Effects of Cognitive Behavioral Therapy for Insomnia on Suicidal Ideation in Veterans

Mickey Trockel, MD, PhD[1,2,*]; Bradley E. Karlin, PhD, ABPP[3,4,5,*]; C. Barr Taylor, MD[2]; Gregory K. Brown, PhD[6,7]; Rachel Manber, PhD[1,2]

*[1]Sierra-Pacific Mental Illness Research, Education, and Clinical Center, Veterans Affairs Palo Alto Health Care System, Palo Alto, CA; [2]Stanford University School of Medicine, Palo Alto, CA; [3]Mental Health Services, U.S. Department of Veterans Affairs Central Office, Washington, DC; [4]Education Development Center, Inc., New York, NY; [5]Department of Mental Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD; [6]Mental Illness Research, Education, and Clinical Center, Philadelphia Veterans Affairs Medical Center, Philadelphia, PA; [7]Perelman School of Medicine of the University of Pennsylvania, Philadelphia, PA; * co-first authors*

Objective: To examine the effects of cognitive behavioral therapy for insomnia (CBT-I) on suicidal ideation among Veterans with insomnia.
Design: Longitudinal data collected in the course of an uncontrolled evaluation of a large-scale CBT-I training program.
Setting: Outpatient and residential treatment facilities.
Participants: Four hundred five Veterans presenting for treatment of insomnia.
Interventions: Cognitive behavioral therapy for insomnia.
Measurement and Results: At baseline, 32% of patients, compared with 21% at final assessment, endorsed some level of suicidal ideation [$\chi^2(df = 1) = 125$; $P < 0.001$]. After adjusting for demographic variables and baseline insomnia severity, each 7-point decrease in Insomnia Severity Index score achieved during CBT-I treatment was associated with a 65% (odds ratio = 0.35; 95% confidence intervals = 0.24 to 0.52) reduction in odds of suicidal ideation. The effect of change in insomnia severity on change in depression severity was also significant. After controlling for change in depression severity and other variables in the model, the effect of change in insomnia severity on change in suicidal ideation remained significant.
Conclusion: This evaluation of the largest dissemination of cognitive behavioral therapy for insomnia (CBT-I) in the United States found a clinically meaningful reduction in suicidal ideation among Veterans receiving CBT-I. The mechanisms by which effective treatment of insomnia with CBT-I reduces suicide risk are unknown and warrant investigation. The current results may have significant public health implications for preventing suicide among Veterans.
Keywords: cognitive behavioral therapy, insomnia, suicidal ideation, dissemination, Veterans
Citation: Trockel M, Karlin BE, Taylor CB, Brown GK, Manber R. Effects of cognitive behavioral therapy for insomnia on suicidal ideation in veterans. *SLEEP* 2015;38(2):259–265.

INTRODUCTION

A rapidly expanding body of literature demonstrates that sleep disturbance is a significant risk factor for suicidal ideation and suicidal behavior.[1–9] Insomnia is associated with suicidal ideation among patients with depression, alcohol misuse or dependence, and posttraumatic stress disorder.[1,2,10–13] The link between insomnia and suicide is evident across the life span, including adolescents and older adulthood.[4,14] Two large population-based studies have shown that sleep disturbance, and insomnia specifically, are risk factors for suicide death.[15,16]

Veterans account for an estimated 20% of suicide deaths in the United States,[17] suggesting compelling need for effective strategies to reduce suicide mortality incidence in this population. Two studies have demonstrated the link between insomnia and suicidal ideation in Veterans,[1,2] and a third indicated that sleep disturbance is a stronger predictor of suicidal ideation and suicidal behavior among active military personnel than two well-established risk factors—depression and hopelessness.[18] The growing body of research linking insomnia with suicide risk and the fact that insomnia can be successfully treated suggest that insomnia may constitute a modifiable risk factor for suicidal ideation, suicidal behavior, and suicide death.

A robust body of research supporting the efficacy of the treatment of insomnia using cognitive behavioral therapy for insomnia (CBT-I) has led national consensus statement writers to recommend CBT-I as a first-line treatment.[19–23] Compared with hypnotic medication, CBT-I is equally effective in the short term and more effective in the long term, after treatment is discontinued.[20,24] These results suggest CBT-I may be a particularly promising intervention to reduce suicide risk among individuals with insomnia. CBT-I is also free of common risks associated with pharmacotherapy such as drug-drug interactions and suicide death by overdose of prescribed sedative/hypnotic medication(s).[25,26] If CBT-I can be shown to reduce suicidal ideation, it is possible that this safe and relatively inexpensive treatment may help reduce premature death by suicide.

Depression is also a well-known risk factor for suicide.[27] Some evidence suggests the link between insomnia and suicidal ideation may be mediated by depression,[3,4] while other evidence suggests insomnia is a risk factor for suicidal ideation even after the accounting for the effect of depression.[2,5] Whether the effect of insomnia on suicidal ideation is direct or indirect (mediated by depression), the potential utility of an intervention focusing on this modifiable risk factor has obvious public health importance and is therefore important to evaluate. This was highlighted by McCall, who proposed that a next step

A commentary on this article appears in this issue on page 173.

