QUERI

Systematic Review of Suicide Prevention in Veterans

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PREFACE

The VA Evidence-based Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted healthcare topics of particular importance to clinicians, managers, and policymakers as they work to improve the health and healthcare of Veterans. QUERI provides funding for four ESP Centers, and each Center has an active University affiliation. Center Directors are recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Centers. The ESP is governed by a Steering Committee comprised of participants from VHA Policy, Program, and Operations Offices, VISN leadership, field-based investigators, and others as designated appropriate by QUERI/HSR&D.

The ESP Centers generate evidence syntheses on important clinical practice topics. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The ESP disseminates these reports throughout VA and in the published literature; some evidence syntheses have informed the clinical guidelines of large professional organizations.

The ESP Coordinating Center (ESP CC), located in Portland, Oregon, was created in 2009 to expand the capacity of QUERI/HSR&D and is charged with oversight of national ESP program operations, program development and evaluation, and dissemination efforts. The ESP CC establishes standard operating procedures for the production of evidence synthesis reports; facilitates a national topic nomination, prioritization, and selection process; manages the research portfolio of each Center; facilitates editorial review processes; ensures methodological consistency and quality of products; produces "rapid response evidence briefs" at the request of VHA senior leadership; collaborates with HSR&D Center for Information Dissemination and Education Resources (CIDER) to develop a national dissemination strategy for all ESP products; and interfaces with stakeholders to effectively engage the program.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, ESP CC Program Manager, at Nicole.Floyd@va.gov.

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TABLE OF CONTENTS

FIGURES

EVIDENCE REPORT

INTRODUCTION

PURPOSE

This systematic review updates evidence on the accuracy of methods to identify individuals at increased risk for suicide, and the efficacy/effectiveness and adverse effects of healthcare service interventions in reducing suicide and other suicidal self-directed violence. Important areas of ongoing research and current evidence gaps on suicide prevention are also addressed. This report includes studies relevant to healthcare services provided to Veterans and military personnel in the United States (US).

Previous systematic reviews by the US Department of Veterans Affairs (VA) Evidence-based Synthesis Program (ESP) focused on strategies for suicide prevention in Veterans,[1] suicide risk factors and risk assessment tools,[2] and suicide prevention interventions and referral/follow-up services.[3] While many of the studies included in the previous reviews fall outside the scope of this update, relevant studies are included in order to consolidate the evidence.

BACKGROUND

Suicide is a major health concern in the US. A recent estimate of the overall US crude suicide rate was 12.4 per 100,000 population; the rate for males was nearly four times that for females (19.8 and 5.3 per 100,000).[4] Suicide rates also vary by age and other demographic characteristics.[4] Several factors have been associated with increased risk for suicide in epidemiological studies. The most consistently associated risk factors include the presence of mental health disorders, particularly depression, posttraumatic stress disorder, and substance abuse.[2]

Veterans and military personnel represent 20% of all known suicides in the US.[5] Rates of suicide increased during the wars in Afghanistan and Iraq,[6] and Veterans of these wars who reported suicidal ideation identify challenges during and after deployment as major contributors to their distress.[7] Between 2000 and 2010, the suicide rate among Veterans rose higher than the rate among civilians.[8] Female Veterans are at especially high risk relative to other women.[8] These trends have led to new initiatives within the VA and military to address suicide prevention.

One such initiative is the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS), a multi-component epidemiological and neurobiological study. Army STARRS is designed to increase knowledge about risk and resilience factors for suicidality and support evidence-based recommendations to reduce suicides specifically among Army soldiers.[9] Determination of risk and resilience factors in this population could lead to the development of additional methods to identify individuals at increased risk for suicide who may benefit from prevention interventions.[10,11]

CURRENT PRACTICES

During the year prior to suicide, an estimated 77% of individuals make contact with primary care and 32% with mental health care clinicians.[12] These encounters provide opportunities for suicide

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risk assessment and treatment of physical and psychiatric conditions that are associated with suicide.[13] However, screening for suicide risk in general medical practice is not part of standard care in the US. The US Preventive Services Task (USPSTF) recently concluded that there is currently not enough research to support routine screening for suicide risk[14] based on a systematic review of studies of screening and prevention interventions.[15,16] This recommendation was intended for patients in primary care settings that do not have existing mental health disorders, emotional distress, or previous suicide attempts, and it did not specifically address Veterans and military personnel. The USPSTF encouraged primary care clinicians to be alert to the possibility of suicide during periods of high suicide risk, such as after discharge from a psychiatric facility or following an episode of self-harm or suicide attempt.[14] Other recommendations from the USPSTF support routine screening in primary care for conditions associated with increased suicide risk. These include screening for depression,[17] alcohol use,[18] and intimate partner violence.[19]

The Veterans Health Administration and the Department of Defense issued their *Clinical Practice Guideline for the Assessment and Management of Suicide Risk* in 2013.[20] Goals of the guideline are to reduce practice variation and provide a structural framework to reduce suicide and other suicidal self-directed violence, provide evidence-based recommendations for healthcare providers, and support the development of practice-based evidence. This guideline is organized around 3 clinical algorithms, including Assessment and Management of Risk for Suicide in Primary Care; Evaluation and Management of Risk for Suicide by Behavioral Health Providers; and Management of Patients at High Acute Risk for Suicide. However, the guideline does not recommend a specific risk assessment method or prevention intervention because of the lack of adequate supporting evidence.

Efforts to prevent suicide in individuals at high risk generally include treatment of underlying conditions and psychotherapy.[1,3] Psychotherapy most often includes cognitive behavioral therapy and related approaches, such as dialectical behavior therapy and problem-solving therapy. Additional efforts include restriction of access to lethal means, including firearms and toxic agents.[1]

In addition to individual-level approaches to suicide prevention, initiatives have been implemented at organizational, health system, and community levels. These include multifaceted interventions emphasizing education and awareness, suicide hotlines and outreach programs, treatment coordination programs, and others. However, despite the existence of many types of services, very few studies demonstrating their effectiveness have been published.[1] As a result, their influence on suicide prevention remains unclear.

METHODS

TOPIC DEVELOPMENT

This project was nominated by Theresa Gleason, PhD, (Acting) Deputy Chief Research and Development Officer at the VA, with input from a technical expert panel. It is intended to update 3 previous VA ESP systematic reviews related to suicide screening and prevention published in 2009 and 2012.[1-3] The scope and key questions of this report were determined during a topic refinement process that included a preliminary review of published peer-reviewed literature, discussion with internal partners and investigators, and consultation with content experts and key stakeholders.

This systematic review focuses on the accuracy of suicide risk assessment methods and the efficacy/effectiveness of suicide prevention interventions. Studies of associations between risk and protective factors and suicide are not included because of an ongoing large epidemiological study specifically among Army soldiers, Army STARRS, which will likely provide the strongest and most applicable evidence on this topic.[9] A protocol describing the review was posted to the PROSPERO International Prospective Register of Systematic Reviews website before the review was initiated (http://www.crd.york.ac.uk/PROSPERO; registration number CRD42015019089).[21] This review follows established systematic review methodology.[22]

Investigators created an analytic framework outlining the key questions, patient populations, interventions, and outcomes (**Figure 1**).

Figure 1. Analytic Framework
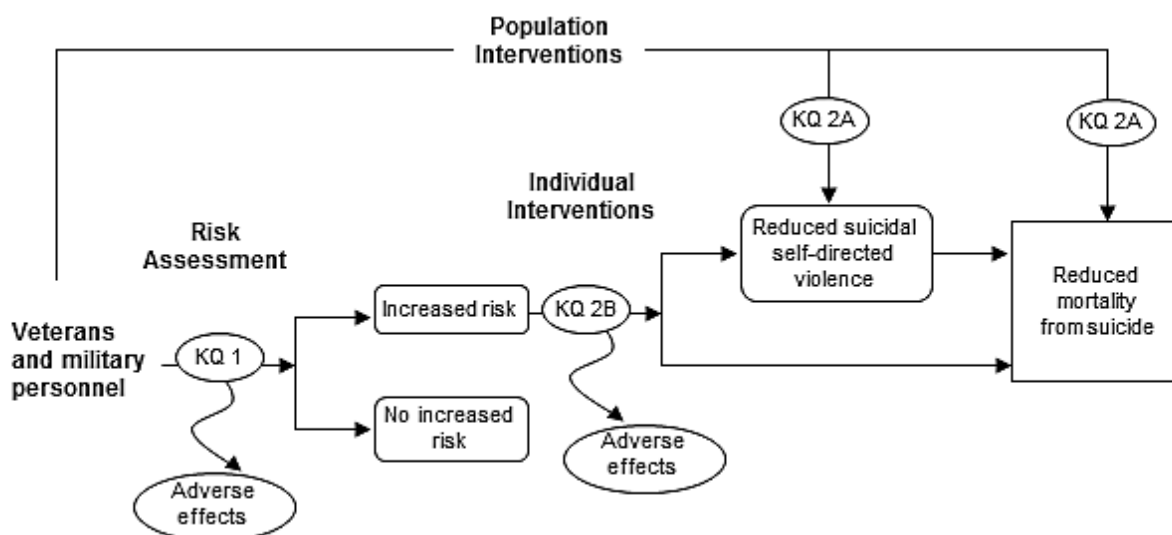
This systematic review is an update of previous VA ESP reviews that addresses the following key questions:

Key Question 1

A) What are the accuracy and adverse effects of methods to identify Veterans and military personnel at increased risk for suicide and other suicidal self-directed violence?

B) Does accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors?

Key Question 2

What are the efficacy/effectiveness and adverse effects of suicide prevention interventions in reducing rates of suicide and other suicidal self-directed violence in Veterans and military personnel? Interventions include healthcare services directed towards:

A) Populations (*eg*, hotlines, outreach programs).

B) Individuals (*eg*, case management, follow-up).

Key Question 3

What are important areas of ongoing research and current evidence gaps in research on suicide prevention in Veterans and military personnel, and how could they be addressed by future research?

Outcomes related to the efficacy and effectiveness of suicide risk assessment and prevention interventions included in this review are reduced suicide and other suicidal self-directed violence. Suicidal self-directed violence is behavior against oneself that deliberately results in injury or the potential for injury with evidence of suicidal intent, as defined by the Centers for Disease Control[23] and the VA.[24] Suicide is a fatal outcome of suicidal self-directed violence. Other types of self-directed violence are outside the scope of this review, including non-suicidal self-directed violence and self-harm, or composite outcomes that include these behaviors.

Adverse effects of suicide risk assessment and prevention interventions include any outcomes related to these activities that are not beneficial to the patients experiencing them. Criteria for adverse effects are intentionally broad, but need to be clinically relevant. Adverse effects generally include health outcomes as well as other types of outcomes, including anxiety and distress, labeling, and stigma.

SEARCH STRATEGY

In conjunction with the systematic review investigators, a research librarian searched electronic bibliographic databases for relevant research published between January 1, 2008 and September 11, 2015, including MEDLINE, PubMed, PsycINFO, SocINDEX, Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews. These dates were selected in order to capture studies published since the search dates of the previous VA ESP systematic reviews on this topic.[1-3] Search terms and strategies are described in **Appendix A**. A search of the grey literature was conducted on July 16, 2015. In addition, citations from reference lists of relevant primary studies, reviews, conferences proceedings, and from clinical and research

experts were reviewed. All citations were imported into an electronic database (EndNote® X6, Thomson Reuters).

STUDY SELECTION

Titles and abstracts were reviewed for inclusion using pre-specified eligibility criteria (**Appendix B**). Full-text articles identified as potentially relevant to the key questions were retrieved for further review and were independently examined by 2 reviewers using the eligibility criteria. Disagreements were resolved through consensus using a third reviewer.

Consistent with the previous VA ESP reviews, eligible studies included populations of Veterans, military personnel, and demographically comparable non-Veteran/military adults aged 18 and older from the US, United Kingdom (UK), Canada, New Zealand, and Australia. These countries were chosen because of their similarities to the US in terms of healthcare services as well as their involvement in the Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) conflicts. Studies enrolling participants substantially different from the general VA/military population (*eg*, children and adolescents) or with serious co-morbidities (*eg*, advanced cancer) were outside the scope of this review. Also, only English-language articles were included. Systematic reviews were eligible if they were timely, and contained relevant studies that addressed the key questions and met inclusion criteria for this update.

For Key Question 1, included studies evaluated the diagnostic accuracy and adverse effects of methods to assess risk for suicide and other suicidal self-directed violence, including instruments, checklists, and other approaches appropriate for clinical settings. Outcomes included measures of the accuracy of the risk assessment method (**Table 1**). Sensitivity measures were emphasized in this review because the serious morbidity and potential mortality associated with suicidal self-directed violence makes identifying individuals at risk for suicide, and thus providing opportunities for prevention interventions, more important than identifying individuals who at not at risk. This approach prioritizes sensitivity over specificity. Studies considering the setting, mode of delivery, and timing of risk assessment were also included. Studies were excluded that primarily determined associations between individual risk factors and suicidal self-directed violence, evaluated psychometric characteristics of instruments, or provided only descriptions of methods without reporting measures of accuracy.

Table 1. Measures of Test Accuracy

Statistical Term	Description
Sensitivity	Probability of a positive test among patients with the condition.
Specificity	Probability of a negative test among patients without the condition.
Positive predictive value (PPV)	Probability of the condition among patients with a positive test.
Negative predictive value (NPV)	Probability of not having the condition among patients with a negative test.
Receiver-operator characteristic curve (ROC)	A graph of sensitivity/(1-specificity).
Area under the ROC curve (AUC)	Reflection of how good the test is at discriminating between patients with and without the condition. Also referred to as the c-statistic. The greater the area, the better the test (0.50 no better than chance; 0.51-0.69 poor; 0.70-0.79 fair; 0.80-0.89 good; 0.90-0.99 excellent; 1.0 perfect).

For Key Question 2, studies of the efficacy or effectiveness of interventions were included that were specifically designed to prevent suicide and other suicidal self-directed violence. Eligible study designs included randomized controlled trials (RCTs), observational studies with comparison groups, and systematic reviews with these study designs. Efficacy studies evaluate an intervention under controlled circumstances, while effectiveness studies generally reflect more real-world conditions. Interventions included healthcare services directed towards populations (*eg*, hotlines, outreach programs) or individuals (*eg*, case management, follow-up services) that are clinically relevant to medical practice in the US. Both primary and secondary prevention studies were included. Primary prevention interventions are intended for individuals who have not experienced previous suicidal self-directed violence, while secondary prevention interventions are for those who have had previous episodes. Studies of interventions that are intended to primarily treat co-existing conditions and studies of pharmacotherapy were outside the scope of this update.

Key Question 3 addresses evidence gaps identified from the synthesis of studies addressing Key Questions 1 and 2. Consequently, studies included for Key Question 3 were identified from the searches for Key Questions 1 and 2. In addition, ongoing studies were selected from websites and other sources identified by our search of grey literature based on their relevance to the key questions. Our list of ongoing studies is likely incomplete because not all ongoing studies are included in these accessible sources.

DATA ABSTRACTION

Data from included studies for Key Questions 1 and 2 were abstracted into a customized, pre-piloted database by one reviewer and over-read for accuracy by a second reviewer. Abstracted information included study design, setting, population, methodology, and results. Additional information for Key Question 1 included measures of accuracy, including sensitivity, specificity, positive and negative predictive value, or similar outcomes. Additional information for Key Question 2 included details of the intervention and control groups, important co-interventions, implementation factors, suicidal self-directed violence outcomes (suicide attempt and suicide), and other relevant outcomes.

QUALITY ASSESSMENT

Two reviewers independently assessed the risk of bias of included studies using pre-specified criteria for RCTs,[25] observational studies,[26,27] and diagnostic accuracy studies[26,28] (**Appendix C**). Each study was given an overall summary assessment of low, high, or unclear risk of bias. Disagreements were resolved through consensus using a third reviewer.

DATA SYNTHESIS

Since this review is an update of previous VA ESP reviews, conclusions are based on qualitative synthesis of the findings of recently published studies as well as relevant studies from the previous reviews. Measures, interventions, outcomes, and study participants were too heterogeneous to combine in statistical meta-analysis.

RATING THE BODY OF EVIDENCE

The overall strength of evidence for studies of interventions reviewed for Key Question 2 was determined using a method developed for the Agency for Healthcare Research and Quality's (AHRQ) Evidence-based Practice Centers (EPC).[29] This method does not provide strength of evidence grades for the diagnostic accuracy studies reviewed for Key Question 1. The AHRQ EPC method considers study limitations, directness, consistency, precision, and reporting bias to classify the strength of evidence for individual outcomes independently for RCTs and observational studies. Supplemental domains include dose-response association, plausible confounding that would decrease the observed effect, and strength of association, as well as separate guidance for applicability. Ratings were based on the following criteria:

- High = Very confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has few or no deficiencies, the findings are stable, and another study would not change the conclusions.
- Moderate = Moderately confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has some deficiencies and the findings are likely to be stable, but some doubt remains.
- Low = Limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). Additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
- Insufficient = No evidence, unable to estimate an effect, or no confidence in the estimate of effect for this outcome. No evidence is available or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

RESULTS

SEARCH RESULTS

Results of the literature search and selection process are summarized in the literature flow diagram (**Figure 2**). Database searches resulted in 7,708 potentially relevant citations and another 80 were identified from the bibliographies of studies and systematic reviews, for a total of 7,788 citations. After review of abstracts and titles, 673 articles were selected for full-text review. After dual review of full-text articles, 28 recently published studies were included, 15 for Key Question 1 and 13 for Key Question 2. In addition, 9 studies from the previous VA ESP reviews also met inclusion criteria for this review.

Figure 2. Literature Flow Chart
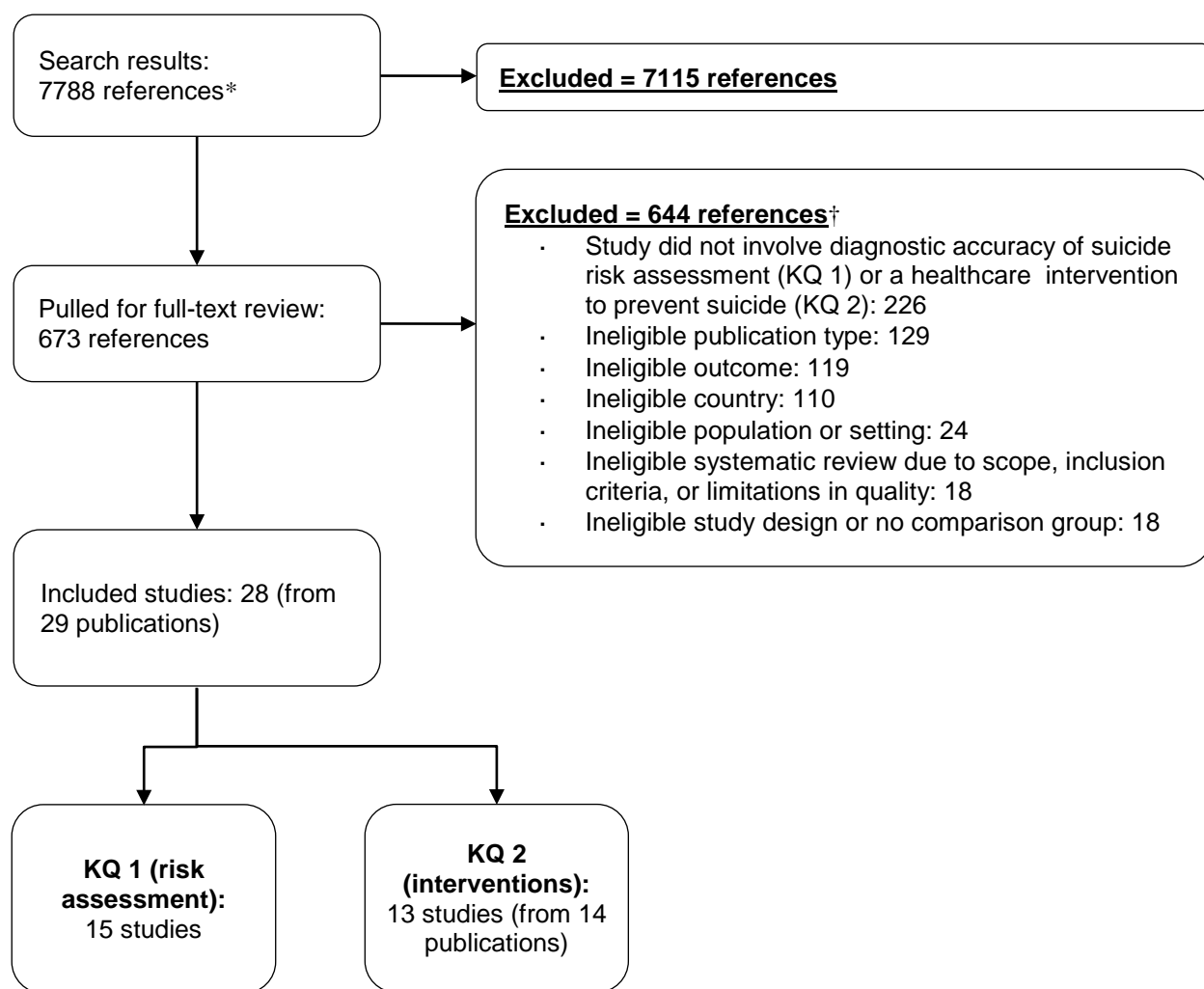
*7708 references were identified through database searches (**Appendix A**), and an additional 80 references were identified from the bibliographies of relevant systematic reviews and primary studies.
†**Appendix B** describes the inclusion/exclusion criteria; studies excluded at the full-text level are listed in **Appendix E**.

