The Impact of Posttraumatic Stress Disorder on CPAP Adherence in Patients with Obstructive Sleep Apnea

Jacob F. Collen, M.D.; Christopher J. Lettieri, M.D., F.A.A.S.M.; Monica Hoffman, M.D.

Pulmonary, Critical Care and Sleep Medicine, Walter Reed National Military Medical Center, Bethesda, MD

Introduction: Obstructive sleep apnea (OSA) is a common comorbid condition in patients with posttraumatic stress disorder (PTSD); insufficiently treated OSA may adversely impact outcomes. Sleep fragmentation and insomnia are common in PTSD and may impair CPAP adherence. We sought to determine the impact of combat-related PTSD on CPAP adherence in soldiers.

Methods: Retrospective case-control study. Objective measures of CPAP use were compared between OSA patients with and without PTSD. Groups were matched for age, BMI, and apnea-hypopnea index (AHI).

Results: We included 90 patients (45 Control, 45 PTSD). Among the cohort, mean age was 39.9 ± 11.2 , mean BMI 27.9 ± 8.0 , mean ESS 13.6 ± 5.7 , and mean AHI 28.2 ± 22.4 . There was a trend towards a higher rate of comorbid insomnia among patients with PTSD (25.8% vs. 11.1%, $p = 0.10$). PTSD was associated with significantly less use of CPAP. Specifically, CPAP was used on $61.4\% \pm 22.2\%$ of nights in PTSD patients com-

pared with $76.8\% \pm 16.4\%$ in patients without PTSD ($p = 0.001$). Mean nightly use of CPAP was 3.4 ± 1.2 h in the PTSD group compared with 4.7 ± 2.2 h among controls ($p < 0.001$). Regular use of CPAP (> 4 h per night for $> 70\%$ of nights) was also lower among PTSD patients (25.2% vs. 58.3%, $p = 0.01$).

Conclusion: Among soldiers with OSA, comorbid PTSD was associated with significantly decreased CPAP adherence. Given the potential for adverse clinical outcomes, resolution of poor sleep quality should be prioritized in the treatment of PTSD and potential barriers to CPAP adherence should be overcome in patients with comorbid OSA.

Keywords: Posttraumatic stress disorder, sleep apnea, obstructive sleep apnea, CPAP, CPAP compliance, CPAP adherence, sleep disordered breathing, deployment related sleep disorders

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Insomnia, nightmares, and sleep fragmentation are hallmark features of posttraumatic stress disorder (PTSD). Poor sleep quality is commonly reported in patients with PTSD and can potentiate symptoms of anxiety and depression.¹ In addition, sleep avoidance, sleep terrors, nocturnal anxiety attacks, dream enacting behavior, and periodic limb movement disorder (PLMD) are also more frequent in these individuals. Concomitant sleep disorders have been shown to independently worsen outcomes. Compared to patients without sleep complaints, PTSD patients with sleep disorders experience an increased severity of depression,² suicidality,² psychiatric distress,³ poor quality of life and functioning,³ poorer perceived physical health,⁴ and substance abuse.⁵⁻⁷

Obstructive sleep apnea (OSA) is common among patients with underlying psychiatric conditions. The prevalence of OSA is higher among patients with PTSD than the general population.⁸⁻¹³ In patients with comorbid OSA and PTSD, adequate treatment of sleep disordered breathing has been shown to improve anxiety, depression, and other PTSD-related symptoms.^{13,14} Similarly, unrecognized or insufficiently treated OSA is associated with worse outcomes.^{9,11,15} Recognizing and treating OSA in patients with PTSD is crucial in optimizing the therapeutic response.

While continuous positive airway pressure (CPAP) therapy is the most effective treatment of OSA, acceptance and adherence of CPAP therapy are problematic in this population. CPAP adherence has been observed to be reduced in patients with comorbid psychiatric disease.¹⁶ Prior studies have docu-

BRIEF SUMMARY

Current Knowledge/Study Rationale: There has been a dramatic rise in diagnoses of PTSD in US military combat veterans over the past decade. PTSD often coexists with both sleep-disordered breathing and insomnia, potentially worsening clinical outcomes. While CPAP is an effective therapy for obstructive sleep apnea, compliance is often worsened in patients with PTSD.

