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Social disconnection in late life suicide: An NIMH workshop on state of the research in identifying mechanisms, treatment targets, and interventions

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Abstract

Both social disconnection and suicide are significant public health concerns among older adults, and social disconnection is associated with greater risk for suicide-related thoughts and behaviors in late life. We present a synthesis of research discussed during a workshop hosted by the NIMH on social disconnection and late-life suicide. Social disconnection is related to suicide risk in late life via a variety of mechanisms, including biological, behavioral, and psychological correlates. Researchers in several scientific fields have begun to establish these connections and identify targets for interventions to reduce risk in late life. While research has demonstrated that social connection is amenable to change, there is little research to date on the most evidence-based interventions to mitigate social disconnection or the related risks. However, there are several promising biological, behavioral, and psychological interventions that may target various mechanisms, as well as social disconnection itself. With a relative paucity of research in this area, these lines of study are ripe for innovative investigation. In order to most effectively advance the

field, we must establish more consistent definitions of social connection and disconnection; more accurately measure and assess older adults' social needs; examine the most effective approaches and modalities for assessment and intervention; take into account important contextual factors; and apply a translational, convergent scientific approach.

Keywords

older adults; geriatric; social connectedness; loneliness; isolation; depression

In the United States and internationally, the number of older adults is increasing: projections suggest one-fifth of the US population will be 65 years or older by 2030, with this population nearly doubling from approximately 40 million in 2010 to approximately 72 million by 2030.[1,2] In response to this changing makeup of the population, more attention to public health concerns related to aging is necessary. Two significant and related public health concerns for the aging population are suicide deaths and social disconnection. In the US and in many regions of the world, older adults exhibit the highest rates of suicide deaths. [3,4] In 2018, the most recent year for which US national data are available, the suicide rate for adults age 65 and older was 17.36 per 100,000, compared to 14.21 in the general population. [3] The highest rates were among those age 85 and older, particularly among white men age 85 and older, with a suicide death rate of 51.85 per 100,000.[3] Social disconnection is associated with suicide ideation, attempts, and deaths in later life and has been identified as a modifiable intervention target to reduce suicide risk, but few research studies have examined social connection as a means of suicide prevention. We describe a workshop sponsored by the National Institute of Mental Health (NIMH) involving experts in this field to discuss current and future directions in research for examining the associations between social connection and suicide in late life, and to work toward identifying mechanisms, treatment targets, and interventions to effectively improve social connection and reduce suicide risk in late life.

Terms for suicide-related thoughts and behaviors used in this paper are those from the CDC's uniform definitions for self-directed violence[5] as well as from research conducted to develop the Columbia Suicide Severity Rating Scale, a commonly used instrument for assessing suicide ideation and behavior in clinical trials.[6] Suicidal ideation refers to thoughts about suicide, and may range in severity from wishing for death (i.e., passive ideation) to active thoughts of ending one's life, consideration of methods, and active intent and specific plans to end one's life. Suicide attempt refers to non-fatal self-directed potentially injurious behavior, which may or may not result in injury, with at least some intent to die. Death by suicide refers to fatal self-directed behavior with at least some intent to die. Risk and protective factors for any of the types of suicide-related thoughts and behaviors defined above can differ, and each presents unique challenges to researchers (e.g., suicide deaths occur at a low base rate, making power an issue for many studies on suicide).[7,8] This NIMH workshop did not examine physician aid in dying.

The terms "social connection" and "social disconnection" encompass a number of dimensions of social relationships, including structural (e.g., size of social networks, marital

status, living situation, social isolation), functional (e.g., received and perceived social support, loneliness), and quality-related (e.g., satisfaction with relationships, conflict) aspects of one's social world.[9] While societal-level variables (e.g., oppression, social capital, discrimination, policy) are relevant to suicide prevention, they were outside of the scope of the NIMH workshop. Lifespan developmental theories and research, including the socioemotional selectivity theory, posit a key role for social relationships in healthy aging and studies show generally increasing quality and satisfaction in social relationships in later life, though size of social networks may be somewhat reduced, due to greater selectivity and focus on more valued relational experiences.[10] Despite misconceptions that older age is associated with loneliness and/or isolation, social disconnection is not considered normative, and loneliness may even decrease in later life.[11] However, among some older adults, factors such as physical health and disability that limit opportunities for social activities, mental health and cognitive functioning, loss of partners, negative perceptions, and ageist stereotypes can lead to increased loneliness.[12,13] While some risk factors for loneliness may be more prevalent in later life, social disconnection (e.g., loneliness) is not inevitable among older adults. The National Academy of Sciences has called for more robust research on interventions for social disconnection in later life, with a goal of translating that research into clinical practice to improve the health of older adults.[14]

Social disconnection is associated with suicide risk at all ages and the importance of social disconnection in suicidal behavior has been posited by theorists for more than a century,[15,16] including Émile Durkheim's work on social factors in suicidal behavior in the late 19th century.[17] A contemporary psychological theory, the Interpersonal Theory of Suicide, posits that an unmet need to belong—termed low belonging—and feeling like a burden on others increase risk for suicide ideation.[16] Other contemporary theories, including the Three-Step Theory of Suicide[18] and the Motivational-Volitional Theory of Suicide[19], also posit central roles for social disconnection in suicide risk.

