and purposefulness, are most strongly associated with individuals' explicit association with death, which in turn predicts suicidal ideation (100% retrieved).

The network outcome analyses for suicide plan and suicide attempt are shown in Fig. 2. Interestingly, in addition to the explicit association with death, the acquired capability for death was the only adverse psychological state that showed direct predictive associations with suicide plans (48% retrieved) at the 6-month follow-up. For the prediction of suicide attempts, hopelessness at baseline was the single key predictor (47% retrieved) in addition to individuals' explicit association with death (65% retrieved).

The estimated network structures and all-important edges with the prospective suicide outcomes presented in the preceding showed sufficient stability in our bootstrapping analysis (Supplementary Figs. 7–9). The network outcome models that were estimated with a conservative hyperparameter (gamma = 0.5) are shown in Supplementary Figs. 4–6. This conservative estimation process showed consistent associations between all suicide-related outcomes and individuals' explicit association with death. Networks that included sex and age as covariates in the network largely replicated the results (Supplementary Figs. 10–12).
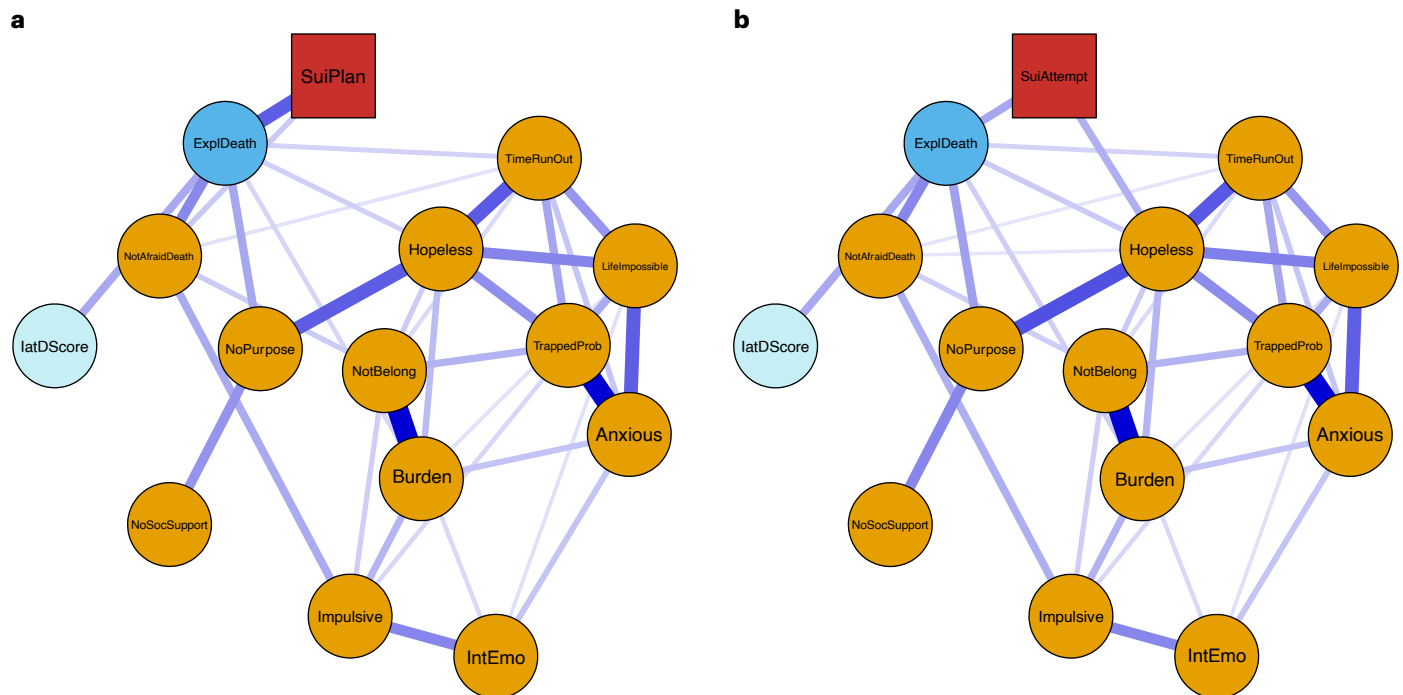
Fig. 2 | Symptom network with suicidal plan and suicide attempt at 6-month follow-up. a, Suicide plans (SuiPlan) at the 6-month follow-up. **b**, Suicide attempts (SuiAttempt) at the 6-month follow-up. All other nodes have been assessed at baseline.