KEY QUESTION 1:

A) What are the accuracy and adverse effects of methods to identify Veterans and military personnel at increased risk for suicide and other suicidal self-directed violence?

B) Does accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors?

Summary of Findings

Studies Included in Previous Systematic Reviews

Five previously published systematic reviews included studies of methods to identify individuals at risk for suicide and other suicidal self-directed violence (**Table 2**).[2,16,30-32] The systematic reviews are provided in this report for context. Only 4 studies included in the previous VA ESP report[2] are relevant to the key questions in this review (**Table 3**).[33-36] All 4 studies enrolled Veterans, specifically those with suicidal ideation,[36] primary affective disorders,[35] traumatic brain injury,[33] and posttraumatic stress disorder.[34] One study derived a decision tree for identifying patients at high risk for suicide attempts,[36] while 3 studies evaluated the accuracy of instruments to predict suicide and suicide attempts (instruments described in **Table 4**).[33-35] Studies had important methodological limitations resulting in high[33,34] or unclear[35,36] risk of bias ratings, including biased or unclear selection criteria for the study populations, non-standardized risk assessment procedures, and inadequate outcome assessments (**Table 5**).

In one study, data from 5,671 Veterans with suicidal ideation, identified from a larger cohort of substance abuse patients at 150 VA Medical Centers nationwide, were used to derive a decision tree to identify patients who reported suicide attempts within the 30 days prior to assessment.[36] Results were expressed at various cut-points representing the percentages of patients with suicide attempts in the past 30 days. At a 20% cut-point, the decision tree had 72% sensitivity and 63% specificity; at a 10% cut-point, it had 89% sensitivity and 42% specificity.

A study of 283 Veterans with primary affective disorders examined the use of a brief screening tool, the Affective States Questionnaire, as a predictor of suicidal behavior within 3 months of assessment.[35] Results indicated 60% sensitivity and 74% specificity. A study of 154 Veterans with traumatic brain injury evaluated the Personality Assessment Inventory and examined the use of 2 subscales, the Suicide Potential Index and the Suicide Ideation scale, to predict suicidal self-directed violence within the next 2 years.[33] In this study, only the Suicide Potential Index subscale was predictive, and when combined with the known risk factor of history of suicidal behavior, it demonstrated 90.9% sensitivity and 95.1% specificity. A study of the Beck Depression Inventory included 630 male Veterans entering a residential treatment program for posttraumatic stress disorder.[34] Results indicated that the Beck Depression Inventory score along with history of suicide attempt in the 4 months prior to intake predicted suicide within 4 months after discharge with 63% sensitivity and 80% specificity in the exploratory sample. However, sensitivity was only 11% when tested in a replication sample.

Table 2. Previous Systematic Reviews of Methods to Identify Individuals at Risk for Suicide and Other Suicidal Self-Directed Violence

Author, Year	Search Dates	Included Populations	Suicide Risk Methods	Suicide-Related Outcomes	Results Relevant to the Current Review
Batterham, 2014[30]	To March, 2014	General adult population.	Self-report measures that could be used in population-based research of adults. Excluded measures requiring interviewer or clinician administration.	Suicidal thoughts and behaviors.	19 eligible self-report measures were identified; however, diagnostic accuracy was not reported.
O'Connor, 2013[15,16]	2002-July, 2012	Adolescents, adults, older adults.	Instruments used in primary care or similar populations to identify individuals at risk for suicide.	Increased suicide risk (usually suicidal ideation) relative to a reference standard.	5 relevant studies of adults were included; no studies considered suicide attempts immediately after screening as a reference standard. One trial of potential adverse effects of screening in adults indicated no increased suicidal ideation or suicide attempts at 2-week follow-up.[37]
Haney, 2012[2]*	2005-November, 2011	Veteran and military populations.	Assessment tools for the risk of engaging in suicidal self-directed violence.	Suicidal self-directed violence, including suicide attempt and suicide.	5 relevant studies were included, 4 reported diagnostic accuracy (summarized in **Table 3**).
Mann, 2005[31]	1966-June, 2005	Not specified.	Screening tools for at-risk individuals.	Suicide and suicide attempt.	3 studies were identified; however diagnostic accuracy was not reported.
Gaynes, 2004[32]	1966-October, 2002	Primary care patients with previously unidentified suicide risk.	Screening tools to detect suicide risk.	Comparison with a gold standard.	No studies were identified that meet eligibility criteria for the current review.

*Previous VA ESP review on suicide risk in Veterans and military personnel.

Recently Published Studies

Fifteen new studies evaluated the accuracy of methods to identify individuals at risk for suicide and other suicidal self-directed violence met inclusion criteria (**Table 3**).[38-52] No studies evaluated the adverse effects of risk assessment methods, or compared how effectiveness and adverse effects vary by settings, delivery modes, targeted populations, or other factors.

One study was conducted in the Veterans Health Administration and included only Veterans,[43] and one study specifically enrolled military personnel.[42] Ten studies were based in the US, 3 in Australia, one in England, and one in Canada, and they included from 157 to over 5.9 million participants. Studies enrolled participants from the community, online, emergency departments, and psychiatry services, or used data from existing patient medical records or administrative data. Most studies included high-risk populations, including adults presenting to emergency departments with suicide attempts,[39,44,46,49-51] or who had psychiatric hospitalizations or psychiatric risk factors that put them at higher risk for suicide,[40-42,45,47,52] most commonly depression or previous suicide attempts. Two studies were designed as nested case-control studies,[38,43] while the majority were case series studies.

Ten studies used one or more clinician-rated or patient self-report instruments to assess individual levels of risk (**Table 4**).[38-41,44,48-52] These included the Affective Intensity Rating Scale, Barwon Health Suicide Risk Assessment, Death/suicide Implicit Association Test, Self-Injurious Thoughts and Behaviors Interview, SAD PERSONS, Schedule for Nonadaptive and Adaptive Personality, Sleep Quality Index, Suicidal Ideation Attributes Scale, Suicide Opinion Questionnaire, and Suicide Trigger Scale. Instruments incorporated questions and scales indicating the presence and severity of known or suspected suicide risk factors. The studies determined how well participants' responses predicted suicidal behaviors. In one study, participants' responses to 9 separate scales were analyzed in various combinations to determine a model with the best diagnostic accuracy.[40]

Five studies used existing data from electronic medical records or administrative databases to identify suicide risk factors in populations of patients, and then stratified the patient populations by levels of suicide risk using regression analysis.[42,43,45-47] One study compared the performance of this type of population-level screening approach with a clinician-rated screening tool.[47]

Outcome measures included suicide attempts,[39-41,44,48-51] suicide,[38,42,43,46] or both outcomes[45,47,52] occurring within a specific time period that varied from the recent past to 10 years after risk assessment. Methods to determine suicide attempt outcomes included the Columbia Classification Algorithm of Suicide Assessment, Columbia Suicide Severity Rating Scale, Self-Injurious Thoughts and Behaviors Interview, Longitudinal Interval Follow-up Evaluation semi-structured interview, International Classification of Disease Codes (ICD) from patient medical records, and an in-depth assessment of suicidal behavior. Suicide was confirmed using death certificates, the National Death Index, and ICD codes (ICD-9 and ICD-10) from patient medical records.

Studies generally used regression analysis to determine relationships between predictors and outcomes and to derive predictive models. Estimates of the area under the receiver-operator characteristic curve (ROC AUC) were used to indicate the accuracy of the methods and determine optimum cut-points to estimate sensitivity, specificity, positive predictive value

(PPV), and negative predictive value (NPV). Three studies derived models from development data sets and tested them in validation data sets.[43,46,47]

Four studies had important methodological limitations resulting in high risk of bias ratings;[41,49-51] risk of bias was unclear in 8 studies;[38-40,44,45,47,48,52] and low in 3 studies[42,43,46] (**Table 5**). Major limitations included small sample sizes, including 5 with sample sizes less than 200;[41,44,49-51] high or unclear loss to follow-up;[39-41,43,44,50,51] and potentially biased participant selection.[38,40,41,44,49-52]

Results of studies indicated estimates of sensitivity ranging from 11% to 100% and AUC from 0.57 to 0.97 (**Figures 3 and 4**). Several risk assessment methods had estimates of sensitivity ≥80% or AUC ≥0.70, suggesting fair or better discrimination between patients with and without suicide or suicide attempts. These methods include SAD PERSONS and variations,[39] Suicide Opinion Questionnaire,[41] ReACT Self Harm Rule,[46] Suicidal Ideation Attributes Scale,[48] modification of the Affective Intensity Rating Scale,[49] Suicide Trigger Scale,[50,51] Schedule for Nonadaptive and Adaptive Personality Self-harm Subscale,[52] and derived models.[40,42,43,47] Methods from studies from the previous VA ESP review with similar results include the Suicide Potential Index subscale of the Personality Assessment Inventory[33] and a decision tree with predictors of suicide attempts.[36]

Figure 3. Summary of Studies of Methods to Identify Suicide Risk Reporting Sensitivity and Specificity
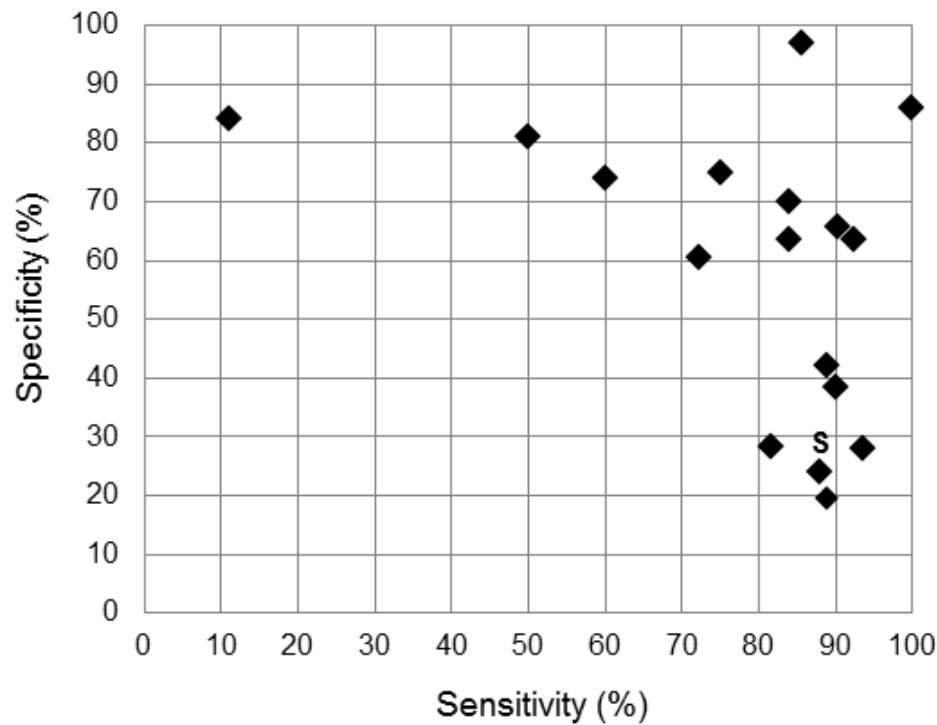
Study*	Sensitivity (%)	Specificity (%)
Bolton, 2012		
SAD PERSONS	88.8	19.6
Modified	81.6	28.3
9 -items	90.4	65.6
5-items	93.5	27.9
Breshears, 2010†	100	86
Galfalvy, 2008‡	75	75
Galynker, 2015	85.7	97
Hartl, 2005†‖	11	84
Hendin, 2010†	60	74
Nock, 2010	50	81
Steeg, 2012‖	88	24
Tiet, 2006†	89	42
van Spijker, 2014	84	63.6
Yaseen, 2012a	72.2	60.5
Yaseen, 2012b	90.0	38.4
Yassen, 2014§	92.3	63.4
Yen, 2011	84	70

S The Steeg, 2012 study reported suicide outcomes; all other studies reported suicide attempts, some included both suicides and attempts (Yen, 2011; Breshears, 2010).

*For studies reporting multiple results based on different cut-points, results for the method with the highest sensitivity are included in this table and figure.
†Included in previous VA ESP review.
‡Model consisting of 3 terms.
‖Results for validation set.
§6-item subscale.

Figure 4. Summary of Studies of Methods to Identify Suicide Risk Reporting Area Under the Receiver-Operator Characteristic Curve (AUC)

Study*	AUC (95% CI)
Bernert, 2014	0.685 (0.549 to 0.820)
Bolton, 2012	
SAD PERSONS	0.572 (0.51 to 0.64)
Modified	0.613 (0.55 to 0.68)
9 -items	0.874 (0.85 to 0.89)
5-items	0.665 (0.61 to 0.72)
Breshears, 2010†	0.972
Galfalvy, 2008‡	0.90
Galynker, 2015‖	0.944
Kessler, 2015	0.89
McCarthy, 2015	0.761 (0.751 to 0.771)
Tran, 2014	
Checklist	0.59 (0.50 to 0.69)
EMR	0.79 (0.70 to 0.85)
Yaseen, 2012a	0.724
Yaseen, 2012b	0.744
Yassen, 2014§	0.814
Yen, 2011	0.855

Individual Studies (order follows the table)

S   Three studies reported suicide outcomes (Bernert, 2014; Kessler, 2015; McCarthy, 2015); all other studies reported suicide attempts, some included both suicides and attempts (Tran, 2014; Yen, 2011; Breshears, 2010).

*For studies reporting multiple results, results for the method with the highest AUC are included in this table and figure.
†Included in previous VA ESP review.
‡Model consisting of 40 terms.
‖20-item model.
§6-item subscale.

Descriptions of Individual Studies

The only new study of Veterans used electronic medical records from nearly 6 million patients of the Veterans Health Administration to create a population-level prediction model to stratify patients according to their risk for suicide.[43] The model explored 381 predictor variables including demographic characteristics; period of military service; military service-related disability, homelessness, or other trauma; mental health diagnoses and assessments; Veterans Health Administration service utilization; and medication use. The AUC estimate for the model was 0.761 (95% confidence interval [CI], 0.751 to 0.771). Results of the study suggested that the model was a better predictor for suicide than the current clinical practice standard of healthcare providers "flagging" medical records of individuals believed to be at higher risk of suicide. The study had low risk of bias; limitations included unclear handling of missing data and reporting of accuracy measures.

The only study of military personnel was based on Army STARRS and included 40,820 active duty US Army soldiers hospitalized with psychiatric admission diagnoses.[42] The study used machine learning methods that included up to 421 individual predictor variables extracted from 38 US Army and Department of Defense administrative data systems to develop a risk algorithm to predict suicides within one year of hospitalization. The predictor variables represented several known risk factors, such as sociodemographics, history of suicidal behaviors, medical and psychiatric history, quality of care, time since hospital discharge, and psychopathological risk factors, as well as US Army career variables, criminal perpetration and victimization, and access to weapons. Results showed that a model with 73 of the predictor variables was most accurate in predicting suicides (AUC 0.89), although a model with only 20 predictors was almost as accurate (AUC 0.84). The study had low risk of bias; limitations included lack of reporting of demographic characteristics and source of suicide outcome data, and not providing lists of predictors used in the various models.

Another model used a similar method, but eliminated variables that did not significantly improve its predictive performance.[46] With this approach, the model was condensed to 4 items, termed the ReACT Self-Harm Rule, and included self-harm in the past year, living alone or homelessness, cutting as a method of harm, and treatment for a current psychiatric disorder. Presentation with self-harm was classified as either low risk or high to moderate risk based on the presence of one or more risk factors. Data from 18,680 patients presenting to emergency departments with self-harm in England (totaling 29,571 self-harm episodes) indicated sensitivity of 88% and specificity of 24% for predicting suicide within 6 months. The study had low risk of bias; limitations included differing methods of data collection across the study sites and unclear loss to follow-up.

Two studies used electronic medical records from a large regional healthcare provider (Barwon Health) in Australia to determine the diagnostic accuracy of their standard risk assessment tool, the clinician-rated Barwon Health Suicide Risk Assessment checklist.[45,47] The first study used 27,061 risk assessments from 8,739 patients receiving care at Mental Health, Drugs and Alcohol Services to evaluate the ability of 15 machine learning algorithms to discriminate between patients who died by suicide, had attempted suicide, and who do not exhibit suicidal self-directed violence within the 6-year study period.[45] The study found that the algorithms typically had sensitivities of 35% to 50% depending on the model, and average specificities of 65% to 70%. In the second study, the electronic medical records from 7,399 patients were used to derive a risk stratification model.[47] The model's diagnostic accuracy was then compared to the Barwon Health

Suicide Risk Assessment. The model had a sensitivity of 70% and specificity of 72% in predicting suicide attempt or suicide at 3 months. Results indicated that that the model was more accurate at various time points between 1 and 6 months after assessment than the clinician-rated checklist (AUC at 3 months: model 0.79 [95% CI, 0.72 to 0.84] versus checklist 0.58 [95% CI, 0.50 to 0.66]). Both studies had unclear risk of bias; limitations included incomplete reporting of the scoring method for the clinician-rated tool, unclear loss to follow-up, low rate of events (3 suicides in the validation cohort within 3 months),[47] and use of a composite outcome measure that potentially included some events of self-harm without intent to die.

A study of 304 adults with major depressive disorder or bipolar disorder compared the accuracy of several prognostic models to predict suicide attempts within 2 years of assessment.[40] The models included combinations of 15 variables including demographic information, results of psychiatric instruments, and their interactions. Using a cut-point score of 0.25, which weighs false-negative results 3 times more highly than false-positive results in order to prioritize sensitivity over specificity, a 3-term model (past suicide attempt, smoking status, and suicidal ideation score) demonstrated sensitivity of 75% and specificity of 75%. More complex models had similar results (9-term model, 71% sensitivity and 77% specificity; 40-term model, 71% sensitivity and 80% specificity). The study had unclear risk of bias; limitations included potential selection bias, small sample size, and unclear loss to follow-up and outcome measurement.