Structural, functional, and quality-related dimensions of social disconnection, measured using both objective and subjective indicators, are related to suicidal ideation, attempts, and deaths.[15,20,21] Indices of social connection, such as degree of social integration are associated with reduced risk of suicide deaths[20,21], and indices of social disconnection, such as loneliness, are associated with increased risk of suicide death.[15] Several dimensions of social disconnection, such as loneliness, relationship conflict, and social network size are associated with passive and active suicidal ideation, attempts, and suicide deaths among older adults, with less precise indicators of social connection, such as marital status, producing mixed findings.[15,22,23] The most reliable findings linking social disconnection to suicide deaths (as well as all-cause mortality) come from studies using measures of social integration, which capture a range of aspects of an individual's social experience, including network size, frequency of contact, and involvement in social groups.[24]

Though there is evidence that social disconnection is likely amenable to intervention[25], there is little knowledge of what types of interventions may improve different aspects of social connection, and the evidence on the effectiveness of any particular intervention is limited, particularly in late life.[25-31] However, social connections and processes have been identified as important mechanisms for explaining behavior, mental disorders, and intervention effects,

including by the NIMH Research Domain Criteria (RDoC),[32] which includes a social processes domain.[33,34] Research to date has also suggested that constructs falling under this social processes RDoC domain are associated with suicide-related thoughts and behaviors.[35]

Due to public health concerns regarding social disconnection and suicide in late life, the NIMH convened a virtual workshop titled "Social Disconnection in Late Life Suicide: Mechanisms, Treatment Targets, and Interventions" on September 17-18, 2020, involving experts in related fields, including clinician scientists, behavioral scientists, neuroscientists, epidemiologists, and implementation scientists. The aims of the workshop were 1) to advance understanding of the mechanisms by which social disconnection may be associated with late life suicide, 2) to identify candidate targets for promising interventions to address social disconnection and suicide in late life, and 3) to discuss translation to develop and implement interventions and provide services to socially disconnected older adults at risk for suicide. Scientists in each of these areas presented current work, and breakout discussion sessions were conducted to discuss the state of the research and priorities for future research. Finally, a synthesis session was conducted to summarize the discussions. Presentations and sessions were recorded (available at https://www.nimh.nih.gov/news/events/2020/virtual-workshop-social-disconnection-and-late-life-suicide-mechanisms-treatment-targets-and-interventions.shtml). There were 47 documented active attendees/participants (chairs, organizers, presenters, moderators, panelists, and discussants). The presentations were open to a live audience that did not actively participate in the live discussion; over 350 audience members were in attendance. We present a summary of the research discussed during the workshop as well as gaps in knowledge and priorities for future research identified. We aim to integrate the ideas put forth at the workshop and the group's consensus regarding research priorities.

We organize the research discussed during the workshop within an experimental therapeutics framework, which involves a process for developing and testing mental health interventions by specifying potentially modifiable mechanisms associated with mental health outcomes that can be 'targeted' by interventions to produce clinical and functional effects. The NIMH RDoC initiative is compatible with experimental therapeutics.[36] We first discuss research on biopsychosocial mechanisms in the causal pathway between social disconnection and suicide; second, we discuss mechanisms that are potentially modifiable by interventions (i.e., target mechanisms); and finally, we discuss potential interventions that may 'engage' these targets. Figure 1 presents a conceptual model of mechanisms, targets, and intervention strategies discussed. Some, but not all, mechanisms may be potentially modifiable through intervention. Targets are selected from potentially modifiable mechanisms, and examples of intervention strategies to engage these selected targets are provided.

Mechanisms Underlying Social Disconnection and Late Life Suicide

Social disconnection likely influences suicide-related thoughts and behaviors by contributing to biological/physiological mechanisms, behavioral mechanisms, and psychological distress, while social connection may serve as a protective factor against suicide by strengthening an individual's resilience to risk factors for suicide.