Discussion

The present study used an innovative methodological approach, prospective network outcome analysis, to identify proximal risk factors of suicide-related outcomes, specifically suicidal ideation, suicide plans and suicide attempts. The crucial finding from our study concerns the specificity of associations found between theory-derived psychological states and suicide-related outcomes.

Individuals' explicit association with death was consistently associated with all suicide-related outcomes, and it emerged as an important bridge node connecting a range of psychological states (that is, lack of purpose, hopelessness) with suicidal ideation. Thus, individuals' explicit association with death may represent a rather general or more abstract cognition that may be the result of various more-specific negative psychological states, such as lack of purpose or hopelessness. Similarly, our findings suggest that implicit measures (suicide IAT D score) represent a convergent marker of explicit suicide cognitions that, in turn, predict suicide-related outcomes. This is in line with recent studies showing no evidence for direct associations between suicide IAT scores and suicide attempts in high-risk samples[22].

A crucial finding from our study is the specificity of associations between suicide-related outcomes and adverse psychological states. In line with Joiner's interpersonal theory of suicide[4,5], suicidal ideation closely relates to feelings of thwarted belongingness that are strongly associated with perceived burdensomeness. This lack of social support and feelings of loneliness may lead to a sense of helplessness that ultimately contributes to suicidal ideation. During the progression from suicidal ideation to suicide attempt, individuals' feelings of not being afraid of death may represent one proximal factor that contributes to individuals' capability for suicide. This finding is in line with previous studies showing associations between acquired capability for death and past suicide attempts[23]. Finally, our results show that hopelessness is the key adverse psychological state that is uniquely associated with suicide attempts. This is consistent with Beck's theory of hopelessness[3]; however, our study represents one of the first to show this specificity with attempts while controlling for (that is, partialing out) a range of other related factors (for example, feelings of not belonging).

Our findings suggest that thwarted belongingness along with the closely related concept of perceived burdensomeness are two critical factors closely connected to suicidal ideation. By contrast, the acquired capability for death appears to be more closely linked to suicidal intent (that is, suicide plans). Although our analysis does not directly examine moderation effects, these key components align with the integrated motivational–volitional model of suicidal behavior[6], where they serve as motivational (thwarted belongingness, perceived burdensomeness) and volitional (acquired capability for death) moderators.

We believe that our study offers valuable insights for advancing future suicide research and clinical implications concerning the assessment of suicide risk[1]: The present study is one of the first to simultaneously test the associations between psychological factors from across different theories and suicidal outcomes to determine which are more predictive of such outcomes. Our findings indicate that the occurrence of suicidal thoughts and behaviors is best predicted using constructs from several different theories of suicide. This underscores the importance of adopting an integrative approach in future studies aimed at predicting suicidal outcomes. We believe that the multimodal nature of our study represents a key strength as we included self-reported psychosocial variables (for example, lack of social support), behavioral measures (that is, implicit self-death associations) and prospectively assessed suicide-related cognitions and behaviors (that is, ideation, plan, attempt). In line with previous work[16], the behavioral indicator of implicit suicide cognition did not provide additional predictive value for suicide-related outcomes beyond what was already captured by the explicit self-reported measure. Future research should explore whether additional behavioral measures, such as attentional biases toward suicide assessed through the Suicide Stroop Task[24] or behavioral indicators of executive functioning, including cognitive inflexibility[25], enhance the prediction of suicidal thoughts and behaviors beyond key self-reported risk factors.

Regarding clinical implications, our findings underscore the importance of addressing three conceptually modifiable and outcome-specific cognitions: hopelessness, lack of belongingness and the acquired capability for death. Clinical intervention studies are needed

to investigate two key questions: (1) the extent to which these cognitions are malleable through targeted interventions and (2) whether addressing these factors at specific risk stages of the process (that is, ideation → lack of belongingness; planning → acquired capability for death; attempt → hopelessness) can effectively prevent the progression from suicidal ideation to suicide attempts.