The diagnostic accuracies of the SAD PERSONS scale, a clinician-rated suicide risk assessment checklist consisting of 10 risk factors, and a modified version that weighs some factors more heavily, were evaluated in a Canadian study.[39] The study included 4,019 consecutive adults who were referred to psychiatric services at the emergency departments of 2 large hospitals. A revised 5-item version that included only items independently predictive of suicide attempts within 6 months had a sensitivity of 93.5% and specificity of 27.9%. A revised 9-item version identified patients with current presentations of suicide attempt with a sensitivity of 90.4% and specificity of 65.6%. The revised versions demonstrated higher diagnostic accuracy than the complete and modified SAD PERSONS scales. The study had low risk of bias; limitations included an undefined patient population and unknown loss to follow-up (assessment of suicide attempts was restricted to patients who returned to the same hospitals).

A study of 733 adults with either a personality disorder or major depressive disorder determined the accuracy of the Self-Harm Subscale of a comprehensive personality inventory, the Schedule for Nonadaptive and Adaptive Personality.[52] Results found that at a cut-point of 10, the subscale predicted suicide or suicide attempt at one year with 84% sensitivity and 70% specificity (AUC 0.855); a cut-point of 11 had 78% sensitivity and 77% specificity. The study had unclear risk of bias; study limitations included potentially biased patient selection methods, unclear blinding of outcome assessors, and partial reliance on participants' family members to report suicide deaths.

Diagnostic accuracy of a brief computer-administered Implicit Association Test was evaluated among 91 adults with histories of suicide attempt presenting to a psychiatric emergency department.[44] Unlike patient self-report instruments, this test uses individuals' reaction times when classifying semantic stimuli in order to predict suicide attempts. Scores representing associations between self and death/suicide, as opposed to self and life, predicted suicide attempts at 6 months with 50% sensitivity and 81% specificity. The study had unclear risk of bias; limitations included small sample size and unclear loss to follow-up.

Three studies evaluated how well scales that measure a specific suicide risk factor predict suicidal behavior.[38,41,48] The Suicidal Ideation Attributes Scale, a short online self-report survey of the frequency and severity of suicidal thoughts, was administered among 1,352 participants from the general population in Australia.[48] Results indicated that use of a low cut-point score identified individuals who had made suicide preparations or attempts over the past year with 85% sensitivity and 63.3% specificity. A higher cut-point score improved specificity (94.9%) but lowered sensitivity (50%). The study had unclear risk of bias; study limitations included the small number of suicide attempts and unknown accuracy of online reporting of risk factors and outcomes.

A case-control study of 420 adults over the age of 65 evaluated the Sleep Quality Index, a brief self-report measure of sleep quality.[38] Results indicated AUC of 0.685 (95% CI, 0.549 to 0.820) for predicting suicide over a 10-year observation period. The study had unclear risk of bias; limitations included undefined inclusion criteria, small sample size, and unclear blinding. A study of 91 adult psychiatric inpatients evaluated the accuracy of a 100-item self-report survey on attitudes toward suicide, the Suicide Opinion Questionnaire, in predicting suicide attempts within 2 months of discharge.[41] A model using only 20 of the items had a sensitivity of 85.7% and specificity of 97% (AUC 0.944), while a condensed 9-item model had 85.7% sensitivity and 69.7% specificity (AUC 0.861). The study had high risk of bias; study limitations included potentially biased patient selection, small sample size, high loss to follow-up, and inconsistent timing of risk factor assessment.

The Suicide Trigger Scale was evaluated in 2 small studies of adults presenting to emergency departments with suicidal ideation or suicide attempts.[50,51] This self-report instrument measures the presence of a distinct panic-like symptom, the suicide trigger state, suggesting the risk of imminent suicide. This state is characterized by frantic hopelessness, overwhelming profusion of negative thoughts, and near psychotic somatization, such as feeling as if excessive thoughts are going to make ones' head explode. A study assessing the scale's ability to predict suicide attempts within 6 months of hospital discharge found that a 6-item subscale had a sensitivity of 92.3% and specificity of 63.4% at the cut-point score of 2, and 69.2% sensitivity and 78.0% specificity at the cut-point score of 3.[51] This subscale had greater accuracy than the complete 42-item scale (69.2% sensitivity, 68.3% specificity). The second study attempted to determine outcomes within one year, but 90% of participants were lost to follow-up.[50] Both studies had high risk of bias; limitations included small sample sizes (N = 183 and N = 161), potentially biased patient selection, and high loss to follow-up.

The Affective Intensity Rating scale, measuring the presence and intensity of positive and negative affects experienced in the previous 72 hours, was tested in a small sample of patients presenting to an emergency department with suicidal ideation or suicide attempts.[49] A subscale consisting of self-report items that were statistically significant predictors was able to distinguish patients with suicide attempts from those with ideation alone (86.7% sensitivity, 41.7% specificity). The study had high risk of bias; limitations included small sample size (N = 176), potentially biased patient selection, and differences among participants regarding the timing of the assessment.

Table 3. Studies of the Accuracy of Methods to Identify Individuals at Risk for Suicide and Other Suicidal Self-directed Violence

Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
Recently Published Studies					
Bernert, 2014[38]	Nested case-control study; used hierarchical logistic multiple regression analysis controlled for baseline depression; determined AUC estimates.	420 older adults selected from a larger US cohort of 14,456 community-dwelling older adults; 20 suicide decedents and 400 controls matched on age, sex, and study site.	Sleep Quality Index, a 5-item self-report measure.	Suicide within 10-year observation period as listed on official death certificates (ICD-9 code between 950 and 959).	AUC 0.685 (95% CI, 0.549 to 0.820). Sleep Quality Index total scores distinguished suicide decedents from matched controls (P=.005).

Bolton, 2012[39]	Case series; logistic regression analysis; used AUC estimates to determine optimum cut-points to estimate sensitivity, specificity, PPV, NPV.	4,019 adults referred to psychiatric services at emergency departments of 2 large hospitals in Canada.	SAD PERSONS and Modified SAD PERSONS, 10-item checklists.	Current suicide attempts and suicide attempts within 6 months as defined by the Columbia Classification Algorithm of Suicide Assessment.	· SAD PERSONS:
					  -Current suicide attempt, score >3: 73.3% sensitivity, 43.8% specificity; PPV 33.0%, NPV 83.0%.
					  AUC 0.657 (95% CI, 0.63 to 0.69), P<0.001.
					  -Future suicide attempt, score >2: 88.8% sensitivity, 19.6% specificity; PPV 3.1%, NPV 98.4%.
					  AUC 0.572 (95% CI, 0.51 to 0.64).
					· Modified SAD PERSONS:
					  -Current suicide attempt, score of >3: 81.3% sensitivity, 36.4% specificity; PPV 31.8%, NPV 84.2%.
					  AUC 0.738 (95% CI, 0.71 to 0.77), P<0.001.
					  -Future suicide attempt, cut score of >3: 81.6% sensitivity, 28.3% specificity; PPV 3.2%, NPV 98.2%.
					  AUC 0.613 (95% CI, 0.55 to 0.68), P<0.01.
					· 9-item risk model (sex, age 19-45, depression or hopelessness, previous attempts or psychiatric care, drug or alcohol abuse, rational thinking loss, organized plan or serious attempt, sickness, stated future intent):
					  -Current suicide attempt, score >4: 90.4% sensitivity, 65.6% specificity; PPV 48.8%, NPV 95.0%.
					  AUC 0.874 (95% CI, 0.85 to 0.89), P<0.001.
					· 5-item risk model (previous attempts or psychiatric care, alcohol or drug abuse, stated future intent, age 19-45 years, rational thinking loss):
					  -Future suicide attempt, score >1: 93.5% sensitivity, 27.9% specificity; PPV 3.6%, NPV 99.3%.
					  AUC 0.665 (95% CI, 0.61 to 0.72), P<0.001.

Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
Galfalvy, 2008[40]	Case series; used Cox proportional hazard regression models and stepwise model selection procedures to determine predictor variables and AUC estimates to determine optimum cut-points to estimate sensitivity and specificity.	304 adults with major depressive disorder or bipolar disorders presenting for evaluation and treatment in the US.	15 candidate predictor variables for models include age, gender, psychiatric diagnosis, co-morbid borderline personality disorder, history of past suicide attempt, smoking, and baseline scores on 9 psychosocial scales.*	Suicide attempts within 2 years based on an in-depth assessment of suicidal behavior.	· Model 2 (3 terms: past suicide attempt, smoking status, and suicidal ideation score): AUC 0.76. -Cut-point 0.5: 27%, sensitivity, 92% specificity. -Cut-point 0.25: 75% sensitivity, 75% specificity. · Model 4 (40 terms): AUC 0.90. -Cut-point 0.5: 63% sensitivity, 91% specificity. -Cut-point 0.25: 71% sensitivity, 80% specificity. · Model 5 (9 terms: past suicide attempt, smoking status, age, past attempt X age, male sex, suicidal ideation score, hostility score, bipolar diagnosis, bipolar diagnosis X hostility score): AUC 0.81. -Cut-point 0.5: 31% sensitivity, 92% specificity. -Cut-point 0.25: 71% sensitivity, 77% specificity.
Galynker, 2015[41]	Case series; based on exploratory factor analysis on questionnaire items associated with suicidality; a simplified 9-item score was calculated as the sum of scores for items loading above 0.5 on factor 1 minus the sum of scores for items loading above 0.5 on factor 2.	91 adult psychiatric inpatients admitted for suicidal ideation or suicide attempt.	Suicide Opinion Questionnaire (SOQ), a 100-item self-report measure.	Suicide attempts within 2 months of discharge based on the Columbia Suicide Severity Rating Scale (C-SSRS).	· 20-item model (items found to be statistically significant between suicide attempters and non-attempters): AUC 0.944. -Optimal cut-point (not reported): 85.7% sensitivity, 97% specificity. Correctly classified 35/40 (87.5%) of participants. · 9-item model: AUC 0.861. -Cut-point <10: 85.7% sensitivity, 69.7% specificity Lower Beck Scale for Suicide Ideation scores showed a non-significant trend to increased risk of post-discharge suicide attempt (AUC 0.650, *P*=.292). C-SSRS rating of suicidal ideation severity showed no relation with post-discharge suicide attempt (AUC 0.521, *P*=.856).
Kessler, 2015[42]	Case series; used administrative data from the Historical Administrative Data System of the Army STARRS and machine learning methods (regression trees and penalized regressions) to develop a risk algorithm to predict post-hospitalization suicides.	40,820 active duty US Army soldiers with 53,769 psychiatric hospitalizations.	Population-level prediction model derived from 38 US Army and Department of Defense administrative data systems (421 individual predictor variables).	Suicides within 12 months of hospital discharge.	· 20-predictor model: AUC 0.84 · 73-predictor model: AUC 0.89 · 421-predictor model: AUC 0.85

Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
McCarthy, 2015[43]	Nested, case-control study; predictive model derived from clinical records; included patients who died from suicide (case patients) and a random 1% of living patients (control patients), divided randomly into development and validation sets; determined AUC estimates.	5,969,662 Veterans alive as of September 2010 and had encounters with the Veterans Health Administration in the US in the previous 2 years.	Population-level prediction model derived from Veterans Health Administration clinical records (381 total measures including 31 interaction terms).	Suicide within 12 months according to the National Death Index.	AUC 0.761 (95% CI, 0.751 to 0.771).
Nock, 2010[44]	Case series; used hierarchical logistic regression analysis with a step controlling for clinician/patient prediction and severity of suicide ideation at presentation; determined sensitivity, specificity, PPV, NPV estimates.	157 adults presenting to a psychiatric emergency department in the US with lifetime histories of suicide attempts at baseline; 91 patients were included in the diagnostic accuracy analysis.	Scores on the Death/suicide Implicit Association Test were dichotomized depending on whether a score represented an association between death/suicide and self (score >0) versus life and self (score <0).	Suicide attempts within 6 months assessed by the Self-Injurious Thoughts and Behaviors Interview.	Cut-point >0: 50% sensitivity, 81% specificity; PPV 32%, NPV 90%.
Rana, 2012[45]	Case series; used 15 machine learning algorithms to determine accuracy in discriminating between patients who die by suicide, attempt suicide, and never attempt suicide; 100 random subsets of data were created, classification was performed and averaged, and sensitivity and specificity were calculated.	27,061 risk assessments from 8,739 patients receiving care at the Mental Health, Drugs and Alcohol Services at a large public health system.	15 separate machine learning algorithms to examine associations between suicide and the Barwon Health Suicide Risk Assessment, an 18-item clinician-rated checklist.	Suicide (death certificates and a centralized registry) or suicide attempts (emergency department ICD codes for self-harm).	Sensitivity 35-50%; specificity 65-70%.

Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
Steeg, 2012[46]	Case series; a clinical screening tool was derived using a classification tree that used binary recursive partitioning to split the data, then was tested with data from patients at another site; determined sensitivity, specificity, PPV, NPV estimates.	29,571 episodes of self-harm by 18,680 adults aged ≥16 years presenting to emergency departments in England (22,532 episodes derivation set, 7,039 validation set).	ReACT Self Harm Rule, a clinical screening tool using 4 domains. Presentation with self-harm was classified as either low risk or high to moderate risk based on the presence of one or more risk factors.	Suicide within 6 months according to the ICD-10 codes from patients' records in national health database.	· Derivation set: 91% (95% CI, 81% to 97%) sensitivity, 15% (95% CI, 15% to 16%) specificity; PPV 40% (95% CI, 30% to 50%), NPV 99.8% (95% CI, 99.6% to 99.9%). · Validation set: 88% (95% CI, 70% to 98%) sensitivity, 24% (95% CI, 23% to 25%) specificity; PPV 50% (95% CI, 30% to 70%), NPV 99.6% (95% CI, 99.5% to 99.7%). · Correctly predicted 83/92 (90.2%) of suicides occurring within 6 months.
Tran, 2014[47]	Case series; a predictive model for 1-6 month risk of suicide was derived from data from electronic medical records; the model was compared to an established clinician-rated checklist to estimate AUC.	7,399 patients undergoing suicide risk assessment (4,911 derivation set, 2488 validation set).	Risk stratification model using data from electronic medical records was compared to the Barwon Health Suicide Risk Assessment, an 18-item clinician-rated checklist.	Suicide or suicide attempts (ICD-10 self-harm codes of high- or moderate-lethality) within 180 days of risk assessment.	AUC for high-risk; clinician checklist versus electronic medical record model: · 30 days: 0.55 (95% CI, 0.44 to 0.67) versus 0.73 (95% CI, 0.62 to 0.84). · 60 days: 0.59 (95% CI, 0.50 to 0.69) versus 0.79 (95% CI, 0.70 to 0.85). · 90 days: 0.58 (95% CI, 0.50 to 0.66) versus 0.79 (95% CI, 0.72 to 0.84). · 180 days: 0.57 (95% CI, 0.49 to 0.63) versus 0.75 (95% CI, 0.69 to 0.80).
van Spijker, 2014[48]	Case series; online responses on the Suicidal Ideation Attributes Scale were compared with a set of psychosocial assessments† to estimate AUC, sensitivity, and specificity.	1,352 adults from the general population in Australia who were recruited online.	Suicidal Ideation Attributes Scale, a 5-item online self-report measure.	Suicide preparation/attempt in the past year based on a condensed version of the Columbia Suicide Severity Rating Scale.	· Cut-point ≥1 (low ideation): 84.0% sensitivity, 63.6% specificity. · Cut-point ≥21 (high ideation): 50% sensitivity, 94.9% specificity.
Yaseen, 2012a[50]	Case series; correlations between suicide attempts and the Suicide Trigger Scale were calculated using binary logistic regression analysis; used AUC estimates to determine optimum cut-points to estimate sensitivity and specificity.	183 adult psychiatric patients with suicidal ideation or attempts in a psychiatric emergency department in the US.	Suicide Trigger Scale, a 42-item self-report measure.	Current suicide attempt and attempts within the next year based on the Columbia Suicide Severity Rating Scale.	· Current attempt: AUC 0.724, P=.002. -Cut-point 13: 72.2% sensitivity, 60.5% specificity. · Future attempt: Not calculated because of high loss to follow-up.

Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
Yaseen, 2012b[49]	Case series; derived a composite suicide-related subscale from items from the Affective Intensity Rating Scale; determined sensitivity and specificity.	176 adult psychiatric patients with suicidal ideation or attempts in a psychiatric emergency department in the US.	Modification of the Affective Intensity Rating Scale, a 17-item self-report measure.	Current suicide attempt based on the Columbia Suicide Severity Rating Scale.	· Cut-point ≥0 overall: AUC 0.768 (95% CI, 0.673 to 0.864), *P*<0.0005. -86.7% sensitivity, 41.7% specificity. · Cut-point ≥0 for substantive attempts: AUC 0.744, *P*=.010. -90.0% sensitivity, 38.4% specificity.
Yaseen, 2014[51]	Case series; transformed scores from the Suicide Trigger Scale were calculated as the absolute value of the total score minus the median score; used AUC estimates to determine optimum cut-points to estimate sensitivity, specificity, PPV, NPV.	161 adult psychiatric patients hospitalized following suicidal ideation or attempt in the US.	Suicide Trigger Scale, a 42-item self-report measure.	Suicide attempt within 6 months of discharge based on the Columbia Suicide Severity Rating Scale, US national death registry, and patient medical records.	· Full scale: -Cut-point ≥19: 69.2% sensitivity, 68.3% specificity; PPV 40.9%, NPV 87.5%; AUC 0.731, *P*=.013. -Correctly classified 37/54 (68.5%) participants. · 6-item subscale (items 2, 4, 7, 23, 27 and 41, median score 7): AUC 0.814, *P*=.001. -Cut-point >2: 92.3% sensitivity, 63.4% specificity. -Cut-point >3: 69.2% sensitivity, 78.0% specificity.
Yen, 2011[52]	Case series; used Cox proportional hazards regression analyses to determine whether baseline scores predicted suicide attempts at follow-up; determined AUC estimates and calculated sensitivity, specificity, and PPV.	733 adults with a personality disorder or major depressive disorder.	Schedule for Nonadaptive and Adaptive Personality–Self-harm Subscale (SNAP-SH), a 16-item subscale of a self-report personality inventory.	Suicide or suicide attempt within 12 months based on self-reported behaviors on the Longitudinal Interval Follow-Up Evaluation semi-structured interview.	AUC 0.855 · Cut-point 10: 84% sensitivity, 70% specificity; PPV 22%. · Cut-point 11: 78% sensitivity, 77% specificity; PPV 26%. · Cut-point 12: 72% sensitivity, 85% specificity; PPV 33%.
Studies Included in the Previous Systematic Review[2]					
Breshears, 2010[33]	Case series; used hierarchical multiple regression and AUC estimates to determine optimum cut-points to estimate sensitivity and specificity.	154 Veterans with traumatic brain injury in the US.	Suicide Potential Index and Suicidal Ideation subscales of the Personality Assessment Inventory.	Suicide and suicidal behavior (not defined) within 2 years of assessment.	Suicide Potential Index: · Cut-point ≥15: 90.9% sensitivity, 76.5% specificity; AUC 0.903. · Cut-point ≥15 plus pre-assessment suicidal behavior: 90.9% sensitivity, 95.1% specificity; AUC 0.972. · Cut-point ≥11 plus pre-assessment suicidal behavior: 100.0% sensitivity, 86.0% specificity. The Suicidal Ideation subscale scores did not increase incremental validity (*P*=.65, diagnostic accuracy not

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Author, Year	Study Design; Approach	N; Population	Risk Assessment Method	Outcome	Measures of Accuracy
					determined).
Hartl, 2005[34]	Case series; used signal detection methods and AUC estimates to determine optimum cut-points to estimate sensitivity and specificity.	630 male Veterans with a primary posttraumatic stress disorder (PTSD) diagnosis entering a residential treatment program for PTSD in the US.	Beck Depression Inventory.	Suicide attempt within 4 months of discharge.	Beck Depression Inventory ≥46 and suicide attempt in the 4 months prior to intake: 63% sensitivity, 80% specificity in the exploratory sample; 11% sensitivity, 84% specificity in the replication sample.
Hendin, 2010[35]	Case series; used AUC estimates to determine sensitivity and specificity.	283 in- and outpatients at a VA Medical Center in the US with affective disorder, or affective disorder plus substance abuse or anxiety disorders.	Affective States Questionnaire; a positive score was determined by rating at least 3 of the 7 affects as "severe" or "extreme."	Suicidal behavior‡ within 3 months of assessment.	60% sensitivity, 74% specificity; PPV 32%, NPV 90%.
Tiet, 2006[36]	Case series; a decision tree for identifying high-risk patients was derived from the Addiction Severity Index and variables from VA databases; used AUC estimates to determine optimum cut-points to estimate sensitivity and specificity for 3 models§.	5,671 adults with suicidal ideation from a national cohort seeking substance abuse treatment at 150 VA Medical Centers in the US.	Decision tree included significant predictors of suicide attempts‖.	Suicide attempts in the past 30 days assessed with the Addiction Severity Index face-to-face interview.	· 30% model: 33% sensitivity, 87% specificity; PPV 37%, NPV 85%. · 20% model: 72% sensitivity, 63% specificity; PPV 30%, NPV 90%. · 10% model: 89% sensitivity, 42% specificity; PPV 25%, NPV 95%.