Biological mechanisms

Some have argued that social connection, or reducing loneliness, is a biological drive akin to hunger, motivating people to connect. Workshop participants discussed studies demonstrating that 10 hours of isolation was associated with a similar neural response pattern (via fMRI) as 10 hours without food[37] and that 'social pain' (i.e., rejection) triggers physical pain-related neural regions.[38] The Social Baseline Theory posits that the normal, or baseline, adaptive human neurological state is predicated on social proximity to and relationships with others as a necessary resource, whereas lack of social relationships puts the neurological system into an alert state due to an implied or perceived increased risk and increased level of effort needed to reach goals.[39] When this state is prolonged, it can lead to depletion in neurological and physical resources and function. Physiological changes of this type may be associated with suicide risk. For example, chronic loneliness or exclusion is associated with chronic inflammation[40], which in turn is associated with negative mental health outcomes such as depression.[41,42] Oxytocin (which is key to social bonding, released with close social contact such as hugging, and impacted by social exclusion) has a complex association with risk for suicide attempts as well.[43,44]

Animal research suggests that potential neurobiological mechanisms include monoamine neurotransmitter levels and hypothalamic-pituitary-adrenal (HPA) axis activation. Social isolation has been shown to contribute to differences in monoamine neurotransmitter presentations in social animals; for example, isolation affects 5HT (serotonin)-related receptor gene transcription, serotonin levels throughout the brain, and excitability of serotonin neurons in studies of rodents and zebrafish.[45-47] Social isolation may also affect levels of dopamine; serotonin and dopamine have effects on aggression, depressive behaviors, and anxiety behaviors.[45-48] HPA axis response to acute stressors is greater in socially isolated rats compared to non-isolated rats.[49] In human adults age 60 to 64 years, social isolation as measured by recent widowhood or newly living alone was associated with higher nighttime cortisol levels.[50] In middle-aged adults, social isolation was associated with a greater increase in cortisol upon awakening at the beginning of the day, as well as higher cortisol output throughout the day.[51] Other neurobiological systems may be associated with social disconnection and contribute to psychological distress and suicide-related thoughts and behaviors, including neuroinflammation, glutamatergic, and neuroplasticity processes.[52] Further research on whether these processes mediate the associations between social disconnection and suicide in late life may identify additional mechanisms and targets for preventive intervention.

Research on the associations between dementia-related neuropathologies and social disconnection suggests other potential mechanisms. Dementia is associated with changes in social functioning and increased loneliness,[53,54] and social changes have also been identified in preclinical, cognitively normal older adults presenting with dementia-related neuropathologies. Social engagement declined more over three years in cognitively normal older adults who present with higher beta-amyloid levels in the brain, a risk factor for Alzheimer's disease, compared to those with lower beta-amyloid.[55] In the group of participants with higher beta-amyloid, those with low baseline social engagement also exhibited faster decline in cognitive functioning over time compared to those who were

more socially engaged.[55] Cross-sectionally, greater beta-amyloid burden in the brain is associated with greater loneliness among cognitively normal older adults, even after controlling for objective social network.[56] Greater tau pathology in the right entorhinal cortex is also associated with greater loneliness among cognitively normal older adults.[57] These studies suggest specific brain pathologies associated with cognitive disorder in older adults may also be related to social engagement and perceived loneliness, independent of objective social support or social network. Social disconnection and suicide risk may also be linked with preclinical or mild neurobiological and neuro cognitive changes; although severe or late-stage cognitive impairment is associated with lower risk of death by suicide in several studies, mild or early-stage cognitive impairment can be a risk factor for suicide.[58-60] Additionally, impairment in specific neurocognitive functions, such as executive functioning, are associated with suicide risk[61,62] and may be related to neurocognitive processes such as those involved in reward learning that are discussed in the next section.

Behavioral mechanisms

Social connections are linked to healthier behaviors, whereas social disconnection has been linked to riskier and/or less healthy behaviors such as substance use and poor sleep patterns/ habits,[63-66] which in turn are associated with suicide-related thoughts and behaviors. For example, substance use is strongly associated with suicide risk at all ages, including late life. [67] Sleep problems such as insomnia are related to suicide risk.[68] Social connections may also be linked to engagement in pleasant activities, which are protective against depression[69]; in one study of community-dwelling older adults, engagement in pleasant activities mediated the association between physical disability and depression.[70] These behavioral mechanisms are likely modifiable, and therefore may be intervention targets.

Another behavioral mechanism by which social connection may influence suicide risk is via coping and help seeking behaviors. According to lifespan developmental theories, such as the Selection, Optimization, and Compensation model (SOC)[71] and the Motivational Theory of Lifespan Development[72], with age people experience changes in functioning that affect their ability to reach their goals. When this occurs, they must utilize different coping strategies to optimize ability to reach goals. One important coping strategy may be seeking help from others. The use of compensatory strategies such as help seeking among those with functional limitations is associated with reduced suicidal ideation.[73] The ability to seek and receive help as a compensatory strategy, however, may be somewhat dependent upon the availability and willingness of one's social network to provide such support. In addition, receiving help that is inconsistent with one's perceived need or values (e.g., receiving care when one places high value on independence) may be detrimental rather than helpful.[74]

Behaviors involved in decision making that may impact social interactions include reinforcement learning and expected reward value calculations in making social choices. Social adaptation and particularly the ability to reciprocate depend on cortico-striato-thalamic reinforcement learning.[75] In turn, impaired reinforcement learning and value-based decision-making have also been linked to suicidal behavior and lethality of suicide attempts in late life.[76-80] Further, while suicidal behavior was previously understood in terms of short-sighted preferences, recent work suggests that older high-lethality suicide attempters

display inconsistent reward valuation, rather than a true stable preference for immediate rewards.[81,82] The interplay of age-related social demands and decision-making deficits may serve to further explain suicide risk in late life.