Study Impact: In a cohort of young combat veterans with PTSD, sleep-disordered breathing significantly worsened adherence with CPAP. Given the particular vulnerability of this population to worsened clinical outcomes, measures that improve CPAP adherence should be a priority.

mented lower CPAP adherence in patients with psychological disease and demonstrated relationships between low therapeutic adherence and anxiety and depression.^{11,17} Misperception of symptoms, overlapping symptoms of depression, and atypical presentations of OSA may limit acceptance of the diagnosis and need for treatment.⁹ Poor adherence with therapy is more common among PTSD patients in particular. Insomnia, sleep fragmentation, and recurrent awakenings common to PTSD may limit adherence with CPAP.⁹ Poor sleep quality may create additional barriers to CPAP therapy and further compromise therapeutic adherence. Similarly, nightmares, mask discomfort, air hunger, and claustrophobia are correlated with poor CPAP adherence among PTSD patients.¹⁸

A recent study in an older veterans population demonstrated that CPAP adherence was significantly reduced in veterans with

concomitant PTSD.¹⁸ The authors found that excessive sleepiness was predictive of improved use of CPAP, while nightmares correlated with poorer CPAP adherence. Given the increased prevalence of OSA among patients with PTSD and the adverse impact of untreated OSA on clinical outcomes, understanding how PTSD affects CPAP adherence is critical.

With the rising prevalence of PTSD among soldiers returning from combat deployments in support of Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF), we sought to determine the impact of combat-related PTSD on CPAP adherence in patients with underlying OSA.

METHODS

Study Design

We conducted an observational, case-controlled study to assess the effects that PTSD had on objective measures of CPAP adherence among patients with concomitant OSA. The protocol was approved by our institution's Department of Clinical Investigation (Scientific Review Committee, Human Use Committee and Institutional Review Board: Exempt Protocol IRB#352703-1). No external funding was utilized to complete this study.

Patients

We included consecutive adult patients with both PTSD and OSA evaluated at the Walter Reed Army Medical Center Sleep Disorders Center between January and October 2009. We did not include soldiers with traumatic brain injury, as we felt this could potentially confound our results. Otherwise, no records were excluded from this analysis. For direct comparison, we included an equal number of patients without PTSD who were diagnosed with OSA and initiated CPAP therapy during the same time period. Control subjects were matched for age, gender, body mass index (BMI), and apnea-hypopnea index (AHI).

All included patients initiated CPAP therapy for the treatment of obstructive sleep apnea syndrome. OSA was diagnosed by level I polysomnography in accordance with American Academy of Sleep Medicine (AASM) criteria in all patients.¹⁹ All polysomnographic studies were interpreted by the study investigators in accordance with established AASM criteria.²⁰

Soldiers with combat-related PTSD were evaluated at our hospital after returning from deployment. All patients underwent a structured clinical interview by a doctoral-level behavioral health provider and were found to meet diagnostic criteria for PTSD, in accordance with both the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) criteria and a standardized military PTSD screening tool (the PTSD Checklist-Military Version, PCL-M Scoring Criteria).^{21,22} The PTSD Checklist-Military Version includes 17 questions (1-5 points each) addressing the 17 DSM-IV criteria for PTSD. A cutoff score of 50 points was used to assess for the presence of PTSD (17-85 points possible).²¹ This is a self-report questionnaire, and the results were interpreted by the administering provider.

Patients were categorized as having insomnia if they had a subjective sleep latency ≥ 30 min during the majority of nights and/or subjective sleep fragmentation (nocturnal awakening)

associated with daytime impairment not better explained by sleep disordered breathing, pain, or other more likely identifiable factors, in accordance with DSM-IV criteria for the diagnosis of insomnia.²²

To prevent confounding, all patients received the same CPAP device (Respironics System One Auto, Phillips-Respironics, Murrysville, PA), and the same clinical evaluations, follow-up assessments, and education regarding OSA and proper use of CPAP. All patients underwent formal mask fitting prior to initiating CPAP therapy.

Data Measurements

Data used in this analysis were obtained from the initial sleep consultation, follow-up evaluations, and polysomnographic studies. For each patient we collected demographic, clinical, polysomnographic, and objectively measured CPAP adherence data. Demographic variables included age, gender, and BMI. Subjective sleepiness was assessed using the Epworth Sleepiness Scale (ESS)²³ and the fatigue analog scale. Clinical data included comorbid insomnia and chronic use of sedating or psychoactive medications (≥ 3 months). Polysomnographic data included the AHI and SpO₂ nadir observed during a diagnostic polysomnogram.

