Obstructive Sleep Apnea and Posttraumatic Stress Disorder among OEF/OIF/OND Veterans

Peter J. Colvonen, PhD[1,2]; Tonya Masino, MD[1]; Sean P.A. Drummond, PhD[1,2,3]; Ursula S. Myers, MS[3]; Abigail C. Angkaw, PhD[1,2,3]; Sonya B. Norman, PhD[1,2,3,4]

[1]VA San Diego Healthcare System and Department of Psychiatry, University of California, San Diego, CA; [2]Center of Excellence for Stress and Mental Health (CESAMH), VA San Diego Healthcare System, San Diego, CA; [3]San Diego State University/University of California, San Diego Joint Doctoral Program, San Diego, CA; [4]National Center for PTSD, White River Junction, VT

Objectives: This study examined: (a) the relationship between self-reported posttraumatic stress disorder (PTSD) symptoms and risk of obstructive sleep apnea (OSA) in a younger, Iraq and Afghanistan (OEF/OIF/OND) veteran sample seeking treatment for PTSD; and (b) the relationships between PTSD symptom scores and each risk factor of OSA (snoring, fatigue, high blood pressure/BMI).

Methods: Participants were 195 Iraq and Afghanistan veterans presenting to a VA outpatient PTSD clinic for evaluation. Veterans were 21 to 59 years old (mean 33.40, SD 8.35) and 93.3% male (n = 182). Logistic regressions were run to examine whether veterans with greater PTSD symptom severity had an increased probability of screening as high risk for OSA, even after controlling for known risk factors (older age, positive smoking status, and use of CNS depressants).

Results: Of 159 veterans screened, 69.2% were assessed as being at high risk for OSA. PTSD symptom severity increased the risk of screening positive for OSA. PTSD symptom severity increased risk of screening positive for snoring and fatigue, but not high blood pressure/BMI.

Conclusions: OEF/OIF/OND veterans with PTSD screen as high risk for OSA at much higher rates than those seen in community studies and may not show all classic predictors of OSA (i.e., older and higher BMI). This study is the first to suggest that the Berlin may be a useful screener for OSA in a younger OEF/OIF/OND veteran population with PTSD. Screening of younger veterans with PTSD for OSA should be standard care, and polysomnography and OSA interventions should be readily available to younger veterans.

Keywords: OEF/OIF/OND, veterans, obstructive sleep apnea, PTSD

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Lifetime prevalence of posttraumatic stress disorder (PTSD) is estimated at approximately 30% of Vietnam veterans and 11% to 17% of recent Iraq and Afghanistan (Operation Enduring Freedom, Operation Iraq Freedom, and Operation New Dawn; OEF/OIF/OND) veterans.[1,2] However, the lifetime prevalence rates of PTSD in OEF/OIF/OND veterans are expected to match or surpass those of the Vietnam veterans.[3] Among veterans with PTSD, sleep disturbances are nearly universal. Beyond the PTSD criterion symptoms of insomnia and nightmares, 40% to 98% of veterans with PTSD also have a co-occurring sleep disturbance such as obstructive sleep apnea (OSA), periodic leg movement disorder, sleep terrors, or nocturnal anxiety attacks.[4–6]

OSA is one of the most common sleep disturbances, affecting between 5% and 10% of the general American population.[7,8] Known risk factors of OSA include obesity, use of central nervous system (CNS) depressants (e.g., opioids, alcohol), older age, male gender, and smoking. Additionally, OSA is associated with a variety of comorbidities including hypertension, cardiovascular disease, coronary artery disease, insulin resistance, diabetes, depression, sleepiness-related accidents, cancer, and increased mortality.[9–11] Individuals with OSA have been found to have a high prevalence of comorbid psychiatric conditions including mood disorders, PTSD, and other anxiety disorders.[12]

Research suggests that civilians with PTSD have higher rates of OSA than the general population.[13–15] In a series of studies looking at female sexual assault victims and mixed-gender crime victims with PTSD, rates of overall sleep disturbance symptoms were as high as 90%, with up to 50% meeting diagnostic criteria for OSA (11% participated in sleep clinic polysomnography (PSG); 89% used subjective measures of sleep disturbances).[16,17]

BRIEF SUMMARY

Current Knowledge/Study Rationale: This study examined the relationship between posttraumatic stress disorder and screening as high risk for obstructive sleep apnea in a younger veteran population. OSA prevalence is higher in individuals with PTSD than without. However there is a dearth of information on the relationship between PTSD and OSA among younger veterans with PTSD.

