Suicide is a significant and growing problem in the United States. According to the Centers for Disease Control and Prevention (CDC), suicide is the tenth leading cause of mortality in the U.S., accounting for almost 45,000 deaths in 2016 [1]. Although mental health concerns are often cited as a primary causal factor for suicide, 52.8% of active-duty service members or reservists who died by suicide in 2016 had no known mental health diagnosis [2].

Suicide prevention is a primary area of focus for the Department of Defense (DoD) and the Department of Veterans Affairs (VA). Previously, the suicide rate among civilians had been higher than the military rate. It was thought that this was due to several factors, including “a selection bias for healthy recruits, employment, purposefulness, access to healthcare and a strong sense of belonging [3].” However, this protective effect has eroded over the past two decades.

As of the most recent Department of Defense Suicide Event Report (DoDSER) in 2016, suicide rates of active-duty service members are on par with those for the U.S. general population [4]. Veterans are at an even higher risk of suicide than active-duty service members, Guard members, or Reservists [5]. The vet-
The VA and DoD have allocated significant resources to reduce suicide rates in active-duty and veteran populations. Multidimensional and multidisciplinary approaches to suicide prevention employed by the DoD include mental health awareness training for all military members; mental health treatment referral guidelines; post-suicide intervention programs; life skills training; and increased staffing of mental health providers [6–11].

In addition to bolstering traditional 24/7 call lines such as the VA's Veterans Crisis Line and increasing access to "Telemental" health services, researchers across the country have turned to emerging technologies to facilitate the prevention of suicide. This research has primarily focused on creating machine learning algorithms to identify predictive risk factors in the electronic health records of patients [12, 13]. Other approaches to detect suicide risk include using natural language processing (NLP) of text, social media, or auditory conversations [14]; passive sensing of mobile phone data [15]; and developing machine learning algorithms to evaluate risk from self-reported data [16, 17].

Intervention strategies that employ technology include the use of mobile health applications to reduce suicide rates [18] and the development of algorithms to identify optimal suicide prevention strategies [19]. The military has adopted a number of these strategies to improve suicide risk detection and prevention. For example, initiatives such as the VA's REACH VET, education-based mobile apps, and the VA's "Make the Connection" outreach campaign have all improved access to resources for at-risk individuals. Despite substantial resources devoted to reducing suicide rates in active-duty and veteran populations, suicide rates remain unacceptably high. Though some initiatives have demonstrated efficacy in reducing rates, the critical question remains: why are suicide rates still increasing?

**Barriers to Suicide Rate Reduction**

Unfortunately, there are substantial barriers to reducing suicide rates in both active-duty and veteran populations. Although a multitude of factors contribute, there are at least four prima-
provides veterans or active-duty service members who are not connected with healthcare services. This is particularly helpful for veterans who live in remote areas, and cannot easily access healthcare services because of geographic or physical constraints. Although the app does require the use of an iOS- or Android-capable smartphone, figures from 2014 indicate that up to 79% of all surveyed active-duty Army personnel [33] and up to 90% of veterans [34] own a smartphone. For service members who are capable of using a smartphone and who accept the approach, they are matched with a trained behavioral health coach who provides 24/7 in-app messaging.

The app is built on a patient engagement messaging platform that has serviced over 200,000 patient-provider exchanges to date. Behavioral health coaches are supported by in-app AI algorithms to increase engagement. Our system utilizes proprietary algorithms to prompt the coach on when and how to reach out to the user to maximize engagement. This elevates the quality of care beyond what is currently available through crisis lines, because the coach is more knowledgeable about how to develop and sustain a meaningful relationship with the user.

**Stigma/aversion to help-seeking:** Though both public and self-stigma will continue to be cultural barriers to accessing care in the military, we believe that our approach has the potential to substantially reduce such stigma: access to care through our app is more private than what is typically afforded through in-person medical or psychotherapy services. Furthermore, with trained veterans serving as behavioral healthcare coaches, military personnel will have more confidence in shared understanding with care providers.

Perhaps most importantly, however, the app provides veterans or active-duty service members the option to invite natural support network members into their care circle. Through a combination of psychoeducation, AI-directed messaging, and direct intervention by behavioral health coaches, this system seamlessly integrates the care of supporting members into the life of an at-risk individual. Our app is consequently a very scalable healthcare solution because a single behavioral health coach can cover hundreds of military personnel.

**Timeliness of intervention:** Unlike other systems, Voi Reach does not require a veteran to overtly ask for help, as it predicts imminent risk using AI. This solves one of the biggest problems associated with suicide prevention. The app uses advanced NLP to identify at-risk communications within the platform, or through social media (if the user grants permission). This NLP system is built on a specific type of supervised machine-learning system called genetic programming (i.e., a computerized system that can learn to recognize patterns associated with a known outcome) [35].

The system was constructed by converting the free-text records of veterans with known suicide attempts into word or word-phrase datasets, or numerical counts of how often a given word or phrase appeared in a patient record. The derived models then identified the combination of words that were associated with suicide. The data were then analyzed using a machine-learning algorithm to generate predictive models. This approach allows a remote behavioral health coach to be aware instantly when a service member transitions to high risk. Furthermore, a remote coach can then send out emergency services for an active rescue within five minutes of the status change.

**Conclusion**

While many technological solutions have been developed to address the problem, suicide rates among active-duty service members and veterans continue to rise. We believe this is due primarily to an inability to stay effectively connected to military personnel and appropriately monitor them for risk long-term. Unlike other solutions, our AI-enabled app-based approach is the first to predict imminent risk, which then allows a behavioral health coach to rapidly reach out to a service member after a risk status change. This is in contrast to other approaches that require those in need of help to ask for it—a problem that, unless we overcome it, will inhibit any significant decline in suicide rates. It is our hope that new, novel applications of technology gain acceptance so that we can move the needle on the tragic and preventable loss of life in the military.

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**References**


11. Medical and Dental Care: Members on Duty Other than Active Duty for a Period of More than 30 Days. 10 U.S.C. § 1074a et seq.