Several important limitations should be noted. First, our assessment of adverse psychological states and explicit association with death was based on individuals' self-report, which may naturally be biased, particularly in the high-stress context of an emergency room. The various theory-derived factors were either adapted from existing scales (Supplementary Table 1) or developed by clinical experts. As a result, some items lack empirical validation, and future work should aim to replicate our results using validated instruments. Second, there was a substantial rate of dropout of participants, with only 66.43% of individuals from the baseline providing valid responses to the 6-month follow-up survey. We used complete case analysis, and thus, our results may be biased by this high rate of attrition. Moreover, a subgroup of individuals chose not to participate in this study due to impairments related to their psychiatric symptoms[26], possibly including strong suicidal urges, and thus, there is a risk of non-participation bias. Third, our analyses integrated a prospective marker of suicide-related outcomes in the network to investigate unique associations with measures assessed at baseline. As a result, our findings should be viewed as temporal associations rather than directed causal effects. Future longitudinal analyses with a continuous assessment of different adverse psychological states and suicide-related outcomes at different measurement waves (that is, panel studies) are necessary to establish temporal within-person pathways[27]. Fifth, while the present study assessed constructs from several prominent theories of suicide, it did not cover all relevant theoretical models. For example, the three-step theory of suicide[28] emphasizes the role of psychological pain, connectedness and acquired, dispositional and practical capability for suicide. Future studies should aim to replicate our findings while incorporating a broader range of theoretical models.

Our study was one of the first to simultaneously investigate the predictive utility of different domains of risk factors (that is, explicit associations, adverse psychological states, behavioral measures of implicit suicide cognition) in a high-risk sample for suicidal ideation, suicide plan and suicide attempts. Our results highlight the importance of attending to individuals' explicit association with death and key adverse states, namely, hopelessness, lack of belongingness and the acquired capability for death to prevent a transition from suicidal ideation to suicide attempts.

Methods

Data source and procedure

The study complies with all ethical regulations and received ethical approval (number 2014P001620/MGH) from Harvard University and Massachusetts General Hospital. Patients presenting due to severe psychiatric distress to the Massachusetts General Hospital Emergency Department (ED) (between February 2015 and March 2017) were approached by study research assistants. Reasons for not obtaining informed consent included impairment due to psychiatric complaints, discharge, refusal to participate, language barriers and various other reasons[26]. To be included in the study, participants had to be adults (18 years or older; no upper age limit), have presented at the Acute Psychiatry Service, and have had access to a phone or email over the 6-month follow-up period. Exclusion criteria encompassed any condition that hinders an individual's capacity to provide informed consent and participate in the study, including (1) the inability to speak or read English, (2) severe cognitive impairments due to conditions, such as florid psychosis, intellectual disability, dementia, and acute intoxication, or (3) the presence of extremely agitated or violent behavior.

The attending psychiatrist on duty determined the applicability of these criteria, with the primary focus being the safety of both participants and research staff. Participants could receive a total compensation of $30 for completing the in-person session and two follow-up surveys ($10 for each), along with additional benefits such as parking and cafeteria vouchers.

After obtaining written informed consent, the baseline visit while in the emergency room included an evaluation from the treating clinician, brief clinical self-report measures (administered through a tablet), and the completion of a brief implicit association test[29]. There were two follow-up surveys conducted over the telephone or email, one month and six months after the baseline visit. The study, sample, and enrollment procedures are described in more detail elsewhere[26]. The data supporting this study are not publicly available due to their highly sensitive nature.

Measures

Suicide-related outcomes. The presence of suicidal ideation ('Did you have thoughts of killing yourself?') and suicide plan ('Did you ever make a plan to kill yourself?') were assessed through self-report at 1 month and 6 months post-ED visit. Presence of a suicide attempt at the 1-month and 6-month follow-up visits was assessed through both self-report ('Did you make a suicide attempt (that is, purposefully hurt yourself with at least some intent to die)?') and the review of medical records (indication of suicide attempt via either self-report or medical record was considered evidence of a suicide attempt). These three items assessing suicidal thoughts and behaviors were adapted from the Self-Injurious Thoughts and Behaviors Interview[30].

Psychological constructs. We assessed several theory-derived psychological factors that have been shown to correlate with suicidal thoughts and behaviors. Each was assessed on a five-point Likert scale (1 = exactly like me; 5 = not at all like me). We recoded the reversely scored items such that a higher score on all items indicates more negative/adverse psychological states/cognitions. All 12 items can be found in Supplementary Table 1. These included emotion reactivity ('when I experience emotions, I feel them very intensely'[31]), hopelessness ('I am hopeless about the future'; 'life is impossible if things don't change right away'[32]), entrapment ('I feel trapped by my problems'[33]), anxiety/agitation ('I am constantly anxious and on edge'[34]), impulsiveness ('when I am upset, I often act without thinking'[35]), burdensomeness ('I am a burden to others'[36]), lack of belongingness (I feel like I don't belong), acquired capability for death ('I am not afraid of injury or death'[37]) as well as the protective factors of belongingness and meaning in life[38] ('I have people who care about me and are there for me whenever I need them'; 'I have a sense of direction and purpose in life').