Submitted for publication December, 2013
Submitted in final revised form July, 2014
Accepted for publication July, 2014
Address correspondence to: Dr. Bradley E. Karlin, PhD, ABPP, Chief, Mental Health and Aging, Education Development Center, Inc., 96 Morton Street, 7th Floor, New York, NY 10014; Tel: (703) 400-5133; Email: bradkarlin@gmail.com

toward understanding the link between insomnia and suicidal ideation is to examine whether treatment of insomnia reduces suicidal ideation.[28] Although there have been no randomized controlled trials to test this hypothesis, an uncontrolled study found that group CBT-I led to reductions in the severity of depression and suicidal ideation among patients who completed treatment.[29] The purpose of the present paper is to examine: (1) change in suicidal ideation during CBT-I treatment in a large group of Veterans, (2) the effects of change in insomnia severity achieved during treatment on change in suicidal ideation and change in depression severity, and (3) the effect of change in insomnia on change in suicidal ideation, after accounting for the effect of concurrent change in depression severity.

METHODS

Data for the current paper were collected as part of program evaluation associated with the U.S. Department of Veterans Affairs (VA) CBT-I Training Program, which represents the largest CBT-I training and dissemination initiative in the United States. The VA CBT-I Training Program is part of a series of evidence-based psychotherapy (EBP) training and dissemination initiatives within the Veterans Health Administration—the health care component of VA—designed to promote the availability and fidelity of EBPs with Veterans.[30] Details of the CBT-I Training Program and therapy protocol have been described elsewhere.[31,32] Briefly, this competency-based training begins with a 3-day CBT-I workshop. Workshop training addresses: (1) regulation of sleep, (2) etiology and treatment of insomnia, (3) CBT-I strategies, and (4) implementation challenges—including the challenges inherent in treating Veterans with diverse comorbidities. Workshop training includes didactic instruction, role-play skills practice with immediate feedback from CBT-I training consultants, video demonstration, and small and large group discussion. Immediately following the workshop, clinicians begin providing CBT-I treatment to patients with insomnia while participating in 4 months of weekly 90-minute telephone consultation sessions. Consultation groups include 4 clinician trainees led by a CBT-I expert training consultant. Group telephone consultation includes review of review of taped CBT-I sessions and feedback, role-play practice of CBT-I skills, and discussion of implementation problems. Clinicians are encouraged to provide CBT-I to at least 2 patients during the consultation phase of their training.

CBT-I Treatment

The CBT-I therapy protocol consists an initial assessment session and 5 treatments sessions (6 sessions in total). Fewer sessions are prescribed on occasions when patients attain sufficient improvement and relapse prevention strategies can be implemented in fewer than 6 sessions. Clinicians tailor treatment components to individual patients based on case conceptualization following comprehensive sleep assessment. CBT-I components include sleep restriction therapy, stimulus control, relaxation exercises, cognitive therapy, and a final session focused on maintenance and relapse prevention.[32]

Clinician Trainees

Clinicians who participated in CBT-I training were licensed VA mental health staff, working with patients who are likely to present with insomnia and in a setting where CBT-I can be implemented. To successfully complete the Training Program, clinicians must achieve minimum CBT-I performance rating criteria based on taped therapy sessions rated by CBT-I training consultants using a standardized rating form.

Patients

Patients included Veterans meeting DSM-IV criteria for insomnia disorder (ascertained by the clinicians) who present for treatment at one of a variety of mental health and primary care settings. Patients agreed to receive the treatment by therapists in training and consented to audio recording of CBT-I sessions for training consultation purposes. Patients were not offered CBT-I if they had bipolar disorder or severe daytime sleepiness. Patients with posttraumatic stress disorder were not excluded unless they were concurrently engaged in prolonged exposure therapy for posttraumatic stress disorder.[33,34] Patients with a history of drug abuse or dependence were not excluded if they had been substance free for ≥ 4 weeks. Patients with other mental health and medical comorbidities were not excluded unless their comorbid conditions were uncontrolled.

Measures

Demographics

Patients completed a demographic form including information regarding their gender, age, race, ethnicity, and education level.

Insomnia Severity

Insomnia symptom severity was measured with the Insomnia Severity Index (ISI), which has been shown to reliably measure changes in insomnia severity.[35] Scores on the ISI range from 0 to 28, with higher scores indicating greater insomnia symptom severity. Recommended cutoffs on the ISI are: 0–7: no clinically significant insomnia; 8–14: subthreshold insomnia; 15–21: clinical insomnia, moderate; and 22–28: clinical insomnia, severe. Moderate improvement in insomnia severity has been defined as a decrease in ISI score of 8.4 points, and marked improvement has been defined as a decrease of 9.9 points.[35] The ISI was administered before each CBT-I session.

Depression

The Beck Depression Inventory-II (BDI-II)[36,37] was employed as a measure of severity of depression. The BDI-II is a patient self-report measure that consists of 21 items scored on a 0–3 scale to reflect the degree of the severity of symptoms. The BDI-II total score ranges from 0 to 63, with higher scores designating greater severity of depression. Recommended BDI-II total score cutoffs are 0 to13 for minimal, 14 to 19 for mild, 20 to 28 for moderate, and 29 to 63 for severe symptoms.[36] The psychometric properties of the BDI-II have been well established and the instrument has been widely used for research as well as clinical purposes.[37] Veterans completed the BDI-II before or at the beginning of the assessment session and at end of CBT-I treatment. BDI-II scores were modified by removing the item assessing suicidal ideation and the item assessing sleep disturbance. Then, the average item score for remaining 19 items was multiplied by 21, the original number of items, to

create a modified depression scale that has the same range of scores as the original BDI-II. This variable is referred to herein as the "modified BDI-II score."