Abbreviations: Army STARRS = Army Study to Assess Risk and Resilience in Servicemembers; AUC = area under the receiver-operator characteristic (ROC) curve; CI = confidence interval; NPV = negative predictive value; PPV = positive predictive value; PTSD = posttraumatic stress disorder; ROC = receiver-operator characteristic (ROC) curve; VA = Veterans Affairs.

* Hamilton Depression Rating Scale, Beck Depression Inventory, Beck Hopelessness Scale, Scale for Suicidal Ideation, Reasons for Living Inventory, Brown Goodwin Lifetime Aggression History Scale, Buss-Durkee Hostility Inventory, Barratt Impulsivity Scale, and St. Paul Ramsey Questionnaire.

† Psychological distress, depression, anxiety disorders, alcohol use, sleep problems, suicidal ideation, suicide literacy, suicide stigma, exposure to suicide, interpersonal risk factors for suicide, and demographic variables.

‡ Attempts, interrupted or aborted attempts, or preparatory acts/behaviors, with some degree of intent to die; or hospitalization/institutionalization.

§ Based on the results of the decision tree, sensitivity and specificity were calculated for 3 hypothetical models using varying cut points of the percentages (10%, 20%, and 30%) of patients who attempted suicide in the past 30 days. A model that uses a cut-point at 30% means that the model requires the true-positive rate to be at least a 30% and that 30% or more of patients are predicted to attempt suicide.

‖ Suicide attempt/ideation history, recent alcohol abuse, recent cocaine abuse, violent behavior, hallucinations, and employment status.

Table 4. Measures Used as Predictors or Outcomes in Studies of Methods to Identify Individuals at Risk for Suicide and Other Suicidal Self-directed Violence Included in the Systematic Review
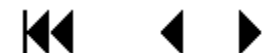
Measure	Abbrev-iation	Items and scoring	Description	Included Studies Using Measure
Addiction Severity Index[53]	ASI	Computer-generated composite scores range from 0-1; severity ratings based on interviewer estimates for each of the 7 subscales range from 0-9.	Semi-structured clinical interview designed as part of an intake process for substance abuse treatment programs. Provides severity ratings and composite scores for 7 areas: psychiatric conditions, alcohol use, drug use, medical conditions, interpersonal issues, employment, and legal problems/functioning experienced in the patient's lifetime and within the 30 days before assessment. The clinical interview takes approximately one hour, must be completed by a provider trained in substance abuse treatment, and is not appropriate for brief screening or primary care settings.	Tiet 2006[36]
Affective Intensity Rating Scale[49]	AIRS	17 items; 3-point scale ranges from 0=not at all to 2=a lot.	Self-report scale to measure the degree to which positive and negative affects were experienced during the 72 hours leading up to psychiatric contact in the emergency room.	Yaseen 2012b[49]
Affective States Questionnaire[35,54,55]	ASQ	7 items; 5-point scale ranges from 1=not at all to 5=extreme.	Clinical interview to measure the intensity of 9 affects (anxiety, rage, desperation, abandonment, loneliness, hopelessness, self-hatred, guilt, and humiliation).	Hendin 2010[35]
Barwon Health Suicide Risk Assessment[56]	None	18 items; 3-point scale (low/ moderate/high).	Clinician-rated checklist based on established risk factors, including suicidal ideation, suicide plan, access to means, prior attempts, anger/hostility/ impulsivity, depression (current level), anxiety, disorientation/ disorganization, hopelessness, identifiable stressors, substance abuse, psychosis, medical status, withdrawal from others, expressed communication, psychiatric service history, coping strategies, and supportive others (connectedness). In addition to the 18 items, clinicians provide overall ratings of suicide risk and carers provide their perceptions of risk on 4-point scales from 1 (low) to 4 (extreme).	Rana 2012[45]; Tran 2014[47]
Beck Depression Inventory-II[57]	BDI-II	21 items; 4-point scale; scores range from 0-63	Self-report inventory to assess depressive symptoms; is brief, easy to administer and score, and often used in primary care settings.	Hartl 2005[34]
Columbia Classification Algorithm of Suicide Assessment[58]	C-CASA	Not applicable; events are categorized into one of 8 definitions	Standardized classification system to accurately classify suicidal ideation and behavior into 8 mutually exclusive definitions (in main 2 categories, suicidal events and non-suicidal events) based on clinical judgment. The scale differentiates between suicide attempts with intention to die and self-harm behaviors that are not intended to result in death.	Bolton 2012[39]
Columbia Suicide Severity Rating Scale[59]	C-SSRS	Suicide attempt lethality: 6-point scale (0=no or very minor injury requiring no care to 5=death). Suicidal ideation severity: 5-point scale (0=no ideation present	Semi-structured interview to identify suicidal ideation and behavior. Assessment of suicidal behavior ranges from preparatory acts to suicide attempt (distinguished from aborted and interrupted attempts). Four constructs are measured: severity of suicidal ideation, intensity of suicidal ideation subscale, suicidal behavior subscale, and lethality subscale (assesses actual attempts).	Galynker 2015[41]; van Spijker 2014[48]; Yaseen 2012a[50]; Yaseen 2012b[49];

Measure	Abbrev-iation	Items and scoring	Description	Included Studies Using Measure
		to 5=active ideation with plan and intent).		Yaseen 2014[51]
Death/suicide Implicit Association Test[44,60]	IAT	*D* score of relative strength of association between "death" and "self" (positive *D* score represents stronger association between death and self; negative *D* score represents stronger association between life and self).	Brief computer-administered test that uses individuals' reaction times when classifying semantic stimuli to measure the automatic mental associations they hold about life and death/suicide. Participants classify stimuli representing the constructs of "death" (*ie*, die, dead, deceased, lifeless, and suicide) and "life" (*ie*, alive, survive, live, thrive, and breathing) and the attributes of "me" (*ie*, I, myself, my, mine, and self) and "not me" (*ie*, they, them, their, theirs, and other).	Nock 2010[44]
Longitudinal Interval Follow-up Evaluation[61]	LIFE	Suicidal behavior is rated for intent (6-point scale from obviously no intent to extreme) and medical threat (6-point scale from no danger to extreme).	Semi-structured interview rating system for assessing the longitudinal course of psychiatric disorders and functioning, including suicidal behaviors. Major Affective Disorders psychopathology is rated on a 6-point scale and Chronic Depressive Disorders psychopathology is rated on a 3-point scale.	Yen 2011[52]
Modified SAD PERSONS[62]	MSPS	10 items; dichotomous; scores range from 0-14.	Simple clinician-assessed checklist of 10 risk factors, with some risk factors weighted more heavily than others. Items worth 2 points: depression or hopelessness, rational thinking loss, organized or serious attempt, stated future intent. Items worth 1 point: male sex, age <19 or >45 years, previous attempts or psychiatric care, excessive alcohol or drug use, single/divorced/widowed, and no social supports.	Bolton 2012[39]
Personality Assessment Inventory[63]	PAI	344 items; 4-point scale ranges from 1=not true at all to 4=very true	Self-report personality test that includes 4 validity scales, 11 clinical scales, 5 treatment scales, and 2 interpersonal scales. Takes 50-60 minutes to administer and 15-20 minutes to score; recommended use is by psychologists as part of a comprehensive assessment.	Breshears 2010[33]
ReACT Self Harm Rule[46]	None	4 items; dichotomous (yes or no).	Clinical screening tool derived from a classification tree. Self-harm is classified as either low or high to moderate risk based on the presence of one or more of the following risk factors: recent self-harm, lives alone or is homeless, cutting used as method of self-harm, and treatment for a current psychiatric disorder.	Steeg 2012[46]
SAD PERSONS[64]	None	10 items; dichotomous; scores range from 0-10.	Simple clinician-assessed checklist consisting of 10 risk factors: male sex, age <19 or >45, depression, previous attempt, alcohol abuse, rational thinking loss, lacking social support, organized plan, no spouse, and sickness.	Bolton 2012[39]
Self-Injurious Thoughts and Behaviors Interview[65]	SITBI	269 items in 5 modules; 5-point scale ranging from 0=low/little to 4=very much/severe.	Structured interview to identify the presence, frequency, and characteristics of self-injurious thoughts and behaviors, including suicidal ideation, suicide plans, suicide gestures, suicide attempts, and non-suicidal self-injury. Administration takes approximately 3-15 minutes.	Nock 2010[44]

Measure	Abbrev-iation	Items and scoring	Description	Included Studies Using Measure
Sleep Quality Index[38]	SQI	5 items; 3-point scale ranges from 1=most of the time to 3=none of the time; scores range from 5-15.	Scale to evaluate sleep quality that includes items relating to difficulty falling asleep, difficulty staying asleep, early morning awakening, daytime sleepiness, and nonrestorative sleep.	Bernert 2014[38]
Suicidal Ideation Attributes Scale[48]	SIDAS	5 items; 10-point scale.	Brief, web-based self-report instrument to measure the severity of suicidal ideation. Assessing frequency, controllability, closeness to attempt, distress, and interference with daily activities over the past month. Respondents who report never having suicidal ideation on the first item of the scale skip the remaining items and are given a total score of 0. The scale generally takes between 30 and 60 seconds to complete, although shorter for individuals with no suicidal ideation.	van Spijker 2014[48]
Schedule for Nonadaptive and Adaptive Personality[66]	SNAP	425 items; true or false.	Self-report questionnaire designed to assess both normal and abnormal personality characteristics. The questions are grouped in to 15 subscales; 3 of the subscales are temperament scales that assess broad, higher-order domains of normal range personality; the other 12 subscales measure lower-order trait dimensions. The SNAP-Self-harm (SNAP-SH) subscale contains 2 highly related subcomponents: low self-esteem (7 items) and suicide proneness (9 items). The low self-esteem scale assesses the tendency for self-loathing or strong self-dissatisfaction. The suicide proneness scale assesses self-destructive thoughts and behaviors.	Yen 2011[52]
Suicidal Ideation scale[63]	SUI	12 items	Subscale of the Personality Assessment Inventory encompasses items ranging from passive thoughts of death, to hopelessness, to serious contemplation of suicide. T-scores of 60 to 69 are typical of clinical respondents; scores ≥70 indicate a "significant warning sign" of suicide potential.	Breshears 2010[33]
Suicide Opinion Questionnaire[67, 68]	SOQ	100 items; 5-point scale ranging from 1=strongly agree to 5= strongly disagree.	Self-report questionnaire measuring beliefs and attitudes toward suicide. Each item consists of a statement regarding an attitude towards suicide.	Galynker 2015[41]
Suicide Potential Index[63]	SPI	20 items; 1 point is assigned for each factor for which an individual's T-score exceeds a statistically derived cut-point; scores range from 0-20.	Subscale of the Personality Assessment Inventory that includes 20 clinical factors (*eg,* hopelessness, severe anhedonia, social isolation) and other latent variables with empirical relationships to suicide risk.	Breshears 2010[33]
Suicide Trigger Scale[50]	STS-3	42 items; 3-point scale ranges from 0=not at all to 2=a lot.	Self-report measure to assess the distinct panic-like syndrome known as the "suicide trigger state," combining frantic hopelessness, ruminative flooding, and near-psychotic somatization. The scale does not contain questions overtly related to suicide in order to avoid over- and under-reporting of suicidal symptoms.	Yaseen 2012a[50]; Yaseen 2014[51]

Table 5. Quality Ratings of Studies of Methods to Identify Individuals at Risk for Suicide and Other Suicidal Self-directed Violence*

Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
Recently Published Studies										
Bernert, 2014[38]	Yes, main characteristics described, but inclusion criteria were not reported.	Unclear for original cohort study (N=14,456) (Cornoni-Huntley 1993[69]). For nested case-control study, control participants were randomly selected from the cohort.	Unclear, N=20 suicides; 400 controls.	Yes, nested case-control design only included participants with complete data.	Yes, assessments were described and referenced.	Unclear, not reported.	Yes, cause of death listed as suicide on official death certificates (ICD-9 code between 950 and 959).	Not applicable.†	Yes, participants matched by age, sex, study site, and duration of study, and analysis controlled for baseline depressive symptoms.	Unclear
Bolton, 2012[39]	No, characteristics were not described (sex only).	Yes, consecutive adult referrals.	Yes, N=4,019; 566 with suicide attempts.	Unclear, not reported.	Yes, assessments were described and referenced.	Unclear, not reported.	Yes, presenting with suicide attempt as defined by the Columbia Classification Algorithm of Suicide Assessment.	Unclear, not reported.	Not applicable.‡	Unclear
Galfalvy, 2008[40]	Yes	Unclear, not reported.	No, N=308; 52 attempts and 4 suicides during	No, 40% lost to follow-up; analysis based on time to first suicide	Yes, described in a separate publication (Oquendo 2004[70]).	Unclear, not reported.	Unclear, based on an in-depth assessment of suicidal behavior, but no	Unclear, not reported.	Not applicable.‡	Unclear

Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
			follow-up.	attempt accounts for attrition (data for 304/308 participants).			definition or standardized method described.			
Galynker, 2015[41]	Yes	No, referred by clinician.	No, N=91; 7 with attempts within 2 months follow-up.	No, 56% (51/91) lost to follow-up.	No, scale was not administered to 25 patients at baseline; items used for the 9-item score were not reported.	Yes, self-report measure.	Yes, post-discharge suicide attempt based on the Columbia Suicide Severity Rating Scale.	Unclear, not reported.	Not applicable.‡	High
Kessler, 2015[42]	No, population characteristics not described.	Yes, included all patients with psychiatric hospitalizations within the study period.	Yes, N= 40,820; 68 suicides.	Yes, 12-month follow-up not available for all patients due to termination of military service; imputation used for missing data.	Yes, risk prediction model described, although list of predictors used for each model was not provided.	Yes, data from existing medical records.	Unclear, suicide data were extracted from administrative databases, but did not explicitly report how suicide deaths were determined.	Not applicable.†	Not applicable.‡	Low
McCarthy, 2015[43]	Yes	Yes, included all cases of suicide and a random 1% sample of the rest of the population as controls.	Yes, N=5.9 million; 2,138 suicides.	Unclear, not reported.	Yes, risk prediction model described.	Yes, data from existing medical records.	Yes, suicide death according to the National Death Index.	Not applicable.†	Not applicable.‡	Low

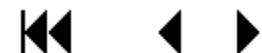| Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
Nock, 2010[44]	Yes	Unclear, all patients presenting with mental health complaints were evaluated and screened for eligibility, but details not reported.	No, N=157; 43 suicide attempts in past week.	Unclear, not reported.	Yes, assessments were described and referenced.	Yes, used a computer-administered test.	Yes, suicide attempt assessed by a structured interview by phone and review of hospital medical records.	Unclear, not reported.	Not applicable.‡	Unclear
Rana, 2012[45]	No, characteristics were not described.	Yes, included all risk assessments in the healthcare system database within the study period.	Unclear, 27,061 risk assess- ments from 8,739 patients; number of suicides and attempts not reported.	Unclear, not reported.	Yes, machine learning algorithms were described and referenced in an appendix; risk assessment tool publicly available, though scoring method is unclear.	No, assessments were completed by clinicians not study staff according to clinical guidelines.	Yes, suicide deaths confirmed with death certificates; suicide attempts obtained from emergency department diagnostic codes.	Not applicable.†	Not applicable.‡	Unclear
Steeg, 2012[46]	Yes, data reported in separate publication.[71]	Yes, data were collected on all patients who presented with self-harm.[71]	Yes, N=18,680; 92 suicides within 6 months.	Yes, missing data low (16% of episodes); loss to follow-up may have occurred, although audits	Unclear, data collection differed across study sites; 68% of patient presentations resulted in thorough psychosocial assessments.	No, assessments were completed by clinicians not study staff according to clinical guidelines.	Yes, death by suicide and undetermined causes according to the ICD-10 codes from patients' records in England's national health database.§	Not applicable.†	Not applicable.‡	Low

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Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
				estimated minimal loss.						
Tran, 2014[47]	Yes	Yes, included all patients within study period meeting inclusion criteria based on data from electronic medical records.	Yes, N=7,399; 29 suicides, 2,208 attempts.	Unclear, not reported.	Yes, risk stratification model described, and clinician risk assessment publicly available and completed for each participant according to hospital policy.	No, assessments were completed by clinicians not study staff according to clinical guidelines.	Unclear, diagnostic codes for suicide attempts varied and did not necessarily represent intention to die (*eg*, very high blood alcohol level).	Not applicable.†	Not applicable.‡	Unclear
van Spijker, 2014[48]	Yes	Yes, all who completed the online survey were included, but they may not represent the general population.	No, N=1,352; 13 attempts.	Yes, no follow-up; all assessment measures were completed by 97% of participants.	Yes, assessments were described and referenced.	Yes, online self-report.	Yes, suicide attempt or preparations in the past year were based on a condensed version of the Columbia Suicide Severity Rating Scale.	Yes, online self-report.	Not applicable.‡	Unclear
Yaseen, 2012a[50]	Yes	Unclear, clinical records were reviewed and clinical staff was approached to confirm patients' appropriateness for the study.	No, N=183; 55 with current attempts.	No, 90% were lost to follow-up.	Yes, risk assessment described and administered before other assessments in order to reduce the likelihood of biased	Unclear, not reported.	Yes, current suicide attempt based on the Columbia Suicide Severity Rating Scale	Unclear, not reported.	No, only controlled for Brief Symptom Inventory subscale scores in regression analysis.	High

Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
					responses.					
Yaseen, 2012b[49]	Yes	No, referred by clinician.	No, N=176; 31 with current attempts.	Yes, no follow-up assessment; few missing data.	Unclear, some patients were assessed immediately, while others needing more care were assessed within 24 hours of stabilization.	Unclear, not reported.	Yes, current suicide attempt based on the Columbia Suicide Severity Rating Scale.	Unclear, not reported.	Unclear, controlled for some factors in regression analysis (including gender, diagnostic category, and substance abuse).	High
Yaseen, 2014[51]	Yes	No, referred by clinician.	No, N=161; 13 with attempts.	No, 67% lost to follow-up.	Yes, assessments were described and referenced.	Unclear, not reported.	Yes, suicide attempt based on the Columbia Suicide Severity Rating Scale, US national death registry, and patient medical records.	Unclear, not reported.	Not applicable.‡	High
Yen, 2011[52]	Yes	No, recruited from study clinics.	Yes, N=733; 156 with attempts.	Yes, 14% lost to follow-up or with missing data.	Yes, assessment was described and referenced.	Yes, self-report measure.	Yes, suicide attempt assessed by the Longitudinal Interval Follow-up Evaluation semi-structured interview; suicide deaths confirmed by family member	Unclear, not reported.	Not applicable.‡	Unclear

Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
							and/or death certificate.			
Studies Included in the Previous Systematic Review[2]										
Breshears, 2010[33]	Yes	Unclear, not reported.	No, N=154; 11 with suicide behavior.	Unclear, included only patients with medical record information to confirm traumatic brain injury and assess injury severity.	Unclear, all risk factors were assessed by chart review; scoring of the Personality Assessment Inventory was likely standardized.	Unclear, not reported.	No, chart review was used as the reference standard for suicidal behavior.	Unclear, not reported.	Not applicable.‡	High
Hartl, 2005[34]	Yes	Yes, consecutive admissions.	No, N=630; 7 with attempts 4 months prior to intake.	Unclear, missing data not reported.	Unclear, intake questionnaires were not described.	Unclear, not reported.	Unclear, suicide attempt items were reportedly added to the Northeast Program Evaluation Center survey and are not standard.	Unclear, not reported.	Not applicable.‡	High
Hendin, 2010[35]	Yes	Unclear, not reported.	No, N=283; 40 with suicidal behavior.	Yes, 240/283 patients completed both assessments.	Yes, assessments were described and referenced.	Yes, research assistant assessors were independent.	Yes, procedures were described; all patients were assessed at follow-up.	Unclear, not reported.	Not applicable.‡	Unclear

Author, Year	Adequate description of population?	Non-biased selection?	Adequate sample size for study design?	Low loss to follow-up/ missing data?	Standardized method of risk factor assessment and scoring clearly described or referenced?	Unbiased risk factor assessment by independent assessors?	Adequate outcome measurement?	Unbiased outcome measurement by independent assessors?	Adequate accounting for potential confounders?	Overall assessment of potential for bias (Low/ Unclear/ High)
Tiet, 2006[36]	Yes	Unclear, recruitment time frame not described.	Yes, N=5,671; 1,163 with attempts within 30 days.	Yes, 2% missing data (95/5671).	Yes, assessments were described and referenced.	Unclear, not reported.	Yes, assessed during face-to-face interview with Addiction Severity Index.	Unclear, not reported.	Not applicable.‡	Unclear

Abbreviations: ICD = International Classification of Disease.