Study Impact: Younger veterans with PTSD screen positive for OSA at much higher rates than those seen in community studies and may not show all classic predictors of OSA (i.e., older and higher BMI). Our findings suggest making screening of younger veterans with PTSD for OSA standard care and that polysomnography and OSA intervention should be available to younger veterans.

Similar to civilian samples, OSA prevalence is higher in veterans with PTSD. Yesavage and colleagues, using PSG at a VA hospital, found that in a sample of 110 Vietnam veterans diagnosed with PTSD (mean age 59.9; mean BMI 31.1), 69% had moderate to severe OSA.[5] Kinoshita and colleagues, using PSG at a VA hospital, found that 83% of Vietnam veterans had at least mild OSA (mean age 61.3; mean BMI 30.7).[18] In sample of older adult (mean age 71.3 years old) veterans with PTSD, 40% were found to have OSA using PSG at a sleep disorders clinic.[19] This literature supports that among older, treatment-seeking samples of veterans with PTSD, rates of diagnosed OSA are higher than among the general population.

While rates of OSA are higher among older veterans with PTSD than veterans without PTSD,[13] there is a dearth of information on the relationship between PTSD and OSA in a younger (e.g., OEF/OIF/OND) sample. Orr and colleagues, at a VA hospital, used PSG to evaluate sleep with 80 soldiers recently returning from combat.[4] Among those diagnosed with PTSD, 61% met criteria for OSA (mean age 37.7 years). Among a group of active duty military with PTSD, 67.3% were diagnosed with OSA using PSG at multi-site military medical centers.[20] However, it is unclear if higher incidence of PTSD relates to higher rates of OSA. There was only one study with a comparison condition using a younger veteran sample to date comparing veterans with PTSD to those without.[21] In a Dutch veteran sample, the investigators did not find higher incidence of diagnosed OSA in veterans with combat-related PTSD (n = 20) relative to age- and trauma-matched (n = 21) or healthy controls (n = 17). However, the authors did note significantly higher mean Clinician-Administered PTSD Scale (CAPS) scores in veterans with both PTSD and OSA, compared to those with PTSD but no OSA. This suggests OSA rates may not necessary be higher in younger veterans with PTSD; rather, OSA may exacerbate the severity of PTSD. These studies highlight the need to further understand the relationship between OSA and PTSD among younger veterans.

The first goal of the study was to describe the rates of screening as high-risk for OSA in a cohort of OEF/OIF/OND veterans presenting to a VA outpatient PTSD clinic. Our second goal was to examine whether increased PTSD symptom scores were associated with increased likelihood of screening as high risk for OSA. We hypothesized that veterans presenting for PTSD treatment with higher PTSD Checklist (PCL) scores would be more likely to screen as high risk for OSA on the Berlin Questionnaire than veterans with lower PCL scores. The third goal was to examine the relationships between PTSD symptom scores and each screening factor of OSA (snoring, fatigue, and high blood pressure/BMI). We hypothesized that PTSD symptom severity would increase risk of each category and would most strongly increase risk of fatigue.

METHODS

Participants

Participants were 195 consecutive OEF/OIF/OND veterans presenting to a VA outpatient PTSD clinic for PTSD orientation group between March 20, 2012, and July 31, 2013. The veterans provided voluntary informed consent and completed self-report questionnaires. Approval to conduct this study was obtained from the UC San Diego and VA San Diego institutional review boards. Veterans' ages ranged from 21 to 59 years (mean = 33.40, SD = 8.35); 93.3% were male. Participants were predominantly non-Hispanic/Latino (70.2%). The sample was ethnically diverse, with Caucasian (59.0%), African American (17.9%), Asian/Pacific Islander (12.9%), biracial (2.1%), and Native American (1.0%) ethnicities represented (no response, 5.1%).

Analyses

Descriptive analyses used t-tests and χ^2 tests. Goals 2 and 3 were analyzed using logistic regressions to examine the relationship between PTSD symptoms and high-risk status for OSA. For Goal 3, logistic regression models were run separately with each OSA screening factor (snoring, fatigue, and high blood pressure/BMI) as an outcome. Other OSA risk factors such as older age, positive smoking status, and use of CNS depressants were controlled for within a single step for each analysis. While males tend to have higher rates of OSA than females, gender was not included in analyses because the sample was 93.3% male.