Suicidal Ideation

The BDI-II contains an item that consists of 4 statements that describe the severity of suicidal ideation: no suicidal ideation, suicidal ideation but no intent, desire to suicide, and intent to suicide if given the chance.[37] In studies with inpatient and outpatient psychiatric samples, the BDI-II suicide item has been found to be moderately correlated (r = 0.48 to 0.58) with the Scale for Suicide Ideation.[38] Using data from a prospective study of risk factors for suicide in psychiatric outpatients, the predictive validity of this item has been established.[27,39] A dichotomous variable defined as any suicidal ideation endorsed on the BDI-II (BDI-II suicidal ideation item > 0) vs. no suicidal ideation (BDI-II suicidal ideation item = 0) was used for analysis of suicidal ideation during CBT-I treatment because of low numbers of patients with more severe categories of suicidal ideation.[40,41]

Data Analysis

Analysis and publication of de-identified program evaluation data from the VA CBT-I Training Program was deemed exempt from review by the Institutional Review Board at Stanford University. A multivariate logistic regression model was specified to test the effect of suicidal ideation at baseline on odds of missing final assessment data, since a significant effect of suicidal ideation on odds of missing final assessment data would have important implications regarding the interpretation of subsequent analysis results.

A χ^2 test was used to test the significance of change in probability of suicidal ideation (defined as any level of suicidal ideation endorsed on the BDI-II) achieved during CBT-I, from baseline to final assessment. Multivariate logistic regression and multivariate linear regression, respectively, were used to assess the effects of change in insomnia severity achieved during treatment on change in the dichotomized suicidal ideation variable and change in depression severity (modified BDI-II). Multivariate logistic regression was then used to assess the effect of change in insomnia on change in suicidal ideation, accounting for the effect of concurrent change in depression severity. To assist in interpretation of logistic regression model effect estimates, prior to entry into regression models as independent variables, baseline raw ISI scores were divided by 7, and modified BDI-II scores were divided by 10. Baseline scores for both of these variables were centered on their sample means.

RESULTS

Patients

A total of 647 patients began treatment early enough during the consultation phase of training to allow them to complete therapy by the end of the training period, when final evaluation data were collected. Of these, 405 (63%) completed a baseline and final BDI-II and were included in the analysis (Figure 1).

A logistic regression model (n = 647) revealed that baseline suicidal ideation was not significantly associated with change in odds of missing final assessment data (odds ratio [OR] = 0.73; 95% confidence intervals [CI] = 0.50 to 1.06). The model included adjustments for age (dichotomized: ≥ 65 or < 65 years of age), gender, race, education category (high school education or less, some college, or college graduate), baseline ISI score, and baseline modified BDI-II score. Unadjusted comparisons of patients who were missing final assessment data versus those who were not did not indicate any statistical difference at baseline in percentage with suicidal ideation (missing data = 38% vs 31%; $\chi^2[df = 1] = 2.20$; P = 0.14), mean modified BDI-II score (missing data mean = 24.6 [standard deviation (SD) = 12.3] vs 23.2 [SD = 12.1]; $t[df = 608] = 1.42$; P = 0.16), or mean ISI score (missing data mean = 20.9 [SD = 4.5] vs 20.4 [SD = 4.3]; $t[df = 642] = 1.53$; P = 0.15).