* Risk of Bias tool modified from Hayden, 2006 and Harris, 2001.[26,28]

† Deaths confirmed by reliable external sources (*eg,* death certificate).

‡ Not relevant to this study.

§ "Undetermined cause" was combined with "suicide" in this study consistent with customary practice in the United Kingdom (UK).

KEY QUESTION 2: What are the efficacy/effectiveness and adverse effects of suicide prevention interventions in reducing rates of suicide and other suicidal self-directed violence in Veterans and military personnel? Interventions include healthcare services directed towards A) populations and B) individuals.

Summary of Findings

Studies Included in Previous Systematic Reviews

Five previously published systematic reviews included studies of the efficacy or effectiveness of suicide prevention interventions in reducing suicide and other suicidal self-directed violence,[1,3,16,31,32] including 2 previous VA ESP reports of individual[3] and population-level interventions[1] (**Table 6**). These systematic reviews are provided in this report for context. Only 6 studies cited in the systematic reviews are relevant to this review because of differences in scope and inclusion criteria.[72-77] One of these studies is an initial publication of a population-level intervention, the Air Force Suicide Prevention Program, that has since been updated.[78] This study is described in the next section (**Table 7**).

Five additional studies cited in the previous systematic reviews provide results of individual-level interventions (**Table 8**).[72,73,75-77] All are RCTs enrolling non-military and non-Veteran populations that compared usual care to individual psychotherapies, including cognitive behavioral therapy, dialectical behavior therapy, personal construct psychotherapy, and problem-solving therapy. A trial of 111 women meeting criteria for borderline personality disorder compared dialectical behavior therapy with usual care.[75] Results indicated fewer suicide attempts with the therapy versus usual care at one-year follow-up (23% versus 46%; $P = .01$). Results of the other 4 trials indicated no differences between comparisons; however, they were underpowered to detect differences in suicide and suicide attempts,[72,76,77] and were compromised by other methodological limitations including unclear or lack of measures of suicidal behavior outcomes (**Table 9**).[73]

Table 6. Previous Systematic Reviews of the Efficacy or Effectiveness of Suicide Prevention Interventions in Reducing Suicide and Other Suicidal Self-directed Violence

Author, Year	Search dates	Included populations	Interventions	Suicide-related outcomes	Results relevant to the current review
O'Connor, 2013[15,16]	2002-July, 2012	Adolescents, adults, older adults.	Psychotherapy, enhanced usual care, medication.	Suicide, suicide attempts, suicidal ideation, depression.	· 6 RCTs of psychotherapy reported suicide deaths; results were inconclusive. · 11 RCTs of psychotherapy suggested reduced suicide attempts, but studies were heterogeneous. · 13 RCTs of enhanced usual care indicated no significant reductions in suicide attempts. · 2 RCTs met inclusion criteria for the current review and are summarized in Table 8.
O'Neil, 2012[3]§	2005-November, 2011	Veteran and/or military patient subgroups from the US, UK, Canada, New Zealand, and Australia.	Any intervention with the potential to reduce or prevent suicidal self-directed violence.*	Suicidal self-directed violence including suicide and suicide attempts; did not include suicidal ideation and undetermined or non-suicidal self-directed violence.	· No RCTs in military or VA healthcare settings. · 5 RCTs of relevant individual-level interventions met inclusion criteria for the current review and are summarized in Table 8.
Shekelle, 2009[1]§	June, 2005-May, 2008	Studies reporting results from any country for military or Veterans were included, as were studies in Anglo/American countries.	System-level interventions and others except strictly mental-health interventions.	Only studies reporting direct effects of interventions on suicide and suicide attempts were considered.	· Insufficient studies of suicide prevention programs specifically in Veterans. · Studies of multicomponent interventions in military personnel, psychosocial interventions after suicide attempts, and restriction of access to lethal means suggest potential effects in reducing risk of suicide.
Mann, 2005[31]	1966-June, 2005	Not specified.	Various interventions to reduce suicide.	Suicide and suicide attempts.	Physician education in depression recognition and treatment as well as restricting access to lethal methods reduces suicide rates. Other interventions require more evidence of efficacy.†
Gaynes, 2004[32]	1966-October, 2002	Primary care patients with previously unidentified suicide risk.‡	Various interventions to reduce suicide.	Suicide and suicide attempts.	Psychotherapy for suicide prevention can be an effective treatment in adults; evidence was limited in older adults and adolescents.

Abbreviations: RCT = randomized controlled trial, UK = United Kingdom.
*Includes interventions related to environmental modification, psychotherapy, medication, somatic treatment, and monitoring.
†Includes various types of psychotherapy, post-crisis interventions, and other approaches.
‡Included RCTs were conducted in high-risk groups as identified by a deliberate self-harm episode, diagnosis of borderline personality disorder, or admission to a psychiatric unit. Clinical trials targeting patients with chronic psychotic illnesses were excluded.
§Previous VA ESP review on suicide prevention interventions in Veterans and military personnel.

Recently Published Studies

Healthcare Service Interventions Directed Towards Populations

Eight new population-level intervention studies met inclusion criteria (**Table 7**).[78-85] These studies evaluated multi-component initiatives implemented within existing organizational structures that included military populations,[78,81] police officers,[83] college students,[82] and healthcare systems.[79,80,85] The initiatives were comprised of components generally categorized as education, awareness, individual health, and individual risk monitoring. One study was designed as a retrospective cohort study;[80] 6 were before-after studies[78,79,82-85] and one was a post-intervention series[81] for which risk of bias criteria were not applicable. All interventions except for one[82] were designed for primary prevention of suicide. No studies evaluated adverse effects of population-level interventions.

The Air Force Suicide Prevention Program is an Air Force-wide intervention that includes policy and education initiatives and emphasizes early identification and treatment. Leaders are responsible for changing expectations of behaviors to improve suicide prevention awareness. Specifically, the program consists of 11 initiatives that are clustered into 7 prevention domains: leadership involvement, continuous professional military training, development of guidelines for commanders, ongoing community education, development of integrated delivery system and community action information boards, enhancement of community mental health services, and instituting policies. Implementation began in 1997, and Air Force leaders and installation commanders completed surveys and checklists regarding the 11 initiatives twice (2004 and 2006) during the 12-year intervention period.[78]

An initial before-after study of the Air Force Suicide Prevention Program examining suicide deaths in the Air Force from 1990 to 2002 found that implementation of the program was associated with reduced risk for suicide in a cohort of over 5 million active duty US Air Force personnel (relative risk 0.67; 95% CI, 0.57 to 0.80).[74] The program was monitored until 2008 and long-term outcomes were reported in a subsequent publication.[78] The suicide rate before implementation (estimated per quarter mean from 1981 to 1997) was 3.033 per 100,000 compared with 2.387 per 100,000 after implementation (from 1997 to 2008) (*P<.01*).

A post-intervention series study reported outcomes of a suicide prevention program implemented in an Army Infantry Division deployed to Iraq.[81] The program integrated specific efforts at each phase of deployment, including education, early detection, intervention, communication, command/leader emphasis, and treatment for all unit members and their significant others. The 15-month deployment rate of suicide was compared to the average theater rate and the current US Army rate. While the rate for the intervention unit was lower than either of these comparison populations (16.0 per 100,000 versus 24.0 per 100,000 for service members in theater and 19.2 per 100,000 for US Army specifically), comparative statistics were not provided. Since the suicide rate was compared to that of all deployed forces, there were no specific comparisons with usual care or other types of prevention/intervention programs.

A before-after study evaluated results of the Together for Life suicide prevention program for 4,178 police officers in Montreal, Quebec, Canada.[83] The program consisted of education, police resources, and training for supervisors and union representatives. A half-day training was given to all police personnel about the nature of suicide, how to identify suicide risk, and the process of

helping a colleague in difficulty. In addition, a telephone helpline was created for police officers, and a publicity campaign was promoted by internal police newspapers, posters, and brochures. During the 11 years before the program began (1986 to 1996), the rate of suicide for Montreal police officers (30.5 per 100,000 per year; 14 total suicides) was higher than the rate for Quebec police forces (26.0 per 100,000). In the 12 years after the program was implemented (1997 to 2008), the suicide rate for Montreal police officers decreased to 6.4 per 100,000 (4 total suicides; pre- versus post-intervention P = .008), while the rate for Quebec police forces increased slightly (29.0 per 100,000).

Three studies evaluated population-level interventions implemented in healthcare settings.[79,80,85] A before-after study examined outcomes from the Perfect Depression Care initiative, which was based on the 6 aims and 10 rules from the Institute of Medicine report *Crossing the Quality Chasm*.[86,87] The Perfect Depression Care initiative was implemented by the Henry Ford Health System, a large health maintenance organization in the US.[79] The main aim of this initiative was to eliminate suicide by emphasizing aspects of high quality care for depression, such as patient partnership, access to care, and continually implementing and assessing measures of care quality. Methodological procedures and outcome measures were not described. Suicide rates decreased from 89 per 100,000 at baseline to 22 per 100,000 after implementation (P = .007).

A retrospective cohort study evaluated the long-term impact of a program of specialized early psychosis treatment on suicidal behaviors among 7,760 young adults with psychotic disorders in Australia.[80] Patients who received care at a specialized early psychosis program clinic between 1991 and 1999 (N = 1141) were compared to patients who received care at non-specialist adult public mental health services (N = 6619) during the same time period. Data were collected retrospectively from the Victorian Psychiatric Case Register. Specialized treatment at the Early Psychosis Prevention and Intervention Centre[88] consisted primarily of inpatient care lasting up to 24 months with a minimum of 6 days, and follow-up community-based services. A total of 154 suicide deaths were recorded over the 8.5-year period, and suicide rates did not differ between the program and usual care (P = .84). Cumulative suicide rates progressively increased after initial treatment for the entire cohort (one-year 0.7%, 3-year 1.5%, 5-year 2.3%). The study had unclear risk of bias; limitations included incomplete consideration of potential confounders leading to questionable comparability of intervention and usual care groups, and lack of details regarding treatment with usual care.

A before-after study evaluated the implementation of mental health service recommendations from the English Suicide Prevention Strategy.[85,89] This study was designed to examine the relationship between provision of mental health services and national suicide rates, as well as to determine the number of recommendations implemented.[85] In England and Wales from 1997 to 2006, 9 key service recommendations were observed, including removing ligature points on inpatient wards; assertive outreach; 24-hour crisis team care; follow-up after psychiatric discharge within 7 days; a written policy on response to patients non-compliant with treatment; a written policy on management of patients with dual diagnoses; criminal justice sharing; multidisciplinary review and sharing information with families after suicide; and clinical training for staff about suicide risk. Rates were expressed as the number of suicides per 10,000 individuals per year. Mental health services that provided 24-hour crisis care had the largest decline in suicide rates, from 11.44 per 10,000 (95% CI, 11.12 to 11.77) before implementation to 9.32 per 10,000 (95% CI, 8.99 to 9.67) after implementation (P<.0001). Suicide rates were

also lower for establishment of local policies on patients with dual diagnoses (10.55 [95% CI, 10.23 to 11.88] versus 9.61 [95% CI, 9.18 to 10.05]; *P* = .0007); and multidisciplinary reviews after suicide (11.59 [95% CI, 11.31 to 11.88] versus 10.48 [95% CI, 10.13 to 10.84]; *P*<.0001).

The effectiveness of the Garrett Lee Smith Youth Suicide Prevention Program, implemented in over 3,000 US counties, was evaluated in an ecological comparison study.[84] The program included education, gatekeeper training, screening activities, improvements in linkages to services, crisis hotlines, and community partnerships for US state, territory, tribal, and college settings.[90] The program allowed site-specific data collection, management, analysis, interpretation, and reporting, but had some degree of uniformity of process and outcome measurements at nearly all sites. From 2007 to 2010, suicide rates in 479 counties that implemented one aspect of the program, gatekeeper training sessions, were compared with rates in matching counties with no training.[84] Results indicated no statistically significant differences for adults ages 19 years and older.

A secondary prevention before-after study examined the effects of mandated treatment after suicidal threats or attempts for students at the University of Illinois.[82] The program consisted of 4 treatment sessions that began within a week of the attempt or threat or after discharge from the hospital. These included an assessment of current suicidal risk by mental health professionals; working with the student to observe the circumstances of the event; determining lifetime history of suicidality and its origins; and drawing attention to the school's standards of self-welfare and the consequences of not adhering to them. Student suicide rates decreased from 6.91 per 100,000 in the 6 years prior to program implementation (1976 to 1983) to 3.78 per 100,000 during the first 21 years of the program (1984 to 2005).

Table 7. Studies of Population-level Healthcare Service Interventions for Suicide Prevention

Author, Year	Study Design	N; Population	Intervention	Outcome	Results
Recently Published Studies					
Coffey, 2007[79]	Before-after study	General mental health and substance abuse patients in a US healthcare system; baseline year 2000, follow-up years 2002-2005.	Henry Ford Health System's Perfect Depression Care initiative utilized 6 aims and 10 rules from the Institute of Medicine report: *Crossing the Quality Chasm.*[86,87]	Suicide	Suicide rate: 89/100,000 baseline versus 22/100,000 follow-up average (P=.007); 77/100,000 initially versus 22/100,000 follow-up average (P=.022).
Harris, 2008[80]	Retrospective cohort	7,760 patients (ages 15-29 years) with psychotic disorder receiving mental health services in Victoria, Australia; 59.7% male; from 1991-1999.	The Early Psychosis Program involved inpatient specialized care at the Early Psychosis Prevention and Intervention Center for a period of up to 24 months.[88] All patients receiving care in the program were compared to patients receiving non-specialist adult mental healthcare from other clinics in the area.	Suicide	Across 8.5 years, suicide rate: 3.8% intervention versus 4.2% usual care (P=.84).
Joffe, 2008[82]	Before-after study	College students at the University of Illinois and citizens of Champaign county from 1984-2005.	Secondary prevention intervention that mandated students with suicide attempts or threats to receive 4 professional treatment sessions conducted by mental health professionals. Failure to comply resulted in sanctions.	Suicide	Suicide rate: 6.91/100,000 pre-intervention versus 3.78/100,000 post-intervention after 21 years of the program.
Knox, 2010[78]*	Before-after study	>5 million service personnel in the US Air Force; 1981-2008.	11-component initiative implemented starting in 1997: leadership involvement, suicide prevention education, commander guidelines for use of mental health services, community prevention services, community education and training, investigative interview policy, trauma stress response, integrated delivery system and community action information board, limited privilege suicide prevention program (increased confidentiality), assessment, and suicide event surveillance.	Suicide	Mean quarterly suicide rate: 3.033/100,000 pre-intervention versus 2.387/100,000 post-intervention (P<.01).
Mishara, 2012[83]	Before-after study	4,178 members of the Montreal police; Quebec, Canada; 1997-2008.	The Together for Life Suicide Prevention Program consisted of education, police resources, training for supervisors and union representatives, and a publicity campaign.	Suicide	Suicide rate: 30.5/100,000 pre intervention versus 6.4/100,000 post-intervention (P=.008).
Walrath, 2015[84]	Ecological comparison study	Youths and adults in 479 counties across the US; 2007-2010.	The Garrett Lee Smith Youth Suicide Prevention Program consisted of education, gatekeeper training, screening activities, improvement of linkages to services, crisis hotlines, and community partnerships. The study compares counties that implemented gatekeeper training with matched counties without training.	Suicide	At one and 2 years after training, no differences for adults ages 19 and older.

Author, Year	Study Design	N; Population	Intervention	Outcome	Results
Warner, 2011[81]	Post intervention series	40,283 in US deployed military unit; 15 months in Iraq (March 2007-May 2008).	Multiple component intervention for deployed unit included: · Pre-Deployment Phase: suicide risk recognition and response training, early identification, and resiliency training for soldiers and families. · Deployment: education, suicide prevention review board and suicide risk management teams, unit behavioral health needs assessment, unit behavioral health advocates, incident response, and trend monitoring. · Re-Deployment: education, post deployment health assessment, and risk stratification. · Reintegration: complete redeployment tasks, prepare for reuniting with families, address post-deployment health issues.	Suicide	Suicide rate: 16.0/100,000 intervention unit during the deployment cycle versus 24.0/100,000 for service members in theater and 19.2/100,000 for US Army specifically.
While, 2012[85]	Before-after study	12,881 suicide deaths within mental health services in Wales and England from 1997-2006.	Assessed 9 of the 12 key service recommendations from the English Suicide Prevention Strategy: removing ligature points on inpatient wards, assertive outreach, 24-hour crisis team, follow-up after psychiatric discharge within 7 days, written policy on response to patients non-compliant with treatment, written policy on management of patients with dual diagnoses, criminal justice sharing, multidisciplinary review and sharing information with families after suicide, and clinical training around suicide risk for staff.	Suicide	Suicide rates that declined pre- versus post-intervention (per 10,000 per year): 24-hr crisis care 11.44 versus 9.32 (*P*<.0001); multidisciplinary review 11.51 versus 11.39 (*P*<.0001); dual diagnoses 10.51 versus 9.61 (*P*=.0007).
Studies Included in the Previous Systematic Review[1]					
Knox, 2003[74]	Before-after study	>5 million service personnel in the US Air Force; 1981-2008.	11-component initiative implemented starting in 1997: leadership involvement, suicide prevention education, commander guidelines for use of mental health services, community prevention services, community education and training, investigative interview policy, trauma stress response, integrated delivery system and community action information board, limited privilege suicide prevention program (increased confidentiality), assessment, and suicide event surveillance.	Suicide	Suicide relative risk pre- versus post-implementation: 0.67 (95% CI, 0.57 to 0.80).

