Curr Psychiatry Rep (2014) 16:459
DOI 10.1007/s11920-014-0459-7

The Impact of Sleep on Soldier Performance

Scott G. Williams · Jacob Collen · Emerson Wickwire · Christopher J. Lettieri · Vincent Mysliwiec

Published online: 20 June 2014

Abstract The military population is particularly vulnerable to a multitude of sleep-related disorders owing to the type of work performed by active duty servicemembers (ADSMs). Inadequate sleep, due to insufficient quantity or quality, is increasingly recognized as a public health concern. Traditionally, ADSMs have been encouraged that they can adapt to insufficient sleep just as the body adapts to physical training, but there is a substantial body of scientific literature which argues that this is not possible. Additionally, the military work environment creates unique challenges with respect to treatment options for common sleep disorders like obstructive sleep apnea, restless legs syndrome, and parasomnias. This review highlights sleep disorders which are prevalent in the modern military force and discusses the impact of poor sleep on overall performance. Medical treatments and recommendations for unit leaders are also discussed.

Keywords Sleep deprivation · Combat related sleep disorder · Insomnia · Obstructive sleep apnea · Sleep disordered breathing · Posttraumatic stress disorder · Nightmares

This article is part of the Topical Collection on *Military Mental Health*

S. G. Williams
Pulmonary, Critical Care, and Sleep Medicine, Womack Army Medical Center, 2817 Reilly Rd, Fort Bragg, NC, USA

S. G. Williams (✉) · J. Collen · C. J. Lettieri
Department of Medicine, Uniformed Services University, Bethesda, MD, USA
e-mail: scott.g.williams@us.army.mil

J. Collen
Pulmonary, Critical Care, and Sleep Medicine, San Antonio Military Medical Center, Fort Sam Houston, TX, USA

E. Wickwire
Howard County Center for Lung and Sleep Medicine, Columbia, MD, USA

E. Wickwire
Department of Psychiatry and Behavioral Sciences, Johns Hopkins School of Medicine, Baltimore, MD, USA

C. J. Lettieri
Pulmonary, Critical Care, and Sleep Medicine, Walter Reed National Military Medical Center, Bethesda, MD, USA

V. Mysliwiec
Pulmonary, Critical Care, and Sleep Medicine, Madigan Army Medical Center, Joint Base Lewis-McChord, Tacoma, WA, USA

Introduction

Sleep management in the military has long been complicated by the nature of the work performed by active duty servicemembers (ADSMs). Sleep quality and duration are increasingly recognized as critical variables which impact military readiness. Many soldiering tasks can be adversely impacted by poor sleep quality. Complex mental operations, such as planning and executing military operations, are particularly vulnerable to sleep loss. Additionally, the ability to maintain alertness in situations with little mental or physical stimulation, such as during guard duty or equipment maintenance, can be compromised [1].

Specialized populations such as those in aviation, the special operations community, medical personnel and emergency services have well established procedures for dealing with sleep management as a component of operational planning. In reality, these policies are often not able to be enforced because of operational demand. Less commonly recognized, however, are other jobs such as staff personnel who often work extremely long hours preparing information for leadership and food service personnel who are subject to frequently rotating shifts. Work is often performed during the natural circadian lull (night operations, overnight flights, frequent time zone changes). Some tasks are largely sedentary and monotonous, punctuated by periods of heightened vigilance (e.g., security personnel, pilots preparing for landing, etc.). Figure 1 lists some common challenges encountered by ADSMs when attempting to obtain adequate sleep.

ADSMs recognize that they are not receiving adequate rest. In a large survey of pilots, 73 % reported widespread fatigue [2] and 50 % stated that they had fallen asleep in the cockpit on at least one occasion. Most adults need 7-8 hours of sleep per night, and those who do not achieve adequate sleep do not perform optimally. During the most recent mental health advisory team (MHAT) report, more than half of the Soldiers who reported making a mistake which affected their mission attributed it to sleepiness [3•]. Despite this knowledge, sleep loss remains epidemic and some may not realize their true level of impairment [4].

The military can be a very competitive environment and many ADSMs may not wish to admit that they need more sleep than they are actually obtaining. This review will highlight some of the common sleep complaints in the military and discuss recommendations for treatment. It is not intended to be exhaustive, but should provide a starting point to further increase awareness to help guide both medical and operational policy.