Psychological distress and mental disorders

As mentioned above, later life is generally associated with improved emotional well-being due to greater selectivity around rewarding, close social relationships.[10] Research has shown that maintaining such close, intimate social relationships, even while pruning less-close or peripheral relationships, in late life is associated with greater emotional well-being.[10,83] However, emotional or psychological distress may still occur among those who lack or have lost closer social partners.[10] On the other hand, variety in types of social contacts, and particularly more peripheral/weak ties, may also have benefits in late life.[84]

Depression and other forms of psychological distress are the most commonly identified risk factors for suicide in late life.[85] Therefore, one mechanism through which social disconnection may contribute to suicide risk is through increases in psychological distress. Many studies discussed above on biological and behavioral mechanisms have demonstrated effects on depression, suggesting direct and indirect effects of social disconnection on psychological distress. Workshop participants discussed research on associations between social disconnection and depression. For example, research with African American older adults has shown that emotional support is negatively associated with depressive symptoms, while negative social interactions are positively associated with depressive symptoms.[86] Examining the difference between subjective and objective social isolation, research has shown that subjective isolation is most consistently associated with depressive symptoms and psychological distress in older African American, Black Caribbean, and non-Hispanic White adults.[87] These results show how various aspects of social connection can be associated with psychological distress, and the importance of examining the influence of cultural factors in shaping the experience of social connections and their impact on mental health.

Gaps in knowledge & future directions

Observational studies have demonstrated associations between diverse indices of social connection and suicide risk in later life, but few studies have focused on the mechanisms that explain the association between social disconnection and suicide in late life, and very little is known about the extent to which indices of social connection are modifiable via intervention. Research is needed to identify which dimensions of social disconnection are most strongly linked with suicide-related thoughts and behaviors, and the causal pathways by which risk is affected. A challenge for this work is both 1) examining multidimensional measures of social connection/disconnection and associations between varied mechanisms for the purpose of understanding the structure of risk, and 2) disentangling the specific effects of individual mechanisms for the purpose of targeted intervention. Multidimensional measures that include and differentiate diverse aspects of social connection, including structural, functional, and quality measures, may be especially useful indicators of those at risk for suicide,[9] but it is not known if these measures are suitable for assessing intervention effects over time, nor if they identify useful targets. Translational science may also be

particularly beneficial in examining interactions between the biopsychosocial mechanisms discussed above and in examining pathways from mechanisms to clinical outcomes, rather than examining only segments of the paths. Advances in theories of suicide may facilitate this integrative work.[88] Greater understanding of the degree to which social disconnection contributes to suicide risk versus the presence of social connection mitigating the effect of other mechanisms may identify the most useful intervention targets and increase understanding of the etiology of suicide. Research on cultural and social differences in groups at lower risk for suicide, sometimes even despite arguably greater exposure to stressors (e.g., older Black women who exhibit some of the lowest suicide rates in the U.S. [3]), can inform our understanding of the roles of risk and protective mechanisms. The most potent mechanisms of risk and intervention targets may differ across cultural and sociodemographic groups.

Data science and examining big data may inform the study of mechanisms in the association between social connections and suicide in late life. The Veterans Affairs (VA) healthcare system, as the largest integrated health care system in the U.S., offers an example of using large-scale health data to examine predictors of suicidal behavior and death by suicide. The VA screens patients for suicidal ideation and several risk factors at patient visits, and VA health care data can also be linked with cause-specific mortality data. Research on risk and comorbidity/diagnosis profiles of older adults last seen in primary care before a suicide attempt (fatal and non-fatal) has shown that profiles characterized by chronic pain or by minimal comorbidity (both with low occurrence of depression diagnoses) were associated with more fatal attempts (mostly with firearms) than profiles characterized by higher comorbidity.[89] Such results may reflect lower engagement with the health care system among the lower comorbidity/diagnosis groups, differences in methods used for attempts, and limitations in assessment for and diagnosis of depression in primary care settings. More effective engagement and interaction of Veterans with services may help to mitigate suicide risk. Other research has found that major life transitions (e.g., release from prison) are also associated with greater suicidal behavior in late life.[90] A factor in this phenomenon may be disconnection from one's social network while incarcerated and difficulty transitioning without adequate social support; increasing supportive services upon release/transition may reduce risk. These examples demonstrate how big data can be utilized to identify risk factors for late-life suicide that may be influenced by social processes. One important consideration for big data research is assessment and access. These lines of research are highly dependent upon the types and reliability of data collected by large health care systems, and data on social connections and social processes are rarely collected and documented in primary care and other health care settings on a consistent basis. Policy changes rooted in the public health implications of social disconnection may facilitate greater attention to and collection of social data in health care. The Institute of Medicine and the National Academy of Sciences recommend assessment of social determinants of health, including social connection, in health care settings,[14,91] which would make more data available regarding social connection in large portions of the population.