Abbreviations: CI = confidence interval.
*Update of Knox 2003.[74]

Healthcare Service Interventions Directed Towards Individuals

Five new RCTs of individual-level interventions met inclusion criteria (**Table 8**).[91-95] Trials enrolled outpatient military personnel[93] and psychiatric inpatients or patients at acute risk for suicide;[91,92,94,95] no studies enrolled Veterans specifically. Suicide attempt was the main outcome in trials of military personnel[93] and adults with borderline personality disorder,[95] while suicide was the main outcome in the other trials. However, very few suicides occurred and most trials were underpowered to detect meaningful differences between groups. No studies evaluated adverse effects of individual-level interventions.

A brief cognitive behavioral therapy program was compared with treatment as usual in a trial of outpatient active-duty soldiers with recent suicide attempts or ideation.[93] Treatment as usual consisted of individual and group psychotherapy and psychiatric medication. Participants randomized to cognitive behavioral therapy received usual care plus 12 individual outpatient psychotherapy sessions. These focused on detailed assessment of the participant's most recent suicidal episode or suicide attempt, cognitive strategies to reduce beliefs and assumptions that may exacerbate suicidal behaviors, and relapse prevention. Participants receiving therapy were less likely to make suicide attempts during the 2-year follow-up period than those receiving usual care (13.8% versus 40.2%, $P = .02$; hazard ratio 0.38 [95% CI, 0.16 to 0.87]). These results are consistent with earlier studies that found that cognitive therapy was effective in reducing suicide re-attempt rates compared to usual care.[31] The study had unclear risk of bias; limitations included inadequate information regarding allocation concealment and blinding and possible selective outcome reporting.

Two studies evaluated the effectiveness of dialectical behavior therapy on suicide attempts.[94,95] In one trial, 99 women with borderline personality disorder were randomly assigned to one of 3 different variations of dialectical behavior therapy.[94] All participants had 2 or more suicide attempts or non-suicidal self-injurious acts within the previous 5 years. Standard dialectical behavior therapy consisted of weekly individual therapy and group skills training, a therapist consultation team, and as-needed between session telephone coaching. The second treatment group replaced individual therapy with case management, while the third treatment group replaced skills training with an activity-based support group. Results indicated no statistically significant differences in occurrence of suicide or suicide attempts between the different types of dialectical behavior therapy. The study had unclear risk of bias; allocation concealment was not described, dropout rates differed between comparison groups, and the trial was underpowered to detect differences.

In another trial, 180 adults with borderline personality disorder were randomly assigned to dialectical behavior therapy or general psychiatric management consisting of psychodynamic psychotherapy, case management, and pharmacotherapy.[95] Participants were treated for one year and followed for another 2 years. Suicide attempts did not differ between comparison groups ($P = .83$). The study had unclear risk of bias; many participants received treatment during follow-up assessment phases and the trial was underpowered to detect differences.

A trial of patients admitted to the emergency department and psychiatric service who had engaged in self-harm during the previous 3 days compared a problem-solving skills training program with treatment as usual.[92] Usual care consisted of assessments by mental health professionals and referrals to crisis nurse services and other mental health services (*eg,*

community-based services, pharmacological treatment). In addition to usual care, participants randomized to the intervention received six 2-hour weekly closed group sessions focusing on interpersonal problem-solving skills training. Suicides were identified by hospital record review during a one-year follow-up period. Three participants (2 receiving usual care and one receiving problem-solving training) died by suicide; no other statistical data were provided for suicide attempts. The study had high risk of bias; limitations included unclear information regarding blinding, high differential dropout rates, and no centralized mechanism for identifying cases of suicide. The trial was also underpowered to determine differences between comparison groups.

The effectiveness of day hospital treatment versus conventional inpatient treatment in patients admitted to psychiatric wards was evaluated in an RCT in the UK.[91] Day hospital treatment emphasized intensive group programs comprised of work-based activities, creative activities, art therapy, psychoeducation, cognitively-oriented problem-solving groups, and psychodynamically-oriented talking groups. Participants in the day program were expected to attend 35 hours per week with optional drop-in service on the weekends. The inpatient ward provided conventional psychiatric care with optional daily activities. There were 2 recorded suicide deaths (1 from each comparison group) within one year of discharge from treatment; no additional statistical data were provided. The study had high risk of bias; limitations included lack of information regarding randomization, allocation concealment, blinding, and outcome reporting. The trial was also underpowered to determine differences between comparison groups.

Table 8. Randomized Controlled Trials of Individual-level Healthcare Service Interventions for Suicide Prevention

Author, Year	N; Population	Intervention and Comparison	Outcome	Results
Recently Published Studies				
Jones, 2008[91]	206 patients admitted to an adult psychiatric ward from 1999-2002 (51.5% female); London, UK.	· Day hospital: attendance expected 9:30 am to 4:30 pm with optional drop-in service on weekends; emphasis on group activities. · Inpatient: conventional psychiatric care; limited program of daily activities.	Suicide	1 suicide in the day hospital group versus 1 in the inpatient group at 12-months post discharge follow-up.
Linehan, 2015[94]	99 adult women with borderline personality disorder with at least 2 suicide attempts or non-suicidal self-injury acts within 5 years from 2004-2010; Seattle, WA	· Standard dialectical behavior therapy: weekly individual therapy and group skills training, a therapist consultation team, and as needed between session telephone coaching. · Dialectical behavior therapy with skills training: provided group skills training; removed individual component and replaced it with case management. · Dialectical behavior therapy with individual therapy: eliminated all skills training and added an activity-based support group.	Suicide and suicide attempts	1 suicide; no differences in suicide attempts.
McAuliffe, 2014[92]	433 psychiatric patients ages 18-64 years (65% female) in emergency or inpatient units who reported self-harm within past 3 days; Ireland.	· Problem-solving skills training: six 2-hour sessions of manualized interpersonal problem-solving skills training. · Usual care: assessment and mental health or crisis services referral.	Suicide	1 suicide in problem-solving skills training versus 2 in usual care at 12-months follow-up.
McMain, 2012[95]	180 adults with borderline personality disorder; Toronto, Canada	· Dialectical behavior therapy: comprehensive multicomponent intervention for individuals with high suicide risk. Contains 4 weekly components; individual therapy, group skills training, therapist consultation, and as-needed between-session telephone coaches for one year. · General psychiatric management: psychodynamic psychotherapy, case management, and pharmacotherapy for one year.	Suicide attempts	At 36-months follow-up, no differences between comparisons (*P*=.83).
Rudd, 2015[93]	152 active duty Army (87.5% male); Fort Carson, Colorado, US.	· Brief outpatient cognitive behavioral therapy: 12 sessions, 1-2 weeks apart; first session 90 minutes, following sessions 60 minutes; 3 phases included assessment, cognitive strategies to reduce beliefs and assumptions that serve suicidal thoughts, and relapse prevention. · Usual care: treatment as usual.	Suicide and Suicide Attempt Self-Injury Interview[96]	After 2 years follow-up, at least one suicide attempt by 8 individuals in therapy versus 18 in usual care (14% versus 40%, *P*=.02); multivariate Cox regression controlled for baseline risk (hazard ratio 0.31, 95% CI, 0.13 to 0.75).

Author, Year	N; Population	Intervention and Comparison	Outcome	Results
Studies Included in the Previous Systematic Review[3]				
Comtois, 2011[72]	32 adults ages 19-62 years (62% female) with recent suicide attempt or imminent risk; US.	· Collaborative Assessment and Management of Suicidality (CAMS): patients identify the causes of suicidal ideation and the reduction in suicidal ideation and behavior as a coping strategy; 4-12, 50-60 minute sessions with CAMS clinicians. · Enhanced usual care: intake with psychiatrist, 1-11 visits with case manager, and medication management as needed.	Suicide attempts and Self-Injury Count score[97]	Suicide attempts/self-inflicted injuries at 12 months follow-up: 1.2 (SD 3.9) CAMS versus 3.3 (SD 7.6) enhanced usual care.
Gallo, 2007;[73] Alexopoulos, 2009[98]	599 adults age ≥60 years (71.6% female) and score >20 on the Centers for Epidemiologic Studies Depression scale.	· Intervention: on-site depression care manager working with primary care physicians to provide algorithm-based care. · Usual care: educational sessions for primary care physicians and notification of patients' depression, but no specific recommendations for individual patients except for psychiatric emergencies.	Suicide	Number of suicides at 2-year follow-up; number/1000 person-years: 1; 0.7 (95% CI, 0.0 to 4.2) intervention versus 0; 0.0 (95% CI, 0.0 to 3.3) usual care. Suicide attempts at 2-year follow-up: 2 intervention versus 3 usual care.
Linehan, 2006[75]	111 women ages 18-45 years with borderline personality disorder and current and past suicidal behaviors.*	· Dialectical behavior therapy: cognitive behavioral treatment for suicidal women meeting criteria for borderline personality disorder; targets suicidal behavior, behaviors interfering with treatment delivery, and other severe behaviors for one year. · Community treatment by experts: usual care; treatment provided was uncontrolled by the research team.	Suicide attempts and Suicide Attempt Self-Injury Interview[96]	Suicide attempts: 23% dialectical behavior therapy versus 46% community treatment by experts (P=.01; hazard ratio, 2.66, P=.005).
Stewart, 2009[76]	32 adults ages 20-58 years (53% female) receiving inpatient treatment for suicide attempts.	· Cognitive behavioral therapy: seven, 1-hour sessions. · Problem-solving therapy: four, 1-hour sessions. · Treatment as usual: usual care provided by the local hospital.	Repeated suicide attempts	Average number of suicide attempts: cognitive behavioral therapy 0.22 (SD 0.64) versus usual care 0.22 (SD 0.50) (P=NS); problem-solving therapy 0.33 (SD 0.63) versus usual care 0.22 (SD 0.50) (P=NS).
Winter, 2007[77]	64 adults (53% female) receiving emergency care following self-harm.	· Personal construct psychotherapy: 2-22 sessions (mean 10.38); therapeutic techniques appropriate to particular personal construct formulations of the patient's self-harm were set out in a brief manual. · Usual care: assessment and possible follow-up appointments with a mental health team.	Suicide	1 suicide with therapy versus 2 with usual care.

Abbreviations: CAMS = Collaborative Assessment and Management of Suicidality; CI = confidence interval; NS = not statistically significant; RCT = randomized controlled trial; SD = standard deviation.
*2 suicide attempts or self-injuries within the past 5 years, with one in past 8 weeks.

Table 9. Quality Ratings of Randomized Controlled Trials of Healthcare Service Interventions for Suicide Prevention*

Author, Year	Sequence Generation: Was the allocation sequence adequately generated?	Allocation concealment: Was allocation adequately concealed?	Blinding: Was knowledge of the allocated intervention adequately prevented during the study?	Incomplete outcome data: Were incomplete outcome data adequately addressed?	Selective outcome reporting: Are reports of the study free of suggestion of selective outcome reporting?	Other sources of bias: Was the study apparently free of other problems that could put it at a high risk of bias?	Overall assessment of potential for bias: Low/Unclear/High
Recently Published Studies							
Jones, 2008[91]	Unclear, method not described.	Unclear, method not described.	Unclear, no information on blinding.	Unclear, not reported.	Yes, no omissions of expected suicide-related outcomes.	No, study underpowered to determine differences between comparisons.	High
Linehan, 2015[94]	Yes, computerized adaptive randomization procedure.	Unclear, method not described.	Assessors: Yes. Participants and providers: No.	Yes; no differences between groups in loss to follow-up (18% versus 33% versus 27%, *P*>.15); although time to treatment dropout varied (*P*=.03).	No, rates of suicide attempts were not reported (only reported that no significant differences between groups were found).	Unclear, study underpowered to determine differences between comparisons.	Unclear
McAuliffe, 2014[92]	Yes, computer-generated sequence of numbers.	Yes, allocation was concealed using sealed opaque envelopes.	Assessors: Yes. Participants and providers: Unclear.	No, high differential dropout rates; participants who failed to attend the 6-week follow-up had significantly higher levels of anxiety at baseline, suggesting that they may have been more impaired at follow-up.	Yes, no omissions of expected suicide-related outcomes.	No, no centralized mechanism for identifying cases of suicide and study underpowered to determine differences between comparisons.	High
McMain, 2012[95]	Yes, pre-generated block randomization scheme.[99]	Yes, statistician concealed allocation in sealed envelopes.	Assessors: Yes. Participants and providers: Unclear.	Yes, no statistically significant difference between groups in loss to follow-up (20% versus 13%); participants with partially missing data were included in the analyses using mixed-effects growth curve models.	Yes, no omissions of expected suicide-related outcomes; searched patients lost to follow-up in the Ontario death registry to determine if they had died by suicide.	Unclear, many participants received treatment during follow-up assessment phases and the trial was underpowered to detect differences between comparisons.	Unclear

Author, Year	Sequence Generation: Was the allocation sequence adequately generated?	Allocation concealment: Was allocation adequately concealed?	Blinding: Was knowledge of the allocated intervention adequately prevented during the study?	Incomplete outcome data: Were incomplete outcome data adequately addressed?	Selective outcome reporting: Are reports of the study free of suggestion of selective outcome reporting?	Other sources of bias: Was the study apparently free of other problems that could put it at a high risk of bias?	Overall assessment of potential for bias: Low/Unclear/High
Rudd, 2015[93]	Yes, computerized randomization program.	Unclear, computer program was used for randomization, but unclear if allocation was concealed until enrollment complete.	Assessors: Yes. Participants and providers: Unclear.	Yes, analysis of missing data patterns indicated that self-report data were missing completely at random for both treatment conditions; missing data handled with maximum likelihood estimation and multiple imputation of 10 data sets.	Unclear, only self-report data from baseline to the 18-month follow-up assessment were used in analyses because of higher than planned attrition rate during later follow-up assessments.	Yes, none noted.	Unclear
Studies Included in the Previous Systematic Review[3]							
Comtois, 2011[72]	Yes, minimization algorithm matching several patient characteristics.	Unclear, no information provided.	Assessors: Yes. Participants and providers: Unclear.	No, 75% of treatment and 62.5% of control participants did not complete study.	Yes, no omissions of expected suicide-related outcomes.	No, 2 severe and complex patients removed from treatment group; 1 control participant removed. No demographic or outcome data reported for completers versus noncompleters.	High
Gallo, 2007[73]	Yes, matched pairs randomized by coin flip.	Yes, coin flip randomization done at the clinical practice level, so no allocation concealment related to patients was needed.	Unclear, no information on blinding.	Yes, attritions and exclusions adequately documented; 2% excluded due to insufficient baseline data, and vital statistics available on others.	Yes, no omissions of expected suicide-related outcomes.	Unclear, suicidal ideation higher in patients with intervention at baseline.	Unclear

Author, Year	Sequence Generation: Was the allocation sequence adequately generated?	Allocation concealment: Was allocation adequately concealed?	Blinding: Was knowledge of the allocated intervention adequately prevented during the study?	Incomplete outcome data: Were incomplete outcome data adequately addressed?	Selective outcome reporting: Are reports of the study free of suggestion of selective outcome reporting?	Other sources of bias: Was the study apparently free of other problems that could put it at a high risk of bias?	Overall assessment of potential for bias: Low/Unclear/High
Linehan, 2006[75]	Yes, computerized adaptive minimization randomization procedure, eligible subjects were matched to treatment condition on 5 primary diagnostic variables.	Unclear, study coordinator was not blinded, but executed the randomization program and collected all the data related to treatment.	Assessors: Yes. Participants and providers: No.	Yes, a pattern-mixture analysis was implemented using 2-tailed tests. Attritions and exclusions clearly documented and accounted for in analyses.	Yes, no omissions of any expected suicide-related outcomes.	Unclear, differences in amount of therapy received; statistical analysis accounted for nested data structures.	Unclear
Stewart, 2009[76]	Unclear, method not described.	Unclear, method not described.	Unclear, no information on blinding.	No, high and differential attrition (34.4%, 37.5%, and 26.1%) across groups. Numbers included versus analyzed are not clear; one outlier was eliminated before data analysis.	Unclear, not reported.	Yes, none noted.	High
Winter, 2007[77]	No, not randomized: participants were allocated to the psychotherapy condition if there was a vacancy or to the normal clinical practice condition if not.	No, not concealed.	No, does not appear to be blinded (medical records were monitored for repeat episodes of self-harm).	No, very high and differential attrition: 64 allocated, 45% control and 92% intervention completed post-treatment assessment; 28% and 54% completed 6-month assessment. Repetition of self-harm behavior was traced for all over 3 years.	Yes, no omissions of expected suicide-related outcomes.	No, differences at baseline in 2 of 10 personal construct categories of self-harm.	High

*Risk of Bias tool from the Cochrane Collaboration.[25]

KEY QUESTION 3: What are important areas of ongoing research and current evidence gaps in research on suicide prevention in Veterans and military personnel, and how could they be addressed by future research?

Methods to Identify Suicide Risk

Fifteen recent studies and 4 previously published studies on the accuracy of methods to identify individuals at increased risk for suicide and other suicidal self-directed violence met inclusion criteria for this review. Although these studies provide valuable contributions to an expanding evidence base, important gaps remain. In addition, no studies evaluated the adverse effects of risk assessment methods or compared how accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors.

Previous systematic reviews of suicide risk assessment methods have almost invariably resulted in lists of scales or checklists containing self-report items that are summed and scored. The current systematic review casts a wider net, allowing inclusion of other methods of risk assessment.[42-47] Despite this newer work, validation of many risk assessment methods is still needed, and applications to practice are still exploratory. None of the published studies would be considered definitive for patient care, and the best risk assessment method for clinical practice remains uncertain.

Among studies of suicide risk assessment methods, specific instruments were rarely examined in multiple studies. This pattern of one-off examination of instruments was also observed in studies of the many instruments that were not eligible for inclusion in the current systematic review, including the Suicide Cognitions Scale,[100] Brief Symptom Inventory,[101] Holmes-Rahe Social Readjustment Scale,[102] Suicidal History Self-Rating Screening Scale,[103] Risk Assessment Suicidality Scale,[104] and numerous others. Studies of these instruments were not included for various reasons including enrollment of participants not relevant to Veterans and military personnel, lack of reporting of accuracy measures, and other exclusions detailed in **Appendices B and E**.

Also, new studies of previously developed methods, such as the Columbia-Suicide Severity Rating Scale, are not currently available. This well-known instrument was first developed to assess suicidal ideation and behavior in clinical trials. However, it has undergone substantial dissemination domestically and abroad in both research and clinical settings.[59,105] In an ongoing study, the Columbia-Suicide Severity Rating Scale as well as 3 other commonly-used assessment measures are being tested in 900 military personnel to determine which scale or combination of scales most accurately predicts suicidal behaviors within 3 months.[106] Further studies of the accuracy of these methods and their applications in clinical populations would contribute greatly to the field.