Explicit association with death. We assessed participants' explicit association with death through a single-item measure ('To what extent do you think of death as being 'like you' versus 'not like you?') on a scale from 0 to 100. The use of such semantic differential items that match the respective categories of the IAT is standard practice in implicit cognition research[10], and these explicit measures have been used in previous work[16,39].

Death IAT. A brief version (5 minutes) of the Death IAT was used to assess participants' implicit association with death[8,29]. In this computerized reaction-time-based task, participants are instructed to classify target words (for example, 'funeral') using a left and right keyboard button press. The target words are presented on the center of the screen, and the category labels ('life' or 'death'/'me' or 'not me') appear on the top left and right of the screen. The order of these categories changes across the two critical blocks, such that on one block, death- and me-related words are assigned the same key press, while on the other block, 'life' and 'me' share the same key press. A commonly used difference

score (D score[40]) is computed, which indicates the relative strength of associations between the self and the concepts of death versus life. Higher D scores represent stronger death–me associations indicated through faster responses on the death/me compared with the life/me blocks[39]. The split-half reliability of the IAT used in the current measure was 0.37. This is lower than previous reliability estimates for the Death IAT ($r = 0.61$, $n = 1,979$ (ref. [39]). A Spearman's rank correlation was computed to assess the relationship between the D scores and the explicit association with death. There was a positive correlation between the explicit and implicit measures, $\rho = 0.15$, $P < 0.01$).

Data analysis
Network outcome analysis. We estimated the networks using mixed graphical models[41] that allow for both continuous (for example, psychological states) and binary (for example, suicide attempt) variables. The network consists of both nodes (variables) that are connected through edges (conditional associations, similar to partial correlations) between two pairs of variables that control for all other variables in the network. Following the 'network outcome analysis' approach by Blanken et al.[21], we integrated the prospective outcomes (for example, suicide attempt at 6-month follow-up) as a node in the network. We estimated separate networks for each prospective outcome (that is, ideation, plan, attempt) to prevent multicollinearity issues that are common in network analysis. This network outcome approach allowed us to separate direct predictive pathways (that is, direct connection with the outcome) and indirect predictive associations (that is, connecting with the outcome through other nodes; predictive mediation).

Network estimation. Mixed graphical models are based on a node-wise regression approach in which a variable is predicted by all other variables in the model using a regularized generalized linear model framework[42]. Depending on the type and distribution of the variable (continuous with Gaussian distribution or binary with Bernoulli distribution), an appropriate link function was used. We used the least absolute shrinkage and selection operator regularization method to avoid spurious false-positive edges in the network. The extended Bayesian information criterion (EBIC) was used as the method to select the optimal tuning parameter (lambda). This EBIC model selection method tends to be a more conservative approach than model selection using cross-validation. An EBIC hyperparameter gamma determines the extent of regularization and level of sparsity. Hyperparameters close to 0.5 may be too conservative and miss true positive edges, whereas parameters close to 0 may lead to false-positive edges and err on the side of discovery[43]. A moderately conservative default hyperparameter of 0.25 was chosen to increase specificity and facilitate interpretability[44].

Network stability. To estimate the robustness and stability of the estimated networks, we used a nonparametric bootstrapping stability analysis with 1,000 bootstraps[45]. This involves re-estimating the model on sampled data (with replacement) across 1,000 iterations. The bootstrapped confidence interval around the edge weights (Supplementary Figs. 7–9) and the proportion of edge presence in all bootstraps describe the precision of these estimates. We report the retrieved percentage of edge presence in 'Results'. All analyses were conducted in RStudio (R version 4.4.0)[46]. Networks were estimated using the packages bootnet[47] and mgm[41] and visualized using qgraph[48]. We used the layout of the 6-month follow-up suicidal ideation network for all visualizations to facilitate visual comparisons. No additional thresholds or scaling parameters were used for the network visualization.

Reporting summary
Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability
Data available upon reasonable request due to the sensitive nature of the data.

Code availability
All preprocessing and analyses were performed using RStudio (R version 4.4.0). Network estimation was conducted using the bootnet (version 1.6) and mgm (version 1.2-14) R packages. Network visualizations were created using qgraph (version 1.9.8). Supplemental analyses utilized the stats package (version 4.4.0). The Death IAT was implemented using JavaScript.

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Author contributions

All of the authors made a substantial contribution to this study. R.F. drafted the paper. R.F. and B.A.O. analyzed the data. M.K.N. designed the study and was responsible for study conception, funding acquisition and supervision of all activities. All authors contributed to revising the paper, and all authors approved the final version of the paper for submission.