Engaging Targets – Development and Implementation of Interventions

As research moves from the examination of potential target mechanisms through which social disconnection may influence suicide risk in late life, toward the development of interventions to improve social connection and reduce suicide risk, several considerations will be critical. Attendees at the NIMH workshop discussed several issues involved in applying what is known about social disconnection as a mechanism in suicide risk in later life to intervening on social connection as a target of behavioral interventions: assessment and intervention outside research contexts, the role of interventions to reduce psychological distress, the role of interventions to increase social engagement, and the use of digital technology. The discussion also covered lessons learned and new questions highlighted by the current COVID-19 pandemic.

Assessing social connection in the context of interventions involves several decisions: 1) what dimension of social disconnection will identify a population at risk; 2) how is the dimension best operationalized; 3) what language around social disconnection is understandable and acceptable to older adults (including sub-populations such as those with cognitive impairment); 4) what dimension of social connection is hypothesized to change from the intervention and over what period of time; and 5) what organizational factors of the community and/or context where the intervention will be delivered might impact assessment selection (e.g., administration time and availability in the electronic medical record). A person-centered perspective may be especially useful in the context of intervening on social connections, as older adults vary with regards to aspects of social connection that are most important to them; acceptability of interventions will be impacted by such values and preferences.[92] Assessing barriers to social connections may also be useful in an intervention context. For example, older adults living in high-crime neighborhoods may be hesitant to engage socially when there are significant barriers related to safety and opportunity.[93] Two promising assessment methods include the PROMIS patient-reported outcomes measurement system[94] and the Berkman-Syme measure endorsed by the Institute of Medicine.[91] Both include social health domains, have established population norms, and can be integrated into electronic medical records in the context of assessing social determinants of health, consistent with Age Friendly Health System[95] approaches.

Several of the biological, psychological, and behavioral mechanisms discussed above are potentially modifiable, with evidence-based treatments available. For example, given the availability of several types of pharmacological treatments for regulating serotonin and other monoamines, this may be a modifiable biological target for targeting social disconnection or mitigating risk among socially disconnected older adults. However, preferences of older adults should be considered given that many older patients prefer psychotherapies over medications, and psychotropic medications and polypharmacy come with critical challenges in late life (e.g., increased risk for falls and other adverse events).[96] Behavioral interventions may also effectively target behavioral and biological mechanisms, such as evidence-based interventions for depression (e.g., behavioral activation[97]), substance abuse, and insomnia (e.g., cognitive behavioral therapy for insomnia[98]), which may mitigate suicide risk, in part by improving social relationships. Psychotherapeutic interventions for suicide risk in later life may also work, in part, by disrupting the pathway from social disconnection to suicide

risk via psychological and behavioral mechanisms. Cognitive Reappraisal Intervention for Suicide Prevention (CRISP) targets emotion dysregulation and psychological distress for middle-aged and older adults at risk for suicide.[99] Safety Planning is another intervention that holds promise for older adults and can be adapted to emphasize aspects of social connection that are relevant to suicide in later life.[100]

Interventions to directly target social connection are also available and evidence supporting them is increasing. Such interventions may be implemented at the level of the individual (e.g., increasing social engagement, improving social support, reducing loneliness), the structural level (e.g., addressing social connection as an important outcome within the health care system), and from the perspective of prevention (e.g., teaching patients to maintain healthy relationships).[92] Behavioral interventions directly targeting aspects of social connection such as engagement in social activities, improving social skills, and contributing or volunteering can provide opportunities to improve connection and therefore reduce risk for suicide. Though studies have provided evidence that behavioral interventions can reduce loneliness,[25] to date it is unclear what behavioral interventions are most effective in later life, which are preferred by older adults (especially those at risk for suicide), and by what mechanisms they work. Many interventions for social connection have not been tested in older adults who report social disconnection and even fewer among those at risk for suicide. The evidence for the effectiveness of any given intervention targeting social connection in late life is modest, with a number of interventions in need of standardized protocols and replication of efficacy and effectiveness studies to be better established.[26-31] Some interventions have shown promise in randomized trials with older adults who report social disconnection. A trial of the Senior Connection, a program in which older adults are matched with volunteer peer companions (available nationwide through the AmeriCorps Senior program), showed greater reduction in perceived burdensomeness, depression, and anxiety (versus care-as-usual), but no effect on feelings of belonging or suicide ideation.[101] Psychotherapeutic approaches also hold promise. Behavioral activation modified to target social connection has been shown to increase social interactions and support and decrease loneliness among homebound older adults [102,103] and Engage psychotherapy for depression in later life[104] was shown to be especially effective for depression when social engagement was addressed.[105] Engage has also been adapted to focus specifically on increasing social engagement to reduce suicide risk in later life.[105]