CPAP use was objectively measured in all patients during their initial follow-up evaluation 4-6 weeks after initiating therapy using a downloadable monitoring smart-card (Respironics Encore Anywhere). Specifically, we recorded the percentage of nights CPAP was used, the mean hours of CPAP use per night for all nights, and the mean hours of CPAP use per night during nights used. We also measured the rate of regular use of CPAP between groups, which we defined as CPAP use > 4 h/night on $> 70\%$ of nights.²⁴

Endpoints

The primary endpoint was the difference in the absolute use of CPAP between the 2 groups. The impact of chronically used sedating medications on CPAP adherence and the rates of regular use of CPAP served as secondary endpoints.

Statistical Analysis

Data are presented as the mean $\pm$ one standard deviation. Comparisons between categorical variables were performed using the χ^2 test, and continuous variables were assessed using independent samples t-tests. P values < 0.05 were assumed to represent statistical significance. Data were analyzed using PASW 17.0 (SPSS Inc, Chicago, IL).

RESULTS

We included 90 patients with newly diagnosed OSA who initiated CPAP therapy (45 with combat-related PTSD and 45 controls). Among the cohort, the mean age was 37.7 ± 10.3 years, and the majority of patients (84.8%) were men. The mean BMI was 27.1 ± 6.6 kg/m² and the mean ESS was 13.8 ± 4.2 . The majority of patients had moderate to severe OSA, with a mean AHI of 29.3 ± 16.1 events/h among the entire cohort.

As expected, patients with PTSD tended to have less subjective sleepiness and fatigue. In addition, there were twice as many patients with insomnia in the group with PTSD (25.8% vs. 11.1%, $p = 0.10$); however, given the overall small cohort

Table 1—Baseline characteristics

	Control N = 45	PTSD N = 45	p
Age (years)	38.6 ± 9.2	37.0 ± 11.2	0.28
Male (%)	84.4	84.9	0.80
BMI (kg/m ²)	27.8 ± 4.4	26.9 ± 9.2	0.66
Epworth Sleepiness Scale	14.7 ± 4.8	12.5 ± 6.0	0.09
Fatigue	7.4 ± 0.5	5.3 ± 1.0	< 0.001
AHI (events/h)	31.6 ± 24.4	28.2 ± 19.3	0.18
SpO ₂ nadir (%)	83.3 ± 5.2	84.2 ± 4.8	0.20
Insomnia (%)	11.1	25.8	0.10
Chronic use of sedating agents (%)	13.3	82.9	< 0.001

BMI, body mass index; AHI, apnea hypopnea index.

size, this difference did not reach statistical significance. The comparison groups were otherwise similar at baseline (**Table 1**).

PTSD was associated with significantly less CPAP use (**Table 2**). Specifically, CPAP was used on 61.4% ± 22.2% of nights in patients with PTSD compared with 76.8% ± 16.4% in patients without PTSD ($p = 0.01$). Similarly, the mean nightly use of CPAP during nights used was only 3.4 ± 1.2 h/night in the PTSD group, compared with 4.7 ± 2.2 h/night among controls ($p < 0.001$). During all nights, patients with PTSD used CPAP for only 2.5 ± 1.8 h/night versus 4.2 ± 2.1 h/night in the control group ($p < 0.001$). Regular use of CPAP was also significantly less common among patients with PTSD and was observed in 25.2%, compared with 58.3% among patients without PTSD ($p = 0.01$).

The majority (82.9%) of patients with PTSD were chronically using sedating medications (≥ 3 months) for the treatment of their PTSD and/or comorbid insomnia. Greater adherence with CPAP was observed among patients with PTSD who were chronically using sedatives. Among patients chronically using sedating agents, CPAP was used for 70.4% ± 19.8% of nights compared with only 46.2% ± 24.4% in patients not prescribed sedating medications ($p = 0.009$). Similarly, the mean nightly use of CPAP during nights used was 4.1 ± 1.9 h versus 2.6 ± 1.2 h ($p = 0.006$) in patients using versus not using sedative medications, respectively. Regular use of CPAP was observed in 34.6% of patients using sedatives and only 9.1% of patients not using sedating agents ($p = 0.09$). Improvements in CPAP adherence did not differ between patients using non-benzodiazepine sedative hypnotics, benzodiazepines, or atypical antipsychotics. Furthermore, the AHI and SpO₂ nadir did not differ between patients using and not using sedative agents, and these measures did not differ between the different classes of agents. However, compared to patients using non-benzodiazepines, patients using benzodiazepines or atypical antipsychotics had greater BMIs (26.3 ± 12.9 versus 29.9 ± 4.4 kg/m², $p = 0.007$) and more subjective sleepiness as measured by the ESS (11.1 ± 6.1 versus 14.3 ± 5.7, $p < 0.001$).