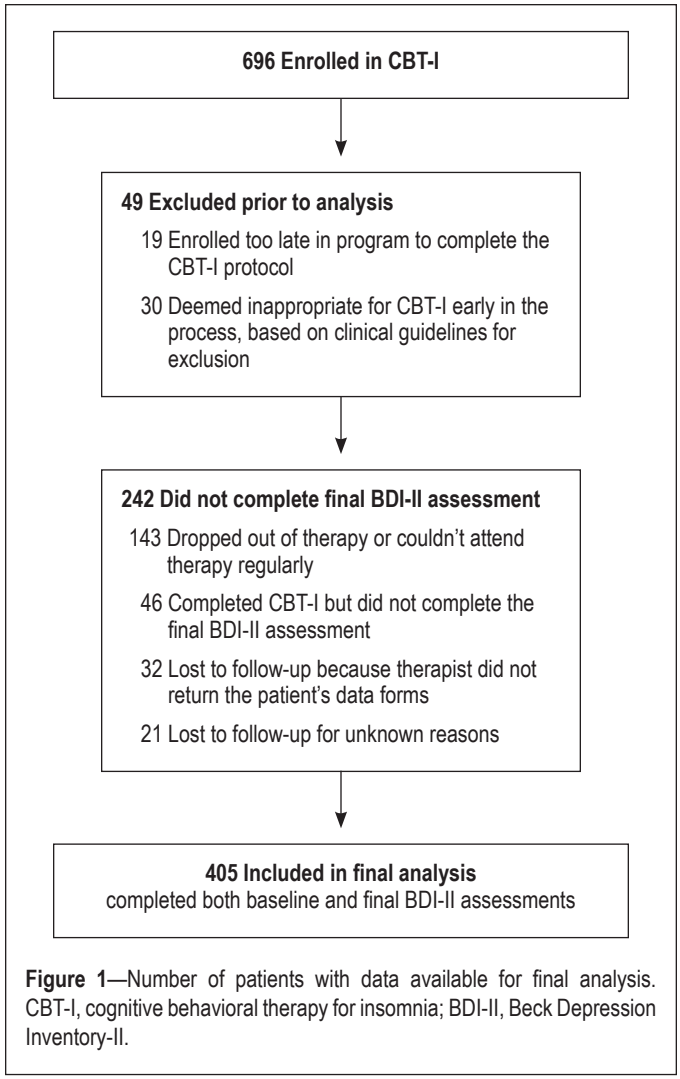

Figure 1—Number of patients with data available for final analysis. CBT-I, cognitive behavioral therapy for insomnia; BDI-II, Beck Depression Inventory-II.

All subsequent analyses were with data from the 405 patients who completed baseline and final BDI-II assessments. Among these 405 patients, most (282) identified themselves as white; 101 identified themselves as part of a minority race; and 22 did not indicate their race. Most (351) identified themselves as non-Hispanic; 34 identified themselves as Hispanic; and 20 did not answer the question on Hispanic ethnicity. Most (n = 347) were men; 40 were women; and 18 did not indicate their gender. The modal education category was "some college" (n = 185); 11 had less than a high school education; 89 were high school graduates; 51 were college graduates; 20 had attended some

Table 1—BDI-II suicidal ideation item frequencies at the baseline and final assessment (n = 405).

BDI-II Suicidal Ideation	Baseline, n (%)	Final Assessment, n (%)
0. No suicidal ideation	277 (68)	318 (78)
1. Suicidal ideation but no intent	121 (30)	85 (21)
2. Would like to kill themselves	6 (1.5)	1 (0.25)
3. Would kill themselves if they had the chance	1 (0.25)	0
Did not answer the BDI-II question on suicidal ideation	0	1 (0.25)

BDI-II, Beck Depression Inventory-II.

graduate school; 26 had a graduate degree; and 23 did not indicate their education level. Among the 382 who reported their age at baseline, age ranged from 22 to 85+ years (mean = 52, SD = 14). Among 336 who reported conflict experience, 9 had served in either World War II or the Korean War, 150 served in Vietnam, 32 served in Kuwait (Operation Desert Shield/Desert Storm), 83 served in Iraq or Afghanistan (Operation Enduring Freedom/Operation Iraqi Freedom), 34 indicated "other" conflict experience, and 28 served in more than one conflict.

Changes in Insomnia Severity and in Suicidal Ideation Achieved During CBT-I

First, we examined the degree of change in insomnia severity and unadjusted change in suicidal ideation achieved during CBT-I treatment. We also examined the relationship between number of treatment sessions completed and change in insomnia severity. Average ISI score was 20.4 (SD = 4.3) at baseline and 10.7 (SD = 6.3) at session 6 or earlier last available assessment point (difference = 9.7, 95% CI = 9.1 to 10.3; Cohen's d = 2.3; $t[df = 404] = 30.4$; $P < 0.001$). ISI reductions achieved by patients who completed 3 or 4 CBT-I sessions (n = 31), 5 sessions (n = 52), and 6 sessions were 12.2 (SD = 7.2), 11.8 (SD = 7.0), and 9.1 (SD = 6.1), respectively.

At baseline, 128 patients (32%) reported suicidal ideation. At final assessment 21% reported suicidal ideation (n = 86) or did not answer the BDI-II question assessing suicidal ideation (n = 1). Therefore, overall, suicidal ideation decreased by 33% during CBT-I ($\chi^2[df = 1] = 125$; $P < 0.001$). See endnote A. In 289 patients with baseline modified BDI-II score ≥ 15, 124 (43%) and 82 (28%) reported suicidal ideation at baseline and final assessment, respectively, which represents a 33% decrease in suicidal ideation. Among women (n = 40), 15 (38%) and 5 (12%) reported suicidal ideation at baseline and final assessment, respectively. Table 1 shows the number of patients who endorsed each response option on the BDI-II item assessing suicidal ideation.

Change in Suicidal Ideation Occurring During CBT-I Attributable to Change in Insomnia Severity

Second, we examined the relationship between change in insomnia severity achieved during CBT-I and concurrent change in suicidal ideation. Table 2 shows the logistic regression model

Table 2—Multivariate logistic regression model: effect of change in insomnia severity on change in suicidal ideation.