Digital technologies hold promise as an intervention modality. Internet-based and app-based interventions show some effect on prevention and intervention for suicide-related thoughts and behaviors.[106,107] Among older adults, digital modalities such as specialized software systems (e.g., PRISM) have shown some promise for improving social connection in late life.[108] Automated digital modalities may be used to coach older adults on social skills; further trials are needed to accurately determine the effectiveness of this type of program.[109] Emotion regulation interventions may also be effectively implemented via technology, such as through cell phone or tablet applications; the VA offers a number of mental health apps, with research being conducted with older adults on feasibility and educational materials to encourage use.[110,111] However, digital modalities present with design challenges that can make them more difficult to implement in late life, including limits in technological knowledge, hesitancy to engage with technology, and subpopulations (e.g., lower

socioeconomic strata) with limited access to technology or needed internet services.[112] When newer or more complex technologies are unfamiliar to older adults, lack of technology efficacy can be a barrier.[113,114] However, when provided with technologies that are perceived as valuable and easy to use, or offered training in using them, older adults express willingness to engage with them.[114] Finally, though older adults tend to exhibit lower rates of use of computers, internet, and smartphones than younger adults, Pew Research showed in 2017 that approximately two-thirds of older adults used the internet, and over 40% owned smartphones; these numbers are likely increasing with time and demonstrate that a significant portion of the older population does have access to and utilizes digital technologies.[115] More research in this area can identify the utility and effectiveness of digital interventions to improve social connections and reduce suicide risk among older adults. Importantly, for digital solutions to be effective, devices must be designed using a user-centered approach. Other recent research has begun to study identification of suicide risk via analysis of digital data such as social media posts and search engine inputs; little has been published yet on this in regard to older adults, but this line of research represents another opportunity to study identification of social disconnection and suicide risk in this population.

Gaps in knowledge & future directions

Challenges to developing and testing social connection interventions for suicide prevention among older adults include determining how effectively such interventions reduce suicide risk (largely unknown at this time), and engaging the most socially disconnected older adults in interventions and research studies, given that these older adults may have little to no interaction with formal mental health services, aging services, or social services. Partnering with organizations or systems that are more likely to make contact with these individuals, such as home-delivered meal services, visiting nurses, other home care services, primary care providers, etc. may allow greater access to those most at risk as well as better scalability for effective interventions. Another challenge is that social disconnection has numerous dimensions and causes, raising the possibility that individualized intervention strategies may be needed (or preferred) by older adults. One hypothesis is that the most effective intervention strategy will engage the target(s) most relevant to the individual, and therefore an evidence base of interventions that engage a variety of targets, accompanied by assessment approaches to determine the most appropriate target, may provide an effective approach. However, this individualized approach may be resource-intensive and could incur challenges in scalability. Research is needed to examine the relative costs and benefits of personalized strategies. Additional challenges for improving social connection given that this intervention target is not a mental health condition include identifying optimal settings and interventionists (e.g., social workers, care managers, nurses in primary care, community health workers, peers), selecting the mode of delivery (e.g., individual or group sessions, in person, or via digital technology), as well as optimal dose to increase connection and reduce suicide risk (e.g., number of sessions, over how much time).

The COVID-19 pandemic and need for physical distancing has increased the saliency of remote and/or digital interventions. The comparative effectiveness of in-person social connection and suicide interventions versus virtual/remote interventions is an area for future

study and will require attention to digital health literacy, access to technology (including for socioeconomically disadvantaged groups), protection of privacy and data security, as well as preferences of older adults. Older adult-friendly technologies are available, including cell phones and tablets designed specifically for older adults, social robots/robotic pets, and artificial intelligence (AI) devices, though there is little scientific research on the use of these technologies for promoting mental health.