DISCUSSION

We found that adherence with CPAP was significantly lower among soldiers with combat-related PTSD than controls. CPAP was used on fewer nights and for approximately one

Table 2—CPAP adherence

	Control N = 45	PTSD N = 45	p
Percentage of nights used	76.8 ± 16.4	61.4 ± 22.2	0.001
Hours/night, all nights	4.2 ± 2.1	2.5 ± 1.8	< 0.001
Hours/night, nights used	4.7 ± 2.2	3.4 ± 1.2	< 0.001
Regular use of CPAP (%)	58.3	25.2	0.01

hour less per night when it was used. In addition, regular use of CPAP was observed in half as many patients with PTSD as the control group.

Concomitant insomnia tended to be more common in patients with PTSD, and while this difference did not reach statistical significance, it may have contributed to the discrepancy in CPAP use. Similar to prior reports in patients with OSA without PTSD, comorbid insomnia can create a barrier to CPAP therapy, as patients may experience greater difficulties initiating and maintaining sleep.²⁵⁻²⁸ Initiation insomnia, sleep fragmentation, and nightmares, common in PTSD, are all potential barriers to CPAP adherence. In our cohort, we found that patients with PTSD who were chronically using sedating medications had greater use of CPAP than patients not using these agents. This may reflect improvements in sleep initiation and reductions in insomnia, which has been shown to enhance therapeutic adherence with CPAP among non-PTSD patients.²⁹ While CPAP was used more often and for longer periods among PTSD patients using sedating medications, adherence was still lower than that observed in the control group, suggesting that the diminished use of CPAP among patients with PTSD is likely multifactorial.

Poor therapeutic adherence with other disease processes has been observed in prior reports of PTSD patients. Several studies have shown that medication adherence to HAART therapy is decreased in HIV patients with comorbid PTSD and depression.^{30,31} A recent study by Lockwood et al. demonstrated that adherence with antidepressant medication was poor among PTSD patients discharged from a residential treatment program during long term follow-up.³² In addition, prior reports have found an increased likelihood of missed appointments, underuse of medications, abuse of prescription psychoactive agents, and the propensity of self-adjust medical treatments among patients with PTSD.³³⁻³⁷

OSA is more common among patients with underlying psychiatric disorders. In a sample of 118,105 military veterans, the prevalence of psychiatric disorders was significantly greater in patients with OSA than those without.¹² Similarly, OSA is significantly more common among patients with PTSD and has been identified in 11.9% to 90%.^{3,8,9,12,14,38,39} In a sample of 78 individuals seeking treatment for posttraumatic sleep disturbances after being evacuated from a fire, 95% of those tested (50% of the subjects) experienced diminished airflow during sleep suggestive of sleep disordered breathing (SDB).⁸ Among 44 consecutive crime victims with PTSD reporting nightmares and insomnia, 91% had SDB.⁹

Untreated OSA appears to be associated with worse outcomes among patients with PTSD.^{14,15} Likewise, CPAP therapy has been shown to improve symptoms of depression among

patients with concomitant PTSD.^{8,9,11-14} In a case report by Youakim et al., CPAP therapy resulted in dramatic improvements in sleep apnea control, daytime sleepiness, and nightmares in one veteran with PTSD.¹³ In a retrospective review of 15 patients with PTSD and SDB, patients who were adherent with CPAP reported a 75% improvement in PTSD symptoms compared with a 43% worsening in PTSD symptoms among patients who were non-adherent.¹⁴ Although the literature addressing the impact of CPAP adherence on PTSD is limited, it suggests improved outcomes.

Sleep disturbances are common among soldiers returning from combat deployments. A recent multi-service survey of US military members found that approximately 30% reported difficulty sleeping, and that military members who had experienced combat were 52% to 74% more likely to report difficulty sleeping than noncombatants.⁴⁰ Among 200 veterans of OIF/OEF evaluated in a Veterans Administration Polytrauma Outpatient Clinic (pain, TBI, PTSD), 93.5% reported difficulty sleeping.⁴¹ In addition, the overall prevalence of sleep disorders among service members has also markedly increased over the past decade. For example, 19,631 service members were diagnosed with insomnia in 2009, compared with 1,013 in 2000. Similarly, the diagnosis of OSA increased from 3,563 to 20,435 among service members over this same time period.⁴² The incidence of PTSD among combat veterans is also significantly higher than the general population, and the prevalence among US Service members has increased dramatically since the start of combat operations in Iraq and Afghanistan.⁴³ Nearly 90,000 Service members have been diagnosed with PTSD over the past decade, with the majority occurring in the Army (67%), predominantly among deployed military members.⁴⁴ Given the increasing prevalence of both PTSD and sleep disturbances among US military Service members, understanding the interplay between these disorders is needed to improve outcomes.^{42,44,45}