	Coefficient (SE)	OR	95% CI	P value
Constant (model intercept)	1.98 (0.47)	7.20	–	–
Change in ISI*	−1.04 (0.20)	0.35	0.24–0.52	< 0.001
Baseline ISI*	0.60 (0.31)	1.83	1.00–3.35	0.05
No baseline SI	−3.22 (0.36)	0.04	0.02–0.08	< 0.001
Woman	−1.42 (0.63)	0.24	0.07–0.83	0.02
Minority race	−0.34 (0.40)	0.71	0.33–1.56	0.40
Some college (vs. high school or less)	−0.21 (0.39)	0.81	0.38–1.75	0.60
College grad (vs. high school or less)	−0.20 (0.48)	0.82	0.32–2.08	0.67
Age ≥ 65 years	−0.46 (0.42)	0.63	0.28–1.44	0.28

*ISI scores were divided by 7 and baseline ISI was centered on the sample mean. SE, standard error; OR, odds ratio; CI, confidence intervals; ISI, Insomnia Severity Index: SI, suicidal ideation.

estimate of the effect of change in insomnia during CBT-I on change in odds of suicidal ideation. Each 7-point decrease in ISI score achieved during CBT-I treatment was associated with a 65% reduction in odds of suicidal ideation, controlling for other variables in the model, including adjustment for age (dichotomized: ≥ 65 or < 65 years of age), gender, race, education category (high school education or less, some college, or college graduate), baseline ISI score, and baseline modified BDI-II score. A complete interpretation of this finding requires consideration of the model intercept term, so that comparisons between patients with equivalent baseline characteristics and scores but with different degrees of subsequent improvement in insomnia (ISI score) can be compared. The logistic regression model intercept is 1.98, corresponding to odds of suicidal ideation of 7.2 to 1, which is the estimated odds of suicidal ideation for an individual with a value of zero for all independent variables entered into the model. A value of zero for all independent variables in the model corresponds to an individual with the sample average baseline ISI score (ISI = 20.4) who was white, male, < 65 years of age, had a high school or lower education, reported suicidal ideation at baseline, and had no change in insomnia severity during CBT-I treatment. The odds ratio of 7.2 to 1 indicates that an estimated 88% of patients in this category had suicidal ideation at final assessment. In contrast to 88% of patients with model reference category baseline characteristics including no change in insomnia severity, the regression model estimates that an estimated 47% of patients with the same baseline characteristics who achieved a 14-point reduction in ISI score during CBT-I treatment had suicidal ideation at final assessment. Compared to 88%, the estimated 47% suicide ideation rate in patients with these baseline characteristics and a 14-point drop in ISI score achieved during treatment represents a 47% reduction [1 − (0.47/0.88) = 0.47] in suicidal ideation attributable to measured improvement in insomnia severity. Controlling for other variables in the model, women achieved a 76% greater reduction than men in odds in suicidal ideation during CBT-I.

We explored the association between CBT-I sessions completed and change in suicidal ideation by adding dummy variables for 3 to 4 sessions completed, and 5 sessions completed to the logistic regression model shown in Table 2. Completing 3 to 4 sessions, compared to 6 sessions, was associated with greater odds of suicidal ideation at final assessment, but this effect was of borderline statistical significance (OR = 3.25; 95% CI = 1.00 to 10.55). Completing 5 sessions, compared to 6 sessions, was not appreciably associated with final assessment suicidal ideation (OR = 1.25; 95% CI = 0.46 to 3.39). Controlling for number of CBT-I sessions did not attenuate the estimated effect of change in ISI on suicidal ideation. In this exploratory model, each 7-point change in ISI was associated with a 68% decrease in odds of suicidal ideation (OR = 0.32; 95% CI = 0.22 to 0.49).

Change in Depression Severity in Relation to Change in Insomnia

Third, we assessed the relationship between changes in insomnia severity achieved during CBT-I and concurrent changes in modified BDI-II scores, which would be consistent with an indirect effect of change in insomnia severity on suicidal ideation, through change in depression severity. Modified BDI-II (See the methods section regarding definition of modified BDI-II) scores decreased from 23.2 (SD = 12.1) at baseline to 16.1 (SD = 12.2) at final assessment (difference = 7.1; 95% CI = 6.1 to 8.0; Cohen's $d = 0.58$; $t[df = 404] = 14.7$; $P < 0.001$). Each 7-point decrease in ISI score was associated with a 4.8-point decrease in modified BDI-II score at final assessment, controlling for baseline ISI, baseline modified BDI-II, age category, gender, race, and education category.

Change in Suicidal Ideation Occurring during CBT-I Attributable to Change in Insomnia Severity, after Adjusting for Change in Depression Severity

Fourth, we assessed the relationship between change in insomnia and change in suicidal ideation, adjusted for changes in depression severity, which would be consistent with a direct effect of change in insomnia severity achieved during CBT-I on concurrent change in suicidal ideation. After adding modified baseline BDI-II score and change in modified BDI-II score to the logistic regression model shown in Table 2, the effect of change in insomnia severity on change in suicidal ideation remained significant. In this fully adjusted model, each 7-point decrease in insomnia severity was associated with 40% lower odds in suicidal ideation at final assessment (OR = 0.60; 95% CI = 0.38 to 0.94; P = 0.027).

This final model also demonstrated a significant relationship between change in depression severity achieved during CBT-I and concurrent change in suicidal ideation. Together with above results indicating a significant relationship between change in insomnia severity and change in depression severity, this finding is consistent with an indirect effect of change in insomnia severity on change in suicidal ideation, through change in depression severity. Specifically, a 68% decrease in odds of suicidal ideation was associated with each 10-point decrease in modified BDI-II score from baseline to final assessment (OR = 0.32; 95% CI = 0.21 to 0.50; P < 0.001), controlling for other variables in the model. In addition, a 142% increase in odds of suicidal ideation was associated with each 10-point increase in baseline BDI-II score (OR = 2.42; 95% CI = 1.59 to 3.69; P < 0.001).