Measures

Obstructive Sleep Apnea Risk

OSA risk was assessed using the Berlin Questionnaire,[22] a 10-item questionnaire used to identify individuals who are likely to have sleep apnea. The Berlin consists of 3 categories: snoring, fatigue, and high blood pressure/BMI and is scored as high risk (if ≥ 2 categories have a positive score) or low risk (≤ 1 category with a positive score). Coefficient α for the Berlin ranged from 0.86 to 0.92. Sub-category Cronbach α was 0.92 for snoring and 0.63 for fatigue. However, when "sleepiness behind the wheel" was excluded, Cronbach α for fatigue increased to 0.86.

Obstructive Sleep Apnea Diagnosis

Charts were reviewed to identify whether participants had been evaluated by the VA pulmonary sleep clinic using the apnea hypopnea index (AHI) through PSG. A diagnosis of sleep apnea was assigned to any veterans with AHI > 5.[23]

Posttraumatic Stress Disorder

PTSD was assessed using the PTSD Checklist Stressor Specific Version (PCL-S),[24] a 17-item questionnaire examining the extent to which participants were bothered by PTSD symptoms in the previous month from 1 (not at all) to 5 (extremely). The PCL-S maps directly onto the diagnostic criteria in the DSM-IV. Scores range from 17 to 85. The PCL-S demonstrates strong internal consistency (Cronbach α = 0.94–0.97).[24,25] This measure has been shown to be valid with an OEF/OIF/OND veteran sample.[26]

Demographics

Demographic information includes gender, age, and race/ethnicity.

Table 1—Means and standard deviations of variables (N = 195).

Variable	Full Sample (N = 195) Mean (SD)	High OSA Risk (N = 135) Mean (SD)	Low OSA Risk (N = 60) Mean (SD)	t/χ^2
PCL-S	61.44 (12.64)	63.01 (12.41)	55.90 (14.71)	−3.89***
BMI	29.08 (5.26)	30.42 (5.07)	25.88 (4.24)	−5.73***
Non-Smokers	70.8%	74.4%	62.1%	2.94
Age	33.40 (8.35)	34.25 (8.64)	31.59 (7.44)	−2.05*
AHI	15.70 (20.17) (n = 37)	16.81 (21.05) (n = 33)	6.56 (5.44) (n = 4)	−0.96

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ for the comparison between high-risk and low-risk categories.

Depression

Depression was assessed using the Patient Health Questionnaire (PHQ-9).[27] The PHQ-9 assesses depression in the past 2 weeks using 9 items ranging from 0 (not at all) to 3 (nearly every day). Cronbach α for the PHQ-9 was 0.86.

Smoking

Current smoking was obtained via chart review and assessed with the Tobacco Cessation Questionnaire. This measure is mandated by the VA to be administered to all patients annually to screen for tobacco use. Patients are categorized as tobacco users or nonsmokers.

Medications

Prescriptions of opiates, barbiturates, benzodiazepines, and other central nervous system depressants were identified through chart review. Medications were categorized as (a) prescribed for < 3 months or (b) prescribed > 3 months.

Substance Use

Current opiate, barbiturate, benzodiazepine, and substance use disorders were assessed in a chart review of veterans' diagnosed problems.

RESULTS

Descriptive Analyses

Of the sample, 69.2% screened as high risk for having OSA. **Table 1** shows means and standard deviations for the variables of interest. While BMI does differ by high/low risk of OSA, it is important to note that BMI is a factor included in the Berlin OSA high-risk category. See **Table 2** for the percentages of veterans who were considered high risk for OSA by each factor on the Berlin: 90.1% of the veterans were not on CNS depressants; 6.8% had acute use within the past 3 months (e.g., Vicodin for a hand injury); and 3.1% had CNS prescriptions longer than 3 months (e.g., chronic pain). No participants had chart diagnoses of abuse or dependence of illicit CNS depressants nor other illicit substance use dependence.

Relationship between PCL-S Scores and Risk of OSA

As hypothesized, higher PCL-S scores were associated with screening as high risk for OSA on the Berlin Questionnaire (**Table 3**). Every 10-point increase in PCL-S scores, considered

Table 2—Percentage of veterans screening positive on each Berlin factor (N = 195).