Five other ongoing studies of risk assessment for suicide in Veterans and military personnel that were identified in our searches address some evidence gaps (**Table 10**). In addition, future research should be directed towards more concerted replication and in-depth examination of the most promising instruments, rather than continuing to examine numerous different instruments in exploratory and nondefinitive studies. Also, more research on other methods of risk assessment is needed, including population-level approaches and objective methods.

Population-level Approaches to Suicide Risk Assessment

Perhaps the most promising approach to suicide risk assessment in the near future involves capitalizing on so-called big data to sort individuals into higher- and lower-risk groups. The traditional approach to using big data has come from secondary data analyses of large population surveys, limiting analyses to the survey items the original investigators thought to include.[107] Newer approaches, in contrast, use current information from patients' medical records and could allow the opportunity to assess a patient's risk in real time.

Studies that used big data to analyze suicide deaths in the VA[43] and the Army[42] were included in this review. However, several other innovative studies were also identified that did not meet inclusion criteria. The first to be published was another study of VA patients that conducted exploratory data mining. Researchers employed a decision tree that allowed them to partition individuals whose VA health records were linked to the National Death Index for verification of death by suicide into high- and low-risk groups based on a constellation of indicators. Although this study took a novel approach, its results were similar to those found in prior studies using more traditional methods of risk factor identification.[108]

More recently, studies have explored machine-learning algorithms. Such approaches may analyze text from clinicians' notes in the electronic medical record, as was done in one small study of Veterans.[109] Similar machine-learning methods have been recently applied to multiple US Army and Department of Defense administrative data systems to identify high-risk strata to target suicide prevention interventions. In one study included in this review, administrative and medical data from over 50,000 psychiatric hospitalizations of soldiers were used to predict suicides in the subsequent year. Results showed that over half of 68 post-hospitalization suicides could be classified into a group of 5% of hospitalizations with the highest predicted suicide risk.[42] Taxometric studies are a related, promising approach, in which researchers use multiple indicators to divide samples into high- and low-risk groups.[110] Though these approaches are not yet ready for clinical applications, the relative ease of accessing and analyzing existing medical record data is promising.

Research conducted in large integrated community health systems may also be applicable to the VA. In one study, data from the Patient Health Questionnaire (PHQ-9) depression questionnaire suggest that this may be a useful approach.[111] Ongoing work in this health system research network is extending applications of the PHQ-9, which is increasingly collected in routine clinical practice.

Future applications of results from Army STARRS, the largest study of mental health risk and resilience ever conducted among military personnel, could provide risk assessment methods uniquely applicable to the military. A series of important investigations from this project have been published recently published,[6,10] and more are expected in the near future. In addition, results of the Millennium Cohort Study, the largest longitudinal US military study, are also becoming available.[112] This work provides important ongoing opportunities for risk assessment studies, particularly with the recent availability of public use datasets from the Army STARRS survey.

Objective Risk Assessment Methods

While most studies of risk assessment methods have relied on patient self-report data, an important exception is a study included in this review of the computer-administered Implicit Association Test, which uses individuals' reaction times when classifying semantic stimuli in order to predict suicide attempts.[44] Although results of this study were not conclusive because of the small sample size and methodological limitations, it provided a novel approach that built on previous developmental work, and may prove particularly useful in identifying individuals unwilling or unable to reveal their suicidal thoughts or intentions. Work evaluating similar methods in Veteran populations is currently ongoing,[113,114] including a study of the Affective Startle measure, which will use the eye blink reaction to different types of images to assess for suicide risk.[115] Individuals with histories of suicide attempts exhibit certain patterns of cognitive deficits that can be detected by tasks commonly included in neuropsychological testing batteries.[116,117] However, future work is needed to determine whether this method could be useful in predicting suicidal behaviors. Another study evaluated attentional bias, or a tendency to pay more attention to suicide-related words presented to individuals in a modified version of a psychological test that measures reaction time (Stroop test). While results showed that the modified Stroop test may be useful in predicting suicide attempts, larger studies reporting diagnostic accuracy are needed.[118]

Although studies have examined biological markers for suicide or other suicidal self-directed violence, this work is currently exploratory. A variety of candidate genes have been examined (*TPH1*, *SLC6A2*, and *5HTTLPR*, among many others), but the interpretation and integration of results across studies is difficult and clinical applications are uncertain.[119-121] In general, studies use case-control designs and focus on gene-environment interactions in subjects with histories significant for psychiatric disorders, adverse early life experiences, or both. For example, one study identified variants in a glutamatergic gene (*GRIN2B)* and polyaminergic gene (*ODC1)* unique to individuals with histories of suicide attempt or early life physical assault.[122] Nearly all currently published studies examined predominantly Caucasian populations and many required invasive procedures, including several Swedish studies that required participants to undergo lumbar punctures to analyze their cerebrospinal fluid.[123-125] Other studies analyzed postmortem tissue samples of individuals who died by suicide.[126,127] Fewer studies have used neuroimaging to identify associations with suicide-related outcomes.[128,129] Research on biological markers and neuroimaging for assessing risk for suicide is expanding, but their role in clinical care has yet to be determined.

Table 10. Ongoing Studies of Methods to Identify Suicide Risk*

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Purpose of Study
Anestis, M.[114] University of Southern Mississippi	Military Suicide Research Consortium	Predicting Suicide Risk in a Military Population.	1,000 Veterans at an Army National Guard base.	Test a number of models for predicting suicidal behavior to see which are most effective for Veterans. Assessments will be taken at baseline, 6, 12, and 18 months, and will include standard measures of depression and hopelessness, as well as an Implicit Association Test to objectively detect unreported suicidal thoughts. The study will also examine whether additional information provided by a collateral reporter (*ie,* the person to whom the Veteran feels closest) can improve the accuracy of predicting future suicide attempts.
Bagge, C. & Conner, K.[130] VISN 2 Center of Excellence for Suicide Prevention; University of Mississippi Medical Center; University of Rochester Medical Center	Military Suicide Research Consortium	Looking for Suicide Warning Signs.	500 Veterans and civilians with recent suicide attempts.	Identify warning signs that indicate when a suicide attempt is imminent. This will be accomplished by examining a comprehensive list of potential warning signs to see which can effectively distinguish when a suicide attempt is likely to occur in the next 6, 24, and 48 hours.
Hazlett, E. & Goodman, M.[115] James J. Peters VA Medical Center	Department of Veterans Affairs (VISN 3 Mental Illness Research, Education & Clinical Center)	Affective Startle Assessment in High Risk Suicidal Veterans.	Veterans with suicide attempts, suicidal ideation, and with neither suicidal ideation nor attempt.	Determine whether Affective Startle, a validated, reliable, non-verbal psychophysiological measure of emotion processing, could be used as a biomarker to assess for suicide risk. The Affective Startle assessment consists of using electromyography to measure the eyeblink reaction to positive, neutral, and negative images and will be completed at baseline and 6-months follow-up.
Joiner, T. & Gutierrez, P.[106] Florida State University; Denver VA Medical Center	Military Suicide Research Consortium	Toward a Gold Standard for Suicide Risk Assessment for Military Personnel.	900 military personnel seeking services from or referred to inpatient psychiatry, outpatient behavioral health services, or an emergency department because of concerns about suicide risk.	Identify a gold standard for clinical suicide risk assessment by testing 4 widely used measures against each other to determine which measure or combination of measures offers the most accurate prediction of suicide-related behaviors 3 months later. Measures include Columbia Suicide Severity Rating Scale, the Self-Harm Behavior Questionnaire, the Suicidal Behaviors Questionnaire-Revised, and the Beck Scale for Suicide Ideation.
Najavits, L.[131] VA Boston Healthcare System	Department of Veterans Affairs (Health Services	Assessment of Risk for Suicide, Violence and Related High-	74 Veterans with substance use disorder.	Determine whether the Short-Term Assessment of Risk and Treatability (START) can be implemented successfully in VA healthcare facilities and evaluate

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Purpose of Study
	Research & Development)	Risk Behaviors in Veterans.		whether START accurately predicts suicidality, aggression, and related high-risk behaviors among Veterans with substance use disorder.
Nock, M.[113] Harvard University	Military Suicide Research Consortium	Looking for Cognitive Differences in Suicidal Veterans.	400 Veterans: Part 1: psychiatric inpatient Veterans, 100 admitted for suicidal ideation or suicide attempt; 100 admitted for reasons unrelated to suicide. Part 2: depressed Veterans, 100 with suicidal ideation plus 100 without suicidal ideation.	Determine cognitive differences between suicidal and non-suicidal Veterans to develop new, objective ways of predicting suicide risk. The multiple-part study will test several facets of cognition, including time perception, attention to the present versus the past or future, and attention to suicide and psychological pain. Suicide attempts will be assessed 3 months after assessment.

*Ongoing studies were selected from websites and other sources identified by a search of grey literature based on their relevance to the key questions. The list of ongoing studies is likely incomplete because not all ongoing studies are included in these accessible sources.

Healthcare Service Interventions for Suicide Prevention

Population-level Interventions

The 8 studies of population-level interventions for suicide prevention included in this review examined interventions comprised of multiple complex components implemented within existing organizational structures.[74,78-81] For example, the Air Force Suicide Prevention Program included 11 components grouped into 7 domains including engagement of military leaders, community education, continuous military training, and policy changes.[74,78] While study results indicated reduced suicide rates after implementation of this program[74,78] and 2 other initiatives in different settings,[79,81] many essential questions have not yet been addressed. These include whether specific components of the intervention are more effective than others; whether characteristics of individuals nonresponsive to the intervention (*ie,* died from suicide) differ from those who were responsive; and how outcomes of the intervention differ from a concurrent, rather than historical, comparison group receiving usual standards of care. Future studies of the effectiveness of these interventions should be conducted in additional populations in order to further validate results of the initial studies, and, in some cases, to demonstrate the programs' applicability to general clinical practice. Additional details about how the program components were actually implemented and maintained in practice are also necessary in order to establish portable service packages and translate this work to other settings.

Restricting access to lethal means (or simply, means restriction) can be an effective method of suicide prevention,[1,31] although no recently published studies of healthcare services using this approach met inclusion criteria for this review. Examples of current efforts in the VA to reduce access to lethal means include an ongoing study of blister packaging for medications[132] and distribution of gun locks. Studies examining efforts to counsel Veterans on firearms safety and delaying or restricting access to firearms have been published,[133,134] but more work is needed to help guide these clinician discussions with Veterans and to establish the effectiveness of such strategies for VA healthcare settings.

Individual-level Interventions

Studies of individual-level interventions included in this review generally targeted individuals identified as high-risk for suicide based on recent suicide attempts or self-harm[72,76,77,92-94] or existence of psychiatric conditions.[73,75,91,95] Few studies have evaluated the effectiveness of prevention interventions among individuals who do not have these characteristics. Additional research to develop health-promotion approaches that target known risk factors for suicide have been called for by experts in the field within the VA, Department of Defense, and the Centers for Disease Control and Prevention.[135-137] Programs such as the European Alliance Against Depression[138,139] and an ongoing study of cognitive behavioral therapy to reduce hopelessness called Window to Hope for Veterans with traumatic brain injury[140] are examples of such work. These interventions address known risk factors for suicide (depression and traumatic brain injury, respectively) over the short term, with the goal of reducing suicide behaviors over the long term. Research is needed to determine the validity of this assumption.

Studies of interventions targeting protective factors for suicide are also needed.[137,141-144] Protective factors, such as meaning in life, grit, gratitude, and social support, have been found to be negatively associated with suicidal ideation or attempts and may protect at-risk individuals from enacting suicidal behaviors.[145-149] For example, interventions to increase social integration

may be especially effective in reducing suicide rates.[147,148] As risk and protective factors become more clearly characterized through the ongoing work of the Army STARRS and other studies, innovative interventions that reduce suicide risk and bolster protective factors need to be evaluated in well-designed RCTs in order to effectively translate these research efforts to clinical practice.

The 3 recently published trials[91-93] and 5 earlier trials[72,73,75-77] of individual-level interventions included in this review evaluated the effectiveness of psychotherapies or care management approaches for individuals with identified suicide risk. Of these, only 2 studies indicated fewer suicide attempts with therapy versus usual care,[75,93] and most others were underpowered to detect differences. Moreover, all trials met criteria for high or unclear risk of bias. Improvement of this evidence base will require larger, more rigorous RCTs of the effectiveness of existing interventions, such as the Collaborative Assessment and Management of Suicidality,[150] dialectical behavior therapy,[75,151] cognitive behavioral therapy and variants,[152,153] and motivational interviewing for suicidal ideation.[154]

In addition to strengthening evidence for established interventions, research should also include evaluations of the effectiveness of innovative approaches. Using technology to support or enhance care for individuals at risk for suicide is an emerging area. For example, efforts are currently under way to evaluate caring emails and text messages as a method of follow-up and continued contact,[155-158] crisis support through online chat forums for Veterans,[159] crisis text messaging,[160,161] and smartphone applications as accessories to therapy.[162,163] More work evaluating outcomes of these efforts and developing additional resources is needed.

Despite implementation of safety planning in VA care settings, evidence to support its use has not yet been established. Safety plans help the patient document person-specific warning signs or triggers for suicidal thoughts as well as resources the patient can access when he or she is feeling suicidal. They are usually completed with the help of a clinician or other clinical staff and are intended to help the patient recognize when he or she may need extra help and to utilize the previously identified resources. Recently completed trials of safety planning in emergency department settings for both VA and military populations[164-166] are beginning to report findings on care utilization outcomes,[167] and another study is currently under way.[168,169] However, the effectiveness of this intervention in reducing suicidal behaviors has not yet been determined.

Peer support specialists in the VA are Veterans with lived experience with mental illness who help provide social support and mental health assistance for Veterans receiving VA care. Peer support initiatives draw from evidence of the benefits of social support and the idea that others can benefit from the lived experience of those who have recovered from substance abuse or other mental health conditions. Efforts to evaluate this use of peer supporters in suicide prevention efforts have recently begun. For example, a recently completed study examined the feasibility of personal health planning and peer support among Veterans after psychiatric hospitalizations.[170] Additionally, an ongoing pilot project is studying peer mentorship to reduce the risk of suicide after psychiatric hospitalizations.[171] Continued work in this area should focus on establishing training requirements, functions, and eligibility of peer supporters, as well as evaluating efficacy and effectiveness in reducing suicidal behaviors.

Our searches identified 17 studies of individual-level healthcare service interventions for suicide prevention in Veteran and military populations that are currently in progress (**Table 11**).

Table 11. Ongoing Studies of Healthcare Service Interventions for Suicide Prevention*

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Suicidal Self-Directed Violence Outcomes	Purpose	Estimated Study Completion
Bryan, C.[168,169] University of Utah, National Center for Veterans	Military Suicide Research Consortium (MSRC); University of Texas Health Science Center at San Antonio	Brief Intervention for Short-Term Suicide Risk Reduction in Military Populations.	360 active-duty military personnel with current suicidal ideation with intent to die or recent suicide attempt.	Suicide attempt at 6 months (using the SASII).	To determine the effectiveness of 3 brief interventions for reducing short-term risk for suicide attempts in "real world" military triage settings. Participants will be randomized to one of 3 commonly-used crisis interventions delivered as routine care in the mental health triage system: treatment as usual, the Crisis Response Plan (CRP), or Enhanced Crisis Response Plan with Reasons for Living (E-CRP).	December 2015
Bush, N. & Dobscha, S.[163] National Center for Telehealth and Technology; Portland VA Medical Center	The Geneva Foundation; Portland VA Medical Center	Virtual Hope Box – Effectiveness of a Smartphone App for Coping With Suicidal Ideation (VHB-RCT).	120 Veterans in active treatment who are at high risk for suicide.	Suicidal behavior at 12 weeks (using C-SSRS).	Assess the impact of a virtual hope box (VHB) smartphone app on suicidal ideation in Veterans undergoing clinical therapy who have recently had suicidal ideation or behavior.	October 2015
Comtois, K.[155,157] University of Washington	University of Washington; Military Suicide Research Consortium (MSRC); Department of Veterans Affairs; Department of Defense	Military Continuity Project (MCP).	800 active duty, Reserve, or National Guard members with a recent suicide attempt or suicidal ideation.	Suicidal behavior at 12 months (using the SASI-C).	Investigate the efficacy of a Continuing Contacts via Text intervention that extends the continuity of care for service members who have engaged in suicidal behavior and/or reported suicidal ideation by sending them regular caring text messages over a 12-month period.	October 2015
Goodman, M.[172] University of Washington	Bronx Veterans Medical Research Foundation, Inc.	High Risk Suicidal Behavior in Veterans.	500 Veterans at high risk for suicide.	Suicidal events at 6 months (using C-SSRS).	Examine the efficacy of Dialectical Behavior Therapy in reducing suicidal behavior in a diagnostically heterogeneous group of Veterans with high risk for suicidal behavior.	December 2015
Goodman, M.[173] Department of Veterans Affairs	Department of Defense	High Risk Suicidal Veterans – Predictors of Suicide	120 Veterans recently discharged from psychiatric	Suicidal events at 18 months (using C-SSRS).	Compare outcomes for Veterans receiving treatment-as-usual with outcomes for Veterans who receive 6	April 2014

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Suicidal Self-Directed Violence Outcomes	Purpose	Estimated Study Completion
(VISN 3 Mental Illness Research, Education & Clinical Center)		Risk and Efficacy of Dialectal Behavior Therapy.	hospitalization for high-risk suicidal behavior.		months of Dialectical Behavior Therapy, consisting of weekly individual sessions, skills training group and telephone coaching as needed.	
Gutierrez, P.[132] VA Eastern Colorado Health Care System	VA Eastern Colorado Health Care System; Department of Defense	Blister Packaging Medication to Increase Treatment Adherence and Clinical Response (BP).	303 psychiatric patients treated at the Denver VA Medical Center.	Suicide and suicide attempts at 12 months.	Determine if increased prescription medication adherence via blister pack administration will reduce suicide related behavior among the high risk population of patients discharged from a psychiatric inpatient unit.	September 2014
Holloway, M.[174] Uniformed Services University of the Health Sciences	Henry M. Jackson Foundation for the Advancement of Military Medicine; Department of Veterans Affairs	Post Admission Cognitive Therapy (PACT) for the Inpatient Treatment of Military Personnel with Suicidal Behaviors.	218 military service members and beneficiaries hospitalized for severe suicide ideation or recent suicide attempt.	Repeat suicide attempt at 12 months (using the C-SSRS).	Evaluate the efficacy of a cognitive behavioral intervention program, the Post Admission Cognitive Therapy (PACT), for military service members and beneficiaries admitted for inpatient care due to severe suicide ideation and/or recent suicide attempt.	February 2019
Holloway, M.[175] Uniformed Services University of the Health Sciences	Henry M. Jackson Foundation for the Advancement of Military Medicine; National Alliance for Research on Schizophrenia and Depression	Inpatient Post Admission Cognitive Therapy (PACT) for the Prevention of Suicide Attempts.	24 service members and beneficiaries at hospitalized for recent suicide attempts.	Repeat suicide attempt at 3 months (using the C-SSRS).	Evaluate a new manual of Post-Admission Cognitive Therapy (PACT) as a targeted inpatient treatment for individuals admitted for a recent suicide attempt to a military hospital.	December 2015
Holloway, M.[176] Uniformed Services University of the Health Sciences	Henry M. Jackson Foundation for the Advancement of Military Medicine, Congressionally Directed Medical Research Programs	Pilot Trial of Inpatient Cognitive Therapy for the Prevention of Suicide in Military Personnel (CDMRP).	50 service members and beneficiaries with symptoms of acute stress disorder or posttraumatic stress disorder hospitalized for a recent suicide attempt.	Repeat suicide attempt at 3 months (using the C-SSRS).	Evaluate an inpatient-based cognitive behavioral care plan, the Post-Admission Cognitive Therapy (PACT), for service members and beneficiaries with symptoms of either Acute Stress Disorder or Posttraumatic Stress Disorder, who are admitted for hospitalization following a recent suicide attempt.	December 2015