Synthesis and Future Directions

Figure 1 provides a simplified visual representation of the variety of mechanisms and potential intervention targets (some more established, others hypothesized) that we have discussed and related types of interventions that may engage these targets. This model could generate research questions to advance the science of social connections and suicide risk in later life. We posit that social disconnection of a variety of types – including structural, functional, and quality – leads to increased suicide risk via biological (e.g., impairments in neurocognitive functioning, chronic inflammation) and behavioral mechanisms (e.g., increased risky behaviors, decreased engagement in positive activities), which each increase suicide risk directly and/or by increasing psychological distress. Prevention and intervention efforts could target any of these mechanisms, depending upon individual and contextual factors and the need to prevent social disconnection versus reducing risk among those already experiencing social disconnection or suicide-related thoughts and behaviors. Interventions can directly target social connection (e.g., peer companionship or increasing social activities); mitigate some of the biological effects of social disconnection (e.g., medications treating the corollaries of HPA axis activation or chronic inflammation or targeting monoamines); address behavioral mechanisms (e.g., reduction of risky behaviors, treating sleep problems, improving problem solving and decision making, or behavioral activation to increase pleasant activities); or mitigate psychological distress (e.g., psychotherapies to reduce depression, implementation of emotion regulation strategies). The creative and novel research described in this report has highlighted a number of areas in which more scientific study can help to clarify etiological trajectories and establish effectiveness of interventions.

Considerations to shape the development of research questions are outlined in Table 1 and include the necessity of considering cultural contexts and recruitment of all populations of older adults at risk. In the U.S., older white men exhibit the highest rates of suicide. However, older men are often underrepresented in research studies on these topics, and may be more difficult to engage and retain in interventions.[116] Other contextual factors such as current events (e.g., the COVID-19 pandemic) and individual circumstances (e.g., level of functioning, comorbidities) may greatly affect findings and intervention strategies. Greater consistency in the conceptualization, definition, and assessment of social connection is necessary for the integration of findings across studies. Older adults themselves may define these constructs in idiographic ways; the terms "lonely" or "isolated" may hold different meanings and connotations for each individual. The development of measures that include and differentiate between multiple components of social connection may provide more accurate and representative conceptualizations of older adults' social needs. Measures developed to be responsive to the unique needs of older adults and with age-specific norms

or clinically-meaningful cut scores are needed to identify older adults at elevated risk and measure response to intervention.

Social disconnection has numerous dimensions, which suggests tailored intervention strategies may be useful; however, tailored treatment strategies are resource-intensive and their potential incremental benefit should be studied. Costs and benefits of various settings and modalities for interventions, including digital technology, should also be studied given potential implications for acceptability, feasibility, accessibility, scalability of interventions. For example, a large proportion of older adults who die by suicide are in contact with a primary care physician within the prior year or prior month;[117] assessment of social connection and implementation of simple interventions or referral for intervention may have significant impact in a primary care setting.

Finally, research that considers mechanisms at multiple levels of analysis could advance the science of social connection and suicide risk, in line with NIMH's RDoC strategy that emphasizes research on domains (including social processes) from multiple levels, from genetic influences to neural circuits to behavior and self-reported symptoms and experiences.[34] Such study designs may generate testable hypotheses that result in actionable next steps to promote more rapid progression of basic science on social connection to intervention efficacy, to dissemination and implementation of suicide risk interventions at scale.

Acknowledgments

Appendix

[a] Members listed in alphabetical order within categories. *Chairs*: Martha L. Bruce, PhD, MPH, Yeates Conwell, MD. *Presenters*: Patricia Areán, PhD, Amy Byers, PhD, MPH, Laura Carstensen, PhD, Alexandre Dombrovski, MD, Nancy Donovan, MD, Amy Fiske, PhD, Josh Gordon, MD, PhD, Julianne Holt-Lunstad, PhD, Dimitris Kiosses, PhD, Sarah Hollingsworth Lisanby, MD, Maria A. Oquendo, MD, PhD, Carla Perissinotto, MD, MHS, Robert Joseph Taylor, PhD, Kimberly A. Van Orden, PhD. *Moderators/Panelists*: George Alexopoulos, MD, Eric D. Caine, MD, Vonetta Dotson, PhD, Jane Pearson, PhD, Charles F. Reynolds III, MD, Jo Anne Sirey, PhD, Barbara Stanley, PhD. *Discussants*: Lisa Barry, PhD, MPH, Emmy Betz, MD, Lisa Brenner, PhD, Sara Czaja, PhD, XinQi Dong, MD, MPH, Paul Duberstein, PhD, Daniel Jiminez, PhD, Julie Lutz, PhD, Paul Maciejewski, PhD, Briana Mezuk, PhD, Sean Mitchell, PhD, Ann W. Nguyen, PhD, Olivia I. Okereke, MD, MS, Wilfred R. Pigeon, PhD, Holly Prigerson, PhD, Patrick Raue, PhD, Jerry Reed, PhD, MSW,

Timothy Schmutte, PsyD, Caroline Silva, PhD, Katalin Szanto, MD, Harry Owen Taylor, PhD, Sara Weisenbach, PhD.