Non-Exclusive Categories	% Positive
None	8.2%
Snoring	61.0%
Fatigue	81.0%
BMI	49.7%
Fatigue + Snoring	52.8%
Fatigue + BMI	35.4%
BMI + Snoring	42.6%
Fatigue + BMI + Snoring	30.8%
Mutually Exclusive Categories	**% Positive**
Fatigue + BMI + Snoring	30.8%
Fatigue + Snoring	22.1%
Fatigue	16.2%
BMI + Snoring	11.8%
None	8.2%
Fatigue + BMI	4.6%
Snoring	3.6%
BMI	2.5%

a clinically significant change,[25] was associated with a 40% increase in the probability of screening as high risk for OSA. Age, smoking status, and CNS depressant medication were not significantly associated with OSA risk.

The omnibus model was re-run using a recomputed PCL-S total score, removing the items about trouble sleeping ("Trouble falling or staying asleep" and "Repeated, disturbing dreams of a stressful experience from the past"). The modified PCL-S did not correlate with screening as high risk for OSA on the Berlin (OR = 1.00, [CI: 0.99–1.00]; ns). Risk of OSA was also not associated with age (OR = 1.04, [CI: 1.00–1.08], ns), smoking status (OR = 0.62, [CI: 0.32–1.23], ns), or use of CNS depressants (OR = 2.59, [CI: 0.71–9.40], ns) in this model.

Relationship between PCL-S scores and Berlin Factors

The fatigue factor had an empty cell (i.e., 0 participants fell into a category) in the "no fatigue" and "using CNS depressants more than 3 months" resulting in standard error overestimations (β = 19.49; SE = 8260.21; Wald T = 0.00; OR = 291226312 "error"). We followed Firth's recommendations[28] and added 1 veteran to the "no fatigue" and "using CNS depressants more than 3 months" category.

Table 3—Logistic regression analyses: PTSD and OSA risk (N = 195).

	Low-Risk OSA V. High-Risk OSA			
Predictors	**B**	**Wald T**	**OR**	**95% CI**
PCL-S	0.04	11.61	1.04	1.02–1.07***
Age	0.03	1.94	1.03	0.99–1.08
Smoking Status	−0.67	3.34	0.51	0.25–1.05
CNS Depressants	0.72	1.14	2.05	0.55–7.73

Low-risk is scored as 0, high-risk is scored as 1. *p < 0.05. **p < 0.01. ***p < 0.001. OR, odds ratio; CI, confidence interval.

Table 4—Logistic regression analyses: PTSD and OSA Berlin sub-scores (N = 195).

	Low-Risk of Snoring V. High-Risk of Snoring			
Predictors	**β**	**Wald T**	**OR**	**95% CI**
PCL-S	0.02	4.09	1.02	1.00–1.05*
Age	0.06	7.82	1.06	1.02–1.10**
Smoking Status	−0.31	0.82	0.73	0.37–1.44
CNS Depressants	0.66	1.38	1.94	0.64–5.89
	Low-Risk of Fatigue V. High-Risk of Fatigue			
Predictors	**β**	**Wald T**	**OR**	**95% CI**
PCL-S	0.08	23.36	1.08	1.05–1.12***
Age	0.00	0.02	1.00	0.95–1.05
Smoking Status	0.30	0.38	1.35	0.52–3.55
CNS Depressants	1.21	1.25	3.37	0.40–28.23
	Low-Risk V. High-Risk of High Blood Pressure/BMI			
Predictors	**β**	**Wald T**	**OR**	**95% CI**
PCL-S	0.02	2.47	1.02	1.00–1.04
Age	0.01	0.31	1.01	0.97–1.05
Smoking Status	−0.76	4.98	0.47	0.24–0.91*
CNS Depressants	0.13	0.06	1.13	0.41–3.11

Low-risk is scored as 0, high-risk is scored as 1. *p < 0.05. **p < 0.01. ***p < 0.001. OR, odds ratio; CI, confidence interval.