DISCUSSION

This study adds to the growing evidence that indicates insomnia is a significant and modifiable risk factor for suicide ideation. To our knowledge, this is the first evaluation to show that treatment of insomnia in Veterans is associated with reduction in suicidal ideation. The results of our analysis indicate large reductions in odds of suicidal ideation associated with each incremental 7-point improvement in insomnia severity, which supports the notion that CBT-I may be an important clinical strategy to reduce suicidal ideation among Veterans and other patients with insomnia. Although the sample of women in this evaluation was small (n = 40), in light of reports documenting high risk of suicide among women Veterans,[42] it is encouraging that multivariate analysis suggested women may achieve even greater reduction in suicidal ideation during CBT-I, after adjusting for baseline and demographic variables. We also observed that patients achieved significant reductions in depression symptom severity during CBT-I treatment and that change in insomnia severity was associated with change in depression severity. Importantly, even after accounting for the effect of concurrent improvement in depression symptom severity, which did attenuate the observed effect of change in insomnia on reduction in suicidal ideation, the adjusted effect remained clinically and statistically significant. This result mirrors previous findings indicating that insomnia is a significant risk factor for suicidal ideation even after accounting for depression.[2,5]

Although not a focus of the present study, there are plausible mechanisms that could explain a causal relationship between insomnia and suicidal ideation. McCall and Black proposed theoretical mechanisms of the relationship between insomnia and suicidal ideation, including serotonergic dysfunction and alterations in the hypothalamic-pituitary-adrenal axis, and several psychological mechanisms.[43] Irregular sleep patterns can lead to desensitization of the serotonergic 1A receptor system,[44] which provides a viable mechanism for the link between poor sleep, depressed mood, and suicide risk. In addition to previously proposed mechanisms of the link between insomnia and suicidal ideation, one functional imaging research study suggested impaired medial prefrontal cortex connectivity with the amygdala and corresponding increased amygdala response to negative emotional stimuli following sleep deprivation.[45] Although in need of replication, this finding could explain impaired regulation of affective stability and suboptimal decision making capacity associated with poor sleep—factors that may increase risk for suicidal ideation and suicide.

It is also possible that the observed reduction in suicidal ideation is related to feeling better rested and therefore an increased sense of self-efficacy to cope with life's challenges. This possibility is consistent with findings that improvements in general problem solving skills are associated with reduced suicide attempts among previous suicide attempters[46] but will need to be tested in future research.

Several limitations of this evaluation are related to the fact that we explored data collected within a real-world effectiveness evaluation context, rather than in a controlled clinical trial.

That is, the advantages of the relatively large sample size and study of patients in real, ongoing clinical treatment settings are at some cost to internal validity, which is characteristic of randomized clinical trials. For example, because the evaluation is based on practice in routine clinical settings in which patients may be concomitantly receiving other treatments during the six weeks during which they received CBT-I, we cannot rule out the possibility that the observed concurrent reductions in insomnia, depression, and suicidal ideation could be explained by factors other than the CBT-I patients received. Although medication alone for depression is unlikely to resolve insomnia for most patients,[47] it could explain decreased depression and suicidal ideation. It is, therefore, encouraging that improvement in insomnia severity was associated with reduced suicidal ideation even after controlling for concurrent improvement in depression severity. In the absence of a control group, we also cannot rule out the possibility that observed reductions in suicidal ideation are attributable to passage of time. However, one multisite randomized controlled trial involving 598 depressed older adults demonstrated reduction in frequency of suicidal ideation in a clinical care as usual condition of only 15% (from 20.1% at baseline to 17.1% four months later), which is less than the 33% reduction we observed in the current evaluation.[41] Nevertheless, randomized controlled research is needed to firmly establish the causal relationship between CBT-I treatment of insomnia and reduced suicidal ideation. A second limitation is related to the fact that for pragmatic reasons BDI-II data were collected only at two time points (baseline and end of treatment). This limitation is moderated, in part, by the fact that discontinuation of treatment was not related to suicide ideation, depression severity, or insomnia severity at baseline. However, without follow-up data we cannot rule out the possibility that patents with missing final assessment data were more severe on unmeasured variables or responded less favorably to treatment. Another limitation is the absence of standard measures of sleep. Whereas objective measures of sleep are impractical in the context of a program evaluation, prospective sleep diary data may have allowed us to further examine what specific aspect of sleep was most relevant to the observed results. Although sleep diary data were collected by the therapists as an aid for treatment, the data were not collected as part of program evaluation. An additional limitation is the lack of data available on comorbid conditions, chronicity of insomnia and depression, history of suicide attempts, and medication use.

In short, the current findings provide for significant optimism regarding therapeutic targets and mechanisms for helping to reduce insomnia among Veterans and others at risk for suicide who present for care in real-world practice settings. The results suggest that effective treatment of insomnia with CBT-I may be an important target for reducing suicide risk. The findings are particularly compelling in light recent research indicating that more than half of Military Servicemembers and Veterans serving in the conflicts in Iraq and Afghanistan reported symptoms of insomnia, and almost all (89%) were classified as "poor sleepers."[48] Moreover, the fact that the results of the current evaluation were observed in the context of the largest dissemination of CBT-I in the nation suggests that the potential benefits of CBT-I are likely being extended to a large number of Veterans. Other CBT-I dissemination efforts may confer similar public health benefits in other clinical populations.