Our findings are similar to a recent study by El-Solh et al., who assessed CPAP use in a cohort of older veterans with PTSD and multiple comorbidities.¹⁸ Despite differences in study populations, they also found that CPAP use was significantly decreased in patients with PTSD and OSA compared to a control group without PTSD. This suggests that PTSD, and not the underlying comorbid conditions, can have a profound impact of adherence.

Our study has several limitations. As a retrospective case-control study, we were unable to assess the presence of insomnia or PTSD using standard psychiatric interview systems (Clinician-administered PTSD scale, Duke sleep inventory, and Structured Clinical Interview for DSM-IV among others).⁴⁶⁻⁴⁹ Similarly, we were unable to calculate an insomnia severity score. We were only able to correlate CPAP use with the presence of insomnia and not the severity of insomnia, and as such cannot determine if a linear or dose-dependent correlation exists. While insomnia was more common among patients with PTSD and likely affected outcomes in this group, this was difficult to assess without being able to correlate insomnia severity with CPAP adherence. We did not examine other medical or behavioral treatments of PTSD that may have altered the use of CPAP and influenced our results. However, the purpose of this study was to assess the impact that PTSD

had on CPAP use, and clinical applicability would depend on both the effects of the disease process and its treatment. Furthermore, our comparison group provided an effective means to assess the impact of PTSD and its treatment on CPAP use. Another limitation is that our population was comprised of predominantly younger male military personnel with combat-related PTSD. As such, our results may not be generalizable to other populations. However, PTSD has been shown to similarly reduce adherence with other medical therapies, and insufficiently treated OSA has been shown to worsen outcomes in patients with psychiatric disorders. As such, we believe our findings are clinically relevant to all PTSD populations. The majority of our patients were habitually using sedating medications; prior studies have shown that non-benzodiazepine sedative-hypnotics may improve CPAP adherence.^{29,50,51} This likely diminished the observed differences in CPAP use, as we found that patients using sedating agents had increased use of CPAP than patients not using sedatives. Despite this, PTSD still impaired CPAP adherence regardless of concomitant sedative use. Finally, while we only measured CPAP use during the first month of therapy and did not assess the long-term impact of PTSD on adherence, it has been previously established that long-term CPAP adherence is predicted by use during the first weeks of therapy.⁵²⁻⁵⁷

Similar to the treatment of other medical conditions, we found that patients with PTSD had significantly less use of CPAP than matched controls. This may reflect the impact of comorbid insomnia, habitual use of psychoactive medications, and nightmares, which are common among patients with PTSD.^{9,10,15,39,58} Insomnia in particular has been linked to sleep disordered breathing, with worsened sleep quality, anxiety, depression, and CPAP adherence.^{27,28,59-61} Given the potential for poorer clinical outcomes in this already compromised population, identification and early interventions targeting common barriers to CPAP use should be prioritized. A multi-modal approach should be used to improve CPAP adherence.⁶² Strategies may include telephonic follow-up, group education, early interventions (non-benzodiazepine sedative hypnotic to improve CPAP titration and early adherence,^{29,51} close follow-up to improve issues such as poor mask fit and difficulties with equipment), and goal-setting, to improve a patient's sense of self-efficacy in their ability to be adherent with therapy.⁶³ Furthermore, there should be a sense of urgency among providers caring for patients with PTSD and sleep disorders, especially combat veterans, as poor sleep may increase the risk for suicidality in this population.⁶⁴⁻⁶⁷ PTSD should be considered a significant barrier to CPAP acceptance and adherence and should prompt a greater focus to enhance CPAP use.

ABBREVIATIONS

AHI, apnea-hypopnea index
 CPAP, continuous positive airway pressure
 ESS, Epworth Sleepiness Scale
 OSA, obstructive sleep apnea
 PTSD, posttraumatic stress disorder
 OIF, Operation Iraqi Freedom
 OEF, Operation Enduring Freedom

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Address correspondence to: Jacob Collen, M.D., Pulmonary, Critical Care and Sleep Medicine, Walter Reed National Military Medical Center, 8901 Rockville Pike, Bethesda, MD 20889; Tel: (301) 295-4191; E-mail: jacob.collen@us.army.mil

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