Examination of the relationship between PTSD symptoms and each factor on the Berlin showed higher PCL-S scores associated significantly with screening positive for snoring and fatigue but not high blood pressure/BMI (see **Table 4**). Results indicated that every 10-point increase in PCL scores translated to a 20% increase in probability of a positive screening for snoring and an 80% increase in probability of a positive screening for fatigue. Finally, we recomputed the PCL-S total score removing the items about trouble sleeping and reran the logistic regression model with each factor as the outcome. The modified PCL significantly correlated only with the fatigue factor (OR = 1.09, [CI: 1.05–1.13]; p < 0.001). Fatigue was not associated with age (OR = 1.00, [CI: 0.95–1.05], ns), smoking status (OR = 1.35, [CI: 0.52–3.52], ns), or use of CNS depressants (OR = 3.74, [CI: 0.45–31.52], ns).

DISCUSSION

Our first goal was to describe the rates of screening as high risk for OSA in a cohort of OEF/OIF/OND veterans presenting to a VA outpatient PTSD clinic for mental health evaluation, and 69.2% screened as high risk for OSA. The veterans were a mean age of 33.4 years and had a mean BMI of 29.08. These findings were consistent with PSG findings with an active duty sample where 62.7% met diagnostic criteria for OSA (mean age 33.6; mean BMI 30.0),[29] as well as two samples of active duty soldiers specifically with PTSD, where 61% (mean age of 37.7 years; mean BMI of 29.0)[4] and 67.3% met criteria for OSA (mean age 35.1 years; mean BMI 28.9)[20] using PSG.

Our rates for screening as high risk for OSA were comparable, albeit slightly higher, to those found in other studies of OEF/OIF/OND veterans using PSG. One reason for the slightly higher rates may have been that our sample was treatment-seeking and at high risk of PTSD. Second, our sample was composed of veterans rather than active duty personnel. The veteran sample may have had more deployments, be less physically fit, and have increased stress from reintegration. Third, the Berlin OSA questionnaire has not been validated in a PTSD sample; as a screening measure, it may produce higher rates of false positives than PSG.

Nonetheless, this emerging body of research suggests veterans with PTSD have higher rates of OSA than the general population.[13–15,30] Yet, OSA is rarely screened and frequently left underdiagnosed among younger veterans with PTSD.[31] Krakow and colleagues suggest OSA may be underdiagnosed because while individuals with PTSD show a combination of

typical (e.g., insomnia and nightmares) and atypical (e.g., OSA) clinical sleep features, the atypical clinical features tend to be overshadowed by the more familiar psychiatric expression of PTSD-related sleep problems such as insomnia and nightmares.[32] Our study adds to the growing evidence that rates of screening positive for OSA and OSA diagnosis in OEF/OIF/OND PTSD veteran samples are strikingly high, require direct clinical attention, and warrant further study.

Given the growing body of research showing higher rates of OSA risk and/or diagnosis in veterans with PTSD, the question arises as to why this might be the case. One explanation may be due to the shared risk factors of PTSD and OSA in a military population. Hoge and colleagues suggest disturbed sleep in combat, which can result from prolonged operations or lack of quality sleep, is a potential precursor not only to PTSD but also OSA.[2] It is possible that prolonged sleep deprivation along with sleep fragmentation and hyperarousal due to the physical and psychological stressors of combat contribute to the etiology of OSA,[33,34] and separately to PTSD severity.[35] Another possibility is that the chronic stress from PTSD increases the likelihood of developing OSA, or that the sleep disturbances of OSA increase the likelihood of getting PTSD. Longitudinal studies are needed to help parse out the temporal relationship of OSA and PTSD.

Our finding that greater PTSD symptom severity increased the probability of screening as high risk for OSA is consistent with studies examining non-veteran samples with PTSD (e.g., Spoormaker[14]). However, when the two items about sleep were removed from the PCL-S ("Trouble falling or staying asleep" and "Repeated, disturbing dreams of a stressful experience from the past"), PTSD symptom severity did not increase the probability of screening as high risk for OSA on the Berlin Questionnaire. At first glance, this might suggest that the sleep items of the PCL-S are the only connection to being high risk for OSA screening. It must be noted, though, the modified PCL-S is not a validated measure, and caution should be used in interpreting this result. Additionally, the relation between the PCL-S and the Berlin becomes clearer when we examine the Berlin factors individually.