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Suicidal Self-Directed Violence Outcomes	Purpose	Estimated Study Completion
Ilgen, M.[177] VA Ann Arbor Healthcare System	Department of Veterans Affairs	Crisis Line Facilitation (CLF).	500 Veterans under treatment for a suicidal crisis in a Veterans Health Administration inpatient psychiatric unit.	Suicide attempt at 12 months (using C-SSRS).	Test a new single-session intervention, Crisis Line Facilitation (CLF), which addresses Veterans' perceived barriers and facilitators of crisis line use during periods of suicidal crisis. The intervention will be compared to an enhanced usual care condition, with outcomes including suicide attempt and utilization of the Veterans Crisis Line.	April 2018
Ilgen, M.[178] University of Michigan	University of Michigan; US Army Medical Research and Materiel Command; Department of Defense; Department of Veterans Affairs	Intervening to Reduce Suicide Risk in Veterans with Substance Use Disorders.	300 Veterans with a Substance Use Disorder and current suicidal ideation.	Suicide attempt at 24 months (using the C-SSRS).	Evaluate the impact of a Cognitive Behavioral Therapy intervention compared to a Supportive Psychoeducational Control in reducing the frequency and intensity of suicidal thoughts and behaviors in Veterans with substance use disorders over a 2-year follow-up period.	November 2018
Interian, A.[179] Lyons Campus of the VA New Jersey Health Care System	Department of Veterans Affairs	Mindfulness-Based Cognitive Therapy for Suicide Prevention (MBCT-S).	164 Veterans at high risk for suicide.	Suicidal behaviors at 12 months (using VA's Self-Directed Violence Classification System); Suicide attempt at 12 months (using C-SSRS).	Test a psychotherapeutic intervention, the Mindfulness-Based Cognitive Therapy, which integrates cognitive therapy and mindfulness meditation techniques to prevent suicide in military Veterans.	September 2017
Jobes, D.[180] The Catholic University of America	The Catholic University of America; University of Washington; Department of Veterans Affairs	Operation Worth Living Project With Suicidal Soldiers at Ft. Stewart (OWL).	150 Active duty Army personnel at Ft. Stewart with significant suicidal ideation.	Suicide attempts.	Compare the use of new clinical intervention, the Collaborative Assessment and Management of Suicidality (CAMS), versus enhanced care as usual for suicidal soldiers who are seen at outpatient mental health clinics at Ft. Stewart, Georgia.	December 2015
Luxton, D.[156,158] National Center for Telehealth and Technology	National Center for Telehealth and Technology, Department of	Caring Letters for Military Suicide Prevention.	4,730 active duty military members or Veterans who are current	Suicide at 2 years (using death certificates in the National Death	Determine if the Caring Letters intervention is effective in preventing suicide and suicidal behaviors among US Service Members and Veterans.	February 2017

Principal Investigator(s)/ Institution	Sponsors and Collaborators	Study Title	Population	Suicidal Self-Directed Violence Outcomes	Purpose	Estimated Study Completion
	Defense, US Army Medical Research and Materiel Command		psychiatric inpatients.	Index Plus); suicidal behaviors requiring hospital admission (using electronic medical records).		
Matarazzo, B.[181] Rocky Mountain Mental Illness Research, Education, and Clinical Center (MIRECC)	Military Suicide Research Consortium (MSRC)	Improving the Inpatient-to-Outpatient Transition.	700 Veterans from 4 VA medical centers.	Not reported.	To test the Home-Based Mental Health Evaluation program (HOME), designed to lower risk of suicide after discharge from an inpatient psychiatric unit by creating a better transition between inpatient and outpatient care for Veterans who are at risk of suicide.	Not reported.
Primack, J. M.[182] Providence VA Medical Center	Department of Veterans Affairs; Butler Hospital	Veterans Coping Long-term With Active Suicide (CLASP-VA).	300 Veterans at high risk for suicide discharged from a VA hospital.	Suicidal attempts at 12 months (using C-SSRS).	Test the efficacy of the Veterans Coping Long Term with Active Suicide Program (CLASP-VA) intervention to reduce suicide behaviors in Veterans. CLASP-VA is a telephone-based intervention that combines elements of individual therapy, case management, and significant other/family therapy, and directly targets high-risk patients at the time of hospital discharge.	September 2017
VA Eastern Colorado Health Care System[165,183]	VA Eastern Colorado Health Care System; Department of Veterans Affairs; Department of Defense	A Brief Intervention to Reduce Suicide Risk in Military Service Members and Veterans- Study 1 (SAFE VET).	600 Veterans at VA emergency departments.	Suicide attempt at 6 months (using C-SSRS).	Evaluate the Suicide Assessment and Follow-up Engagement: Veteran Emergency Treatment (SAFE VET) intervention, designed to attenuate suicide risk by helping Veterans manage suicidal thoughts and behaviors, and adhere to prescribed clinical care.	March 2015

*Ongoing studies were selected from websites and other sources identified by a search of grey literature based on their relevance to the key questions. The list of ongoing studies is likely incomplete because not all ongoing studies are included in these accessible sources.

SUMMARY AND DISCUSSION

A summary of evidence is provided in **Table 12** and strength of evidence ratings for studies of healthcare service interventions for suicide prevention are provided in **Table 13**.

SUMMARY OF EVIDENCE BY KEY QUESTION

Key Question 1

A. What are the accuracy and adverse effects of methods to identify Veterans and military personnel at increased risk for suicide and other suicidal self-directed violence?

B. Does accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors?

Fifteen recently published studies and 4 from the previous VA ESP systematic review evaluated the accuracy of methods to identify individuals at risk for suicide and other suicidal self-directed violence and met inclusion criteria for this review. These include 2 case-control studies and 17 case-series studies designed to determine measures of diagnostic accuracy. No studies evaluated the adverse effects of risk assessment methods, or compared how accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors.

Results of studies indicated estimates of sensitivity ranging from 11% to 100% and AUC from 0.57 to 0.97. Several risk assessment methods had estimates of sensitivity ≥80% or AUC ≥0.70, suggesting fair or better discrimination between patients with and without suicides or suicide attempts. Several studies used data from electronic medical records or administrative databases to identify individuals with known risk factors for suicide. The most relevant study used data from nearly 6 million patients of the VA to create a prediction model to stratify patients according to their risk for suicide within the next year. This method had an AUC of 0.761 (95% CI, 0.751 to 0.771).

Four additional studies of Veterans were included in the previous VA ESP review. In one study, a decision tree for identifying high-risk patients was derived from the Addiction Severity Index and variables from VA databases. Sensitivity/specificity varied across the 3 prediction models that were evaluated (33%/87%, 72%/63%, 89%/42%). Three studies of Veterans evaluated the accuracy of established instruments to predict suicidal attempts and suicide. Results indicated high sensitivity/specificity for the Suicide Potential Index (91%/77%), and lower estimates for the Beck Depression Inventory (63%/80%) and Affective States Questionnaire (60%/74%).

The only study of military personnel was based on Army STARRS and included 40,820 active duty US Army soldiers hospitalized with psychiatric admission diagnoses. A risk algorithm to predict suicides within one year of hospitalization was developed from administrative data systems and demonstrated AUCs as high as 0.89.

Additional studies of non-Veterans evaluated the diagnostic accuracy of the risk instruments, including the Affective Intensity Rating Scale, Barwon Health Suicide Risk Assessment, Death/suicide Implicit Association Test, SAD PERSONS, Schedule for Nonadaptive and Adaptive Personality, Suicide Opinion Questionnaire, Sleep Quality Index, Suicidal Ideation

Attributes Scale, and Suicide Trigger Scale. Results indicated a wide range of estimates depending on the instrument and selected cut-points.

Current conventions do not provide strength of evidence grades for diagnostic accuracy studies. Studies of methods of risk assessment that were derived from large databases provided a rigorous approach with low risk of bias and high clinical applicability. Results indicated fair or better diagnostic accuracy for some of the models. These methods should be replicated in additional patient populations to refine the data variables and optimal cut-points, and further validate findings before they are adapted to clinical care uses.

Studies based on the diagnostic accuracy of individual instruments and scales are also useful, but are currently limited by small sample sizes, methodological limitations, and unclear applicability. Risk assessment instruments may provide diagnostic value to specific patient subgroups, such as those with previous suicide attempts or co-existing conditions. However, the current evidence base includes numerous inconclusive, small studies of a variety of instruments. Instruments demonstrating fair to good diagnostic accuracy in these studies should be further tested in larger clinical populations.

Key Question 2

What are the efficacy/effectiveness and adverse effects of suicide prevention interventions in reducing rates of suicide and other suicidal self-directed violence in Veterans and military personnel? Interventions include healthcare services directed towards A) populations and B) individuals.

Population-level Healthcare Interventions

Eight studies of the efficacy or effectiveness of population-level healthcare interventions met inclusion criteria, including a follow-up analysis of a study that was included in the previous VA ESP review. These studies evaluated multi-component initiatives implemented within existing organizational structures that included military populations, police officers, college students, and healthcare systems. One study was designed as a retrospective cohort study, 5 were before-after studies, one was an ecological comparison study, and one was a post intervention series. All interventions except for one were designed for primary prevention of suicide. No studies evaluated adverse effects of population-level interventions.

Three studies evaluated interventions in military personnel or police officers. An initial before-after study of the Air Force Suicide Prevention Program, an Air Force-wide intervention that included policy and education initiatives, found that implementation of the program was associated with reduced risk for suicide in over 5 million active duty US Air Force personnel. Long-term follow-up also indicated reduced suicide rates after implementation. A program in an Army Infantry Division deployed to Iraq also resulted in lower suicide rates for the intervention unit compared with rates for service members in theater and for the US Army specifically, although statistical comparisons were not provided. Suicide rates were statistically significantly lower after implementation of a suicide prevention program among police officers in Montreal.

Additional studies evaluated population-level interventions implemented in healthcare and other settings. Suicide rates were reduced in studies of the Perfect Depression Care initiative in a large health maintenance organization in the US; implementation of service recommendations in

England and Wales; and after a mandated secondary prevention program for college students in a US university. No reductions were found in a study of the long-term impact of specialized early psychosis treatment on suicidal behaviors in Australia, and among adults in a community program in the US.

The strength of evidence grades for population-level healthcare interventions are insufficient for suicide attempt outcomes (no studies), low for suicide outcomes (8 observational studies), and insufficient for adverse effects (no studies). The low strength of evidence grade for suicide outcomes indicates that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect. Although 6 of the 8 studies of interventions suggested reductions in suicide rates, the interventions varied across studies, risk of bias was unclear, and the comparability of comparison groups was not established. While the studies provided promising initial findings, these interventions should be replicated under more controlled conditions, such as in RCTs, to strengthen the evidence of their effectiveness.

Individual-level Healthcare Interventions

Five recently published RCTs and 5 trials from the previous VA ESP review met inclusion criteria. No studies evaluated adverse effects of interventions. Trials compared usual care to individual psychotherapies, including cognitive behavioral therapy, dialectical behavior therapy, personal construct psychotherapy, problem-solving therapy or skills training, and day hospital treatment. Trials enrolled outpatient military personnel and non-military psychiatric inpatients or patients at acute risk for suicide. No studies enrolled Veterans specifically and no studies evaluated the adverse effects of individual-level interventions.

Only 2 trials reported statistically significant differences between treatment and usual care. In one trial, outpatient active duty soldiers with recent suicide attempts or ideation in a brief cognitive behavioral therapy program were less likely to make suicide attempts at 2 years follow-up than those in usual care. In a trial of women with borderline personality disorder, those receiving dialectical behavior therapy had fewer suicide attempts compared with those receiving usual care at one year follow-up.

The strength of evidence grades for individual-level healthcare interventions are low for suicide attempt outcomes (7 trials), insufficient for suicide outcomes (4 trials), and insufficient for adverse effects (no studies). The low strength of evidence grade for suicide attempt outcomes indicates that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect. The most relevant trial, comparing brief outpatient cognitive behavioral therapy versus usual care in Army soldiers, indicated statistically significantly reduced suicide attempts for the intervention group, although its risk of bias was unclear. These findings support cognitive behavioral therapy as a suicide prevention intervention and are consistent with other trials of cognitive behavioral therapy in various population groups and settings that did not meet inclusion criteria for this review.[15,16] Larger trials of similar therapies in Veteran and military populations would build on this work and strengthen the evidence base.

The insufficient strength of evidence grade for suicide outcomes indicates that the body of evidence has unacceptable deficiencies that preclude deriving conclusions. In this case, the 4 trials reporting suicide outcomes had too few participants and suicide events to determine statistically significant differences between treatment and usual care. These interventions require

replication in larger trials that are sufficiently powered to detect differences in order to determine their effectiveness in suicide prevention.

LIMITATIONS

Study Quality

For studies of risk assessment, risk of bias was rated low in 3 studies, high in 6, and unclear in 10. Limitations of studies with high or unclear risk of bias included biased or unclear selection criteria for the study populations; non-standardized risk assessment procedures; inadequate outcome assessments; small sample sizes; and high or unclear loss to follow-up.

Risk of bias for studies of population-level interventions was unclear for the retrospective cohort study, and could not be determined for other studies because of the lack of risk of bias criteria for these study designs. Limitations of studies included inadequate consideration of potential confounders, non-comparability of comparison groups, and lack of information on usual care.

Risk of bias for trials of individual-level interventions was rated high in 5 trials and unclear in 5. Most studies were underpowered to detect differences between treatment and usual care. Limitations of studies included lack of information on randomization, allocation concealment, blinding, and outcome reporting; and unclear or lack of specified outcome measures.

Heterogeneity

Studies were highly heterogeneous for both the risk assessment and prevention intervention key questions included in this review. Specific risk assessment methods and prevention interventions were rarely examined in more than one study, precluding statistical meta-analysis of results and limiting applicability to clinical practice. In addition, studies were generally conducted in small, specialized populations that may yield unique results. Future research to reduce heterogeneity will improve the evidence base, such as a recent effort by the National Institutes of Health, VA, and Department of Defense to define common data elements for suicide prevention research.[184]

Applicability of Findings to the VA Population

Of the 37 studies included in this review (including 9 from previous VA ESP reviews), 5 studies of risk assessment included Veterans and one included active military personnel, and 3 studies of interventions included active military personnel. In addition, inclusion criteria for studies enrolling participants outside Veterans and military populations focused on participants with similar demographic characteristics. While these criteria may have excluded important studies, they also improved the systematic review's clinical relevance to the VA population.

CONCLUSIONS

Studies of risk assessment methods to identify individuals at increased risk for suicide and other suicidal self-directed violence evaluated numerous different approaches. Methods derived from data from electronic medical records, including studies of Veterans and military personnel, were robust predictors of subsequent suicide. Studies of various clinician-rated or patient self-report risk assessment instruments indicated accuracy that varied across methods and cut-points. Studies of multi-component population-level suicide prevention interventions and individual cognitive behavioral therapy in military populations showed reduced suicide attempts and

suicide. However, evidence is limited by the many single, inconclusive studies of various risk assessment instruments and prevention interventions, methodological deficiencies of studies, inherent challenges in conducting research in this area, and lack of studies addressing adverse effects.

Table 12. Summary of Evidence

Key Question	Number/Type of Studies	Risk of Bias and Limitations	Summary of Findings
1A What are the accuracy and adverse effects of methods tof identify Veterans and military personnel at increased risk for suicide and other suicidal self-directed violence?	· 15 new studies and 4 from the previous ESP review. · 2 case-control studies, 17 case-series; all were designed to determine diagnostic accuracy. · 5 studies of Veterans; 1 of active military.	· Risk of bias: 3 studies low; 6 high; 10 unclear. · Limitations: biased or unclear selection criteria for the study populations; non-standardized risk assessment procedures; inadequate outcome assessments; small sample sizes; high or unclear loss to follow-up; potentially biased participant selection. · No studies of adverse effects.	· Studies used models derived from databases or clinician-rated or patient self-report instruments. · Accuracy varied across methods and cut-points; sensitivity ranged from 11% to 100%; AUC from 0.57 to 0.97. · Method to predict suicide derived from database of >5 million VA patients: AUC 0.761 (95% CI, 0.751 to 0.771). · Method to predict suicide derived from database of US active military with psychiatric hospitalizations: AUC 0.89.
1B Does accuracy and adverse effects vary by settings, delivery modes, targeted populations, or other factors?	No studies	Not applicable	Not applicable
2 What are the efficacy/effectiveness and adverse effects of suicide prevention interventions in reducing rates of suicide and other suicidal self-directed violence in Veterans and military personnel?			
2A Healthcare services directed towards populations.	· 6 before-after studies; 1 post intervention series; 1 retrospective cohort study. · 2 studies in active US military; 1 study in Canadian police.	· Risk of bias: unclear for the retrospective cohort study; could not be determined for other studies. · Limitations: inherent biases of ecological studies; confounders not considered; non-comparability of comparison groups; no information on usual care. · No studies of adverse effects.	· Suicide rates were lower after interventions in 6 studies, including studies of the Air Force Suicide Prevention Program; a program for an Army Infantry Division deployed to Iraq; and studies of police, college students, and health systems. · Suicide rates were not lower in 2 studies of community programs.
2B Healthcare services directed towards individuals.	· 5 new RCTs; 5 RCTs from the previous ESP review. · 1 RCT in active military.	· Risk of bias: high in 5 studies; unclear in 5. · Most studies were underpowered to detect differences between comparisons. · Limitations: lack of information on randomization, allocation concealment, blinding, and outcome reporting; unclear or lack of outcome measures. · No studies of adverse effects.	· Active-duty soldiers with recent suicide attempts/ideation had fewer attempts 2-years after a brief cognitive behavioral therapy program versus usual care (13.8% vs 40.2%, *P*=.02; hazard ratio 0.38, 95% CI, 0.16 to 0.87). · Women with borderline personality disorder had fewer suicide attempts one year following dialectical behavior therapy versus usual care (23% vs 46%; *P*=.01). · 8 other RCTs indicated no differences between treatment and usual care.

Abbreviations: AUC = area under the receiver-operator characteristic (ROC) curve; CI = confidence interval; ESP = Evidence-based Synthesis Program; RCT = randomized controlled trial.

Table 13. Strength of Evidence Ratings for Studies of the Efficacy/Effectiveness and Adverse Effects of Healthcare Service Interventions for Suicide Prevention

Outcome	Study Design/ Number of Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Overall Effect	Strength of Evidence/ Grade*
Population-level interventions versus none								
Suicide attempt	No studies							Insufficient
Suicide	8 observational (N>5,000,000)	High	Indirect	Unknown	Imprecise	Unknown	Decrease or none	Low
Adverse effects	No studies							Insufficient
Individual-level interventions (psychotherapy) versus usual care								
Suicide attempt	7 RCTs (N=670)	High	Direct	Unknown	Imprecise	Unknown	Decrease or none	Low
Suicide	4 RCTs (N=1,337)	High	Direct	Unknown	Imprecise	Unknown	Unclear	Insufficient
Adverse effects	No studies							Insufficient

Abbreviations: RCTs = randomized controlled trials.

*Strength of Evidence tool from the Agency for Healthcare Research and Quality's (AHRQ) Evidence-based Practice Centers (EPC).[29] Rating Definitions: Low = Limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). Additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.

Insufficient = No evidence, unable to estimate an effect, or no confidence in the estimate of effect for this outcome. No evidence is available or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

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