ENDNOTE A

We conducted a mixed effects model analysis, using the HLM software package (version 7), to generate an estimate of change in suicidal ideation using data from all patients who provided at least one measure of suicidal ideation (n = 622), which we could then compare with the change in suicidal ideation estimated with the restricted sample reported above. The associated OR of suicidal ideation at final assessment compared to baseline using data reported above = $(86 \times 277)/(128 \times 319) = 0.58$. The results of the mixed effects model, estimated with a logit link and full maximum likelihood through adaptive Gaussian quadrature (n = 622) were equivalent substantively (OR = 0.58 vs. OR = 0.58) and statistically ($P < 0.001$ vs. $P < 0.001$).

DISCLOSURE STATEMENT

This was not an industry supported study. This project was supported by Mental Health Services, U.S. Department of Veterans Affairs Central Office. Dr. Karlin is currently affiliated with the Education Development Center, Inc., and the Department of Mental Health, Bloomberg School of Public Health, Johns Hopkins University. Dr. Manber is a co-author of a workbook related to the treatment described in this paper from which she receives royalties. The other authors have indicated no financial conflicts of interest.

REFERENCES

1. Chakravorty S, Grandner MA, Mavandadi S, Perlis ML, Sturgis EB, Oslin DW. Suicidal ideation in Veterans misusing alcohol: relationships with insomnia symptoms and sleep duration. Addict Behav 2014;39:399–405
2. Davidson CL, Babson KA, Bonn-Miller MO, Souter T, Vannoy S. The impact of exercise on suicide risk: examining pathways through depression, PTSD, and sleep in an inpatient sample of veterans. Suicide Life Threat Behav 2013;43:279–89.
3. Kato T. Insomnia symptoms, depressive symptoms, and suicide ideation in Japanese white-collar employees. Int J Behav Med 2014;21:506–10.
4. Nadorff MR, Fiske A, Sperry JA, Petts R, Gregg JJ. Insomnia symptoms, nightmares, and suicidal ideation in older adults. J Gerontol B Psychol Sci Soc Sci 2013;68:145–52.
5. Nadorff MR, Nazem S, Fiske A. Insomnia symptoms, nightmares, and suicide risk: duration of sleep disturbance matters. Suicide Life Threat Behav 2013;43:139–49.
6. Norra C, Richter N, Juckel G. Sleep disturbances and suicidality: a common association to look for in clinical practise and preventive care. EPMA J 2011;2:295–307.
7. Pigeon WR, Pinquart M, Conner K. Meta-analysis of sleep disturbance and suicidal thoughts and behaviors. J Clin Psychiatry 2012;73:e1160–7.
8. Pompili M, Innamorati M, Forte A, et al. Insomnia as a predictor of high-lethality suicide attempts. Int J Clin Pract 2013;67:1311–6.
9. Suh S, Kim H, Yang HC, Cho ER, Lee SK, Shin C. Longitudinal course of depression scores with and without insomnia in non-depressed individuals: a 6-year follow-up longitudinal study in a Korean cohort. Sleep 2013;36:369–76.
10. Agargun MY, Kara H, Solmaz M. Subjective sleep quality and suicidality in patients with major depression. J Psychiatr Res 1997;31:377–81.
11. Chellappa SL, Araujo JF. Sleep disorders and suicidal ideation in patients with depressive disorder. Psychiatry Res 2007;153:131–6.
12. McCall WV, Blocker JN, D'Agostino R Jr., et al. Insomnia severity is an indicator of suicidal ideation during a depression clinical trial. Sleep Med 2010;11:822–7.
13. Klimkiewicz A, Bohnert AS, Jakubczyk A, Ilgen MA, Wojnar M, Brower K. The association between insomnia and suicidal thoughts in adults treated for alcohol dependence in Poland. Drug Alcohol Depend 2012;122:160–3.