PTSD severity was associated with high risk of snoring and fatigue, but not high blood pressure/BMI on the Berlin. When the sleep items were removed from the PCL-S, only the fatigue factor was significantly predicted by the PCL-S. One possibility for this finding is that veterans with PTSD do not fit the typical demographic profile of an individual with OSA (older and overweight). Lettieri and colleagues found that BMI was not associated with OSA in a younger military population.[36] They examined 270 subjects (120 active duty, 80 National Guardsmen, 70 civilians). BMI did not predict either prevalence or severity of OSA in the active duty sample. While our sample did show greater BMI in those scoring as high risk for OSA (See **Table 1**), caution should be used in interpreting this result, since the Berlin screener uses BMI as one of its high-risk criteria.

These findings suggest fatigue is the OSA risk factor with the strongest relationship to PTSD severity. If fatigue is the result of the insomnia and/or nightmares common in PTSD, it might produce false positives on the Berlin. However, the PTSD severity-fatigue relationship was equally robust when the two sleep items were removed from the PCL-S, suggesting fatigue in this sample was likely the result of the sleep fragmentation

common in OSA. This, in turn, argues fatigue is indeed a strong predictor of OSA in a young veteran population. Therefore, providers to veteran populations should consider a referral to a sleep clinic when an individual reports significant fatigue, even if other OSA risk factors (high BMI) are not present or severe.

In addition to the main results, our study provides preliminary support for the validity of the Berlin for use with OEF/OIF/OND veterans with PTSD. AHI was reviewed for a subset of our sample who completed PSG (**Table 1**), suggesting that the Berlin has high sensitivity, but further examination of sensitivity and specificity is needed. More than three-quarters (78.4%) of the veterans who underwent PSG had AHI > 5,[37] which resulted in the Berlin accurately predicting 79% of veterans being diagnosed with OSA. The high rate of agreement between the Berlin and PSG, and the fact that we found similar rates of OSA as other studies using PSG with OEF/OIF/OND veterans, further suggest that the Berlin may hold promise as a screening tool for OSA among OEF/OIF/OND veterans and suggests there is enough evidence of sensitivity/specificity to merit a formal investigation of the predictive value of the Berlin in this population.

Several limitations should be noted. First, the Berlin has not been validated in a PTSD population. Like OSA, PTSD is associated with daytime sleepiness and fatigue. Not surprisingly, we found that PTSD symptoms were most strongly related to fatigue on the Berlin. This raises concerns about the risk of false positives on the Berlin among individuals with PTSD. However, three PSG-based studies with OEF/OIF/OND veterans found rates of OSA (61%, 63%, and 67%) similar to ours, suggesting that further psychometric work to validate the measure in this veteran population is warranted. Further studies examining both PSG and the Berlin in veteran populations are needed. Another limitation is the self-report format of the PCL-S, which may lead to over- or under-reporting by the veteran; however, this measure has been shown to be valid with an OEF/OIF/OND veteran sample.[26] Additionally, our sample is predominately male, which limits generalizability of our findings across gender. Finally, the cross-sectional nature of the study rules out understanding the temporal directionality between PTSD and OSA. It is very likely that the stress of PTSD affects OSA severity and that OSA severity directly affects daytime PTSD symptoms. Further investigation of this relationship is needed.

Our findings suggest a need to make screening returning OEF/OIF/OND veterans with PTSD for OSA a more standard aspect of care, and a need to make diagnostic assessments for OSA (access to PSG) and OSA interventions readily available to all veterans. Given the strong association between OSA and PTSD among OEF/OIF/OND veterans across studies, screening in both primary care and mental health settings may be warranted. Our study is the first to suggest that the Berlin may be a useful screener for OSA in a veteran population with PTSD. However, the study also highlights the need to validate the Berlin and/or other OSA screening measures with this population. Results show fatigue may be the primary connection between OSA and PTSD symptoms in OEF/OIF/OND veterans with PTSD. Thus, screening for OSA in younger veterans with PTSD may need to be a higher priority in the clinics with increased access to PSG than what is in currently available or clinically used. Longitudinal studies of OSA and PTSD are

needed to further understand the interplay between the two disorders and trajectories of clinical interventions.

ABBREVIATIONS

AHI, apnea-hypopnea index
BMI, body mass index
CNS, central nervous system
OEF, Operation Enduring Freedom
OIF, Operation Iraq Freedom
OND, Operation New Dawn
OSA, obstructive sleep apnea
PHQ, patient health questionnaire
PSG, polysomnography
PTSD, posttraumatic stress disorder
SD, standard deviation

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SUBMISSION & CORRESPONDENCE INFORMATION

DISCLOSURE STATEMENT