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Highlights

1. We present a synthesis of research discussed during an NIMH workshop on mechanisms, treatment targets, and interventions related to social disconnection and late-life suicide.

2. Social disconnection is related to suicide risk in late life via biological, behavioral, and psychological mechanisms. Social connection is amenable to change, and there are several promising interventions that may target various mechanisms in the association between social disconnection and suicide, as well as social disconnection itself.

3. More research is needed in this area, and we outline several important considerations for future research.
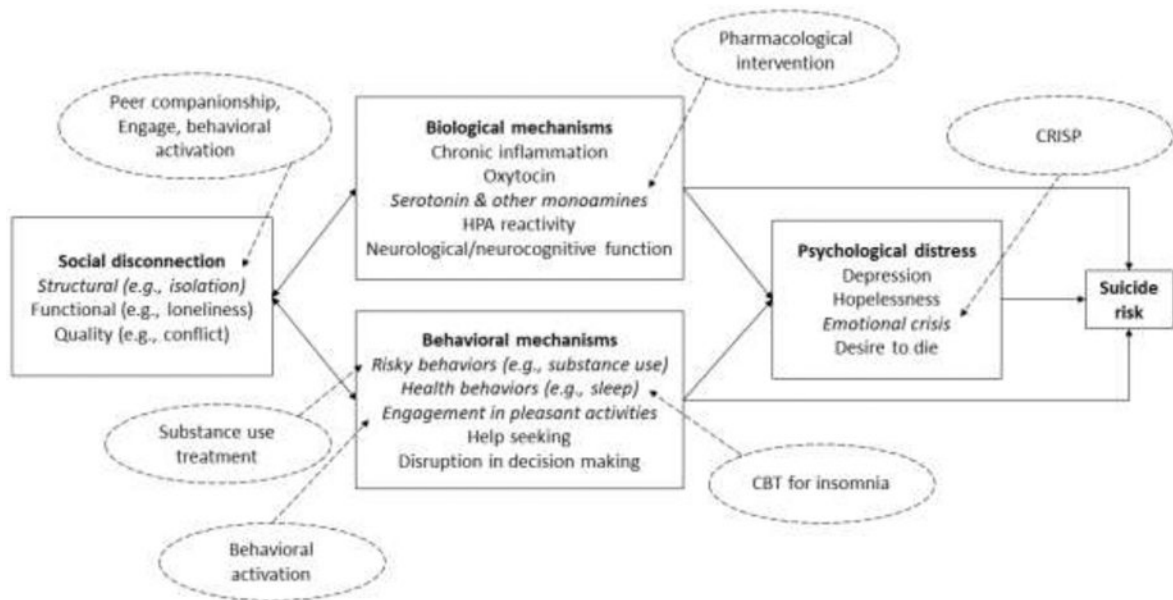
Figure 1.

Model of causal pathway from social disconnection to suicide in late life. Includes mechanisms of this pathway (in solid boxes), as well as potential interventions (in dashed ovals). Examples are provided for all categories; list of examples is not comprehensive. Italicized items are examples of potential targets for intervention discussed in this paper; this is not a comprehensive representation of all mechanisms that may be targeted.

Table 1

Important considerations and future research directions

Contextual/Cultural Factors

- How do we address relevant current events (e.g., COVID-19)?

- What interventions may be most effective for homebound individuals and individuals with functional impairments?

- How does cognitive impairment affect social disconnection and late life suicide? What interventions may be most effective for those with cognitive impairment?

- How do medical comorbidities affect social disconnection and late life suicide? What interventions may be most effective for those with medical comorbidities?

- How do sociodemographic factors (e.g., gender, age, race/ethnicity) affect social disconnection and late life suicide, and what interventions may be most effective for different populations?

- How do cultural and familial social values affect social disconnection and late life suicide and impact the effectiveness of interventions?

- How will intervention be received within the community?

Measurement & Definitions of Social Disconnection

- What are the pros and cons of conceptualizing and measuring social connections in a unidimensional vs. multidimensional way?

- What are the effects of objective vs. subjective social disconnection?

- How validity are assessment instruments among older adults?

Individualization

- Why does this individual feel lonely/isolated/disconnected?

- What aspect(s) of social connection is/are important to this person?

- How does this person define social connection/loneliness/isolation?

- How do we select interventions based on individuals' needs?

Intervention Modality

- How do we engage socially disconnected older adults in intervention?

- In what settings arere interventions implemented (e.g., primary care, emergency department, within community, home services), and how does that affect impact?

- What is the effectiveness of in-person vs. virtual/remote intervention?

- How can we use technologies (e.g., telephone, video, internet, smartphone/tablet app) for intervention?

Transdisciplinary/Convergence Science

- How do we integrate biomedical, neurocognitive, psychological, behavioral, and social sciences in this area?

- How do we examine whole trajectories, mediators, and moderators rather than siloed associations?