Competing interests

M.K.N. receives publication royalties from Macmillan, Pearson and UpToDate. He has been a paid consultant in the past 3 years for Cambridge Health Alliance and for legal cases regarding a death by suicide. He has stock options in Cerebral Inc. He is an unpaid scientific adviser for Empatica, Koko and TalkLife. R.F. and B.A.O. declare no competing interests.

Additional information

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Software and code

Policy information about availability of computer code

Data collection	The death-IAT was implemented using JavaScript and run through the Project Implicit servers based at Harvard University.
Data analysis	All preprocessing and analyses were performed using RStudio (R version 4.4.0). Network estimation was conducted using the bootnet (version 1.6) and mgm (version 1.2-14) R packages. Network visualizations were created using qgraph (version 1.9.8). Supplemental analyses utilized the stats package (version 4.4.0). Relevant code for this method is already widely available online and no custom scripts have been used.

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Data available upon reasonable request due to the sensitive nature of the data. Data was collected from patients presenting due to severe psychiatric distress to the Massachusetts General Hospital Emergency Department (ED) (between February 2015 and March 2017).

Research involving human participants, their data, or biological material

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Reporting on sex and gender	The sample at baseline (n =1412) was predominantly male (54.32%; female: 43.96%, transgender: 1.72%). See results section.
Reporting on race, ethnicity, or other socially relevant groupings	The sample was relatively diverse with respect to ethnicity and race (non-Hispanic white: 68.0%, non-Hispanic African American: 7.22%, Hispanic Other: 7.15%, non-Hispanic other: 6.22%, Hispanic White: 5.79%, non-Hispanic Asian: 3.86%, and other race or ethnicity: 1.76%).
Population characteristics	See Table 1 and results section for detailed population characteristics. The study sample consisted of participants presenting to the emergency room. Study inclusion criteria include adult status (≥18 years-old) and presentation at the ER.
Recruitment	Patients presenting due to severe psychiatric distress to the Massachusetts General Hospital Emergency Department (ED) (between February 2015 and March 2017) were approached by study research assistants.
Ethics oversight	The study received ethical approval from Harvard University and Massachusetts General Hospital.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

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Study description	Patients presenting due to severe psychiatric distress to the Massachusetts General Hospital Emergency Department (ED) (between February 2015 and March 2017) were approached by study research assistants. There were two follow-up surveys conducted over the telephone or email, one month and six months after the baseline visit. The data collected was quantitative - see methods section.
Research sample	Patients presenting to the ER. The sample was predominantly male (54.32%; female: 43.96%, transgender: 1.72%), young (M = 34.95, SD = 13.57), and relatively diverse with respect to ethnicity and race (non-Hispanic white: 68.0%, non-Hispanic African American: 7.22%, Hispanic Other: 7.15%, non-Hispanic other: 6.22%, Hispanic White: 5.79%, non-Hispanic Asian: 3.86%, and other race or ethnicity: 1.76%).
Sampling strategy	Convenience sampling. Patients presenting due to severe psychiatric distress to the Massachusetts General Hospital Emergency Department (ED) (between February 2015 and March 2017) were approached by study research assistants. A target sample size of 2,000 participants was determined based on a power analysis for sufficient statistical power (.80) with alpha set at .05.
Data collection	Data was collected in-person at the emergency room. There was also additional data collection through email or telephone 1 and 6 months after the baseline visit. Study research assistants were present during data collection. Blinding not applicable. Behavioral tasks were administered through iPads or laptops.
Timing	Baseline visit between February 2015 and March 2017
Data exclusions	Exclusion criteria encompassed 1) the inability to speak or read English, 2) severe cognitive impairments due to conditions, such as florid psychosis, intellectual disability, dementia, acute intoxication, or 3) the presence of extremely agitated or violent behavior. The main reasons for failure to obtain consent were psychiatric impairment (n = 193), lack of contact information for follow-up (n = 137), participant refusal (n = 132), language or physical barriers (n = 29), discharge prior to completing the consent process (n = 16), refusal by family or friends (n = 11), and various other factors (n = 14). See http://doi.org/10.1001/jamanetworkopen.2021.44373 for all details.
Non-participation	See results section. At the 1-month follow-up survey, there were complete data for reports of suicidal ideation for 900 participants (63.74%). By the 6-month follow-up, 938 participants (66.43%) completed reports on measures of suicidal ideation. A supplemental analysis (see Table S3) showed that older age, female gender, lower income, and a lifetime history of a suicide attempt were significantly associated with slight increases in the likelihood of dropout.
Randomization	Not applicable as there were no conditions to be randomized to.

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