14. Goldstein TR, Bridge JA, Brent DA. Sleep disturbance preceding completed suicide in adolescents. J Consult Clin Psychol 2008;76:84–91.
15. Bjorngaard JH, Bjerkeset O, Romundstad P, Gunnell D. Sleeping problems and suicide in 75,000 Norwegian adults: a 20 year follow-up of the HUNT I study. Sleep 2011;34:1155–9.
16. Fujino Y, Mizoue T, Tokui N, Yoshimura T. Prospective cohort study of stress, life satisfaction, self-rated health, insomnia, and suicide death in Japan. Suicide Life Threat Behav 2005;35:227–37.
17. Karch DL, Barker L, Strine TW. Race/ethnicity, substance abuse, and mental illness among suicide victims in 13 US states: 2004 data from the National Violent Death Reporting System. Inj Prev 2006;12 Suppl 2:ii22–7.
18. Ribeiro JD, Pease JL, Gutierrez PM, et al. Sleep problems outperform depression and hopelessness as cross-sectional and longitudinal predictors of suicidal ideation and behavior in young adults in the military. J Affect Disord 2012;136:743–50.
19. Morin CM, Culbert JP, Schwartz SM. Nonpharmacological interventions for insomnia: a meta-analysis of treatment efficacy. Am J Psychiatry 1994;151:1172–80.
20. Morin CM, Vallières A, Guay B, et al. Cognitive behavioral therapy, singly and combined with medication, for persistent insomnia: a randomized controlled trial. JAMA 2009;301:2005–15.
21. Smith MT, Perlis ML, Park A, et al. Comparative meta-analysis of pharmacotherapy and behavior therapy for persistent insomnia. Am J Psychiatry 2002;159:5–11.
22. Bernert RA, Joiner TE Jr., Cukrowicz KC, Schmidt NB, Krakow B. Suicidality and sleep disturbances. Sleep 2005;28:1135–41.
23. Wilson SJ, Nutt DJ, Alford C, et al. British Association for Psychopharmacology consensus statement on evidence-based treatment of insomnia, parasomnias and circadian rhythm disorders. J Psychopharmacol 2010;24:1577–600.
24. Jacobs GD, Pace-Schott EF, Stickgold R, Otto MW. Cognitive behavior therapy and pharmacotherapy for insomnia: a randomized controlled trial and direct comparison. Arch Intern Med 2004;164:1888–96.
25. Mendelson WB, Rich CL. Sedatives and suicide: the San Diego study. Acta Psychiatr Scan 1993;88:337–41.
26. Weich S, Pearce HL, Croft P, et al. Effect of anxiolytic and hypnotic drug prescriptions on mortality hazards: retrospective cohort study. BMJ 2014;348:1996.
27. Brown GK, Beck AT, Steer RA, Grisham JR. Risk factors for suicide in psychiatric outpatients: a 20-year prospective study. J Consult Clin Psychol 2000;68:371–7.
28. McCall WV. Insomnia is a risk factor for suicide-what are the next steps? Sleep 2011;34:1149–50.
29. Manber R, Bernert RA, Suh S, Nowakowski S, Siebern AT, Ong JC. CBT for insomnia in patients with high and low depressive symptom severity: adherence and clinical outcomes. J Clin Sleep Med 2011;7:645–52.
30. Karlin BE, Cross G. From the laboratory to the therapy room: national dissemination and implementation of evidence-based psychotherapies in the U.S. Department of Veterans Affairs health care system. Am Psychol 2014;69:19–33.
31. Karlin BE, Trockel M, Taylor CB, Gimeno J, Manber R. National dissemination of cognitive behavioral therapy for insomnia in veterans: therapist- and patient-level outcomes. J Consult Clin Psychol 2013;81:912–7.
32. Manber R, Carney C, Edinger J, et al. Dissemination of CBTI to the non-sleep specialist: protocol development and training issues. J Clin Sleep Med 2012;8:209–18.
33. Foa EB. Prolonged exposure therapy: past, present, and future. Depress Anxiety 2011;28:1043–7.
34. Manber R, Carney C, Edinger J, et al. Dissemination of CBTI to the non-sleep specialist: protocol development and training issues. J Clin Sleep Med 2012;8:209–18.
35. Morin CM, Belleville G, Belanger L, Ivers H. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. Sleep 2011;34:601–8.
36. Beck A, Steer R, Brown G. Beck Depression Inventory–Second Edition: Manual. San Antonio, TX: The Psychological Corporation, 1996.
37. Beck AT, Steer RA, Carbin MG. Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clin Psychol Rev 1988;8:77–100.
38. Beck AT, Steer RA. Manual for the revised Beck depression inventory. New York: Psychological Corporation, 1991.
39. Desseilles M, Perroud N, Guillaume S, et al. Is it valid to measure suicidal ideation by depression rating scales? J Affect Disord 2012;136:398–404.
40. Brown GK, Ten Have T, Henriques GR, Xie SX, Hollander JE, Beck AT. Cognitive therapy for the prevention of suicide attempts: a randomized controlled trial. JAMA 2005;294:563–70.
41. Bruce ML, Ten Have TR, Reynolds CF 3rd, et al. Reducing suicidal ideation and depressive symptoms in depressed older primary care patients: a randomized controlled trial. JAMA 2004;291:1081–91.
42. McFarland BH, Kaplan MS, Huguet NP. Datapoints: self-inflicted deaths among women with U.S. military service: a hidden epidemic? Psychiatr Serv 2010;61:1177.
43. McCall WV, Black CG. The link between suicide and insomnia: theoretical mechanisms. Curr Psychiatry Rep 2013;15:389.
44. Roman V, Walstra I, Luiten PG, Meerlo P. Too little sleep gradually desensitizes the serotonin 1A receptor system. Sleep 2005;28:1505–10.
45. Yoo SS, Gujar N, Hu P, Jolesz FA, Walker MP. The human emotional brain without sleep--a prefrontal amygdala disconnect. Current Biol 2007;17:R877–8.
46. Ghahramanlou-Holloway M, Bhar SS, Brown GK, Olsen C, Beck AT. Changes in problem-solving appraisal after cognitive therapy for the prevention of suicide. Psychol Med 2012;42:1185–93.
47. Manber R, Edinger JD, Gress JL, San Pedro-Salcedo MG, Kuo TF, Kalista T. Cognitive behavioral therapy for insomnia enhances depression outcome in patients with comorbid major depressive disorder and insomnia. Sleep 2008;31:489–95.
48. Plumb TR, Peachey JT, Zelman DC. Sleep disturbance is common among service members and veterans of Operations Enduring Freedom and Iraqi Freedom. Psychol Serv 2014;11:209–19