Occupationally Induced Insufficient Sleep

A lack of adequate sleep is a near universal characteristic of military service, particularly when deployed [3•]. This starts upon indoctrination to the military in basic training when young men and women, who are typically adolescents, are required to awaken much earlier than their natural circadian tendency. Miller et al. reported on two groups of basic trainees; a control group had the usual sleep period of 20:30-04:30 and an intervention group had a sleep period of 23:00-07:00 [5] The intervention, which better aligned to the habitual sleep pattern of the young recruits, resulted in a clinically and statistically significant increase of 31 minutes of sleep per 24 hours. However, both the control group (5.42 hours) and the intervention group (6.05 hours) obtained markedly less than the recommended 8.5 hours for adolescents. Even with this relative sleep deprivation, the intervention group showed improved rifle marksmanship scores, decreased fatigue, and improved overall sleep quality.

Insufficient sleep not only occurs in basic training but also during academic training at military academies. Cadets at the United States Military Academy (USMA) had their sleep monitored with actigraphs during their first year. The average weekday sleep duration was 4 hours and 58 minutes and the average weekend sleep duration was 6 hours and 31 minutes [6] The cadets were then followed as part of a 4 year longitudinal study, which showed that their average weekday sleep duration remained less than 5.5 hours on school nights [7] These findings led the authors to conclude that military cadets have a chronic sleep debt and are inculcated into a cultural norm of sleep deprivation.

Sleep duration for ADSMs who are not in a training status appears slightly longer than what has been reported in training environments. A limitation to all of these reports, though, is that they are based on self-report. The overall sleep duration varies to a small extent depending on branch of service, military duties and deployment status with an average of

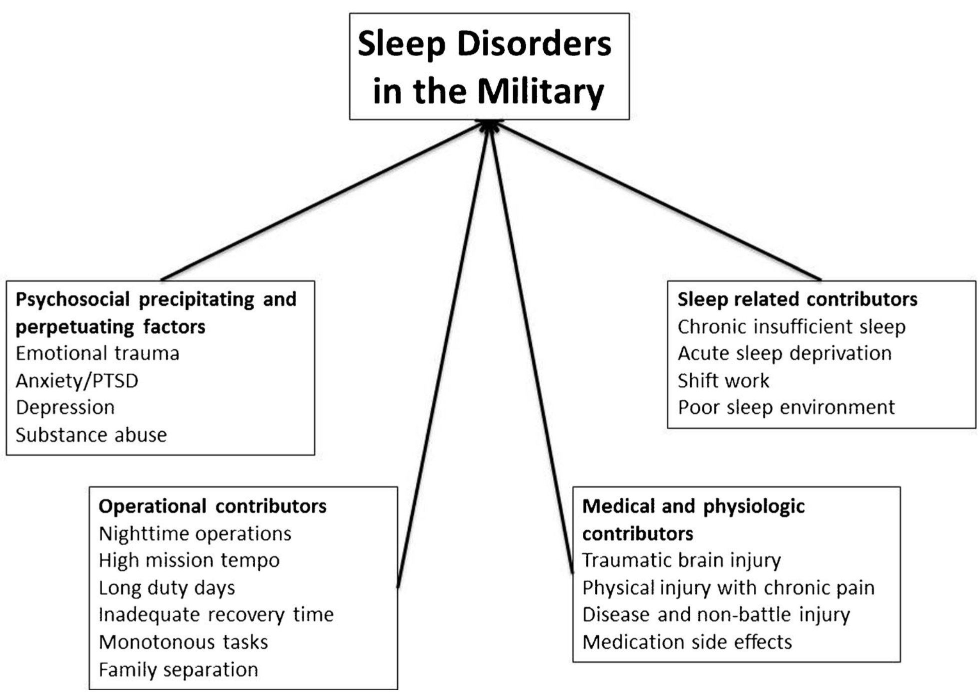

Fig. 1 Contributors to sleep disorders in the military

approximately 6 hours per night. Seelig et al. evaluated the Millennium Cohort study and reported a mean sleep duration of 6.5 hours among 41,225 service members [8] Those service members who were currently or previously deployed or in the Army and Marine Corps reported sleeping less than those who had never deployed or who served in the Navy or Air Force.

During deployment there are additional challenges to adequate sleep. Peterson et al. evaluated data from a cohort of deployed U.S. Air Force Members and found a total sleep time of approximately 6.5 hours with a sleep efficiency of 83.3 % [9] Sleep was fragmented primarily by loud noises, uncomfortable beds and concerns over family members. Upon return from combat, insufficient sleep persists in military personnel to a degree that is not seen in civilians. In a study of 2738 recently redeployed Soldiers, Luxton et al. reported a mean sleep duration of 5.8 hours per night [10]. Overall, 72 % of this cohort reported sleeping 6 hours or less in each 24 hour period. However, only 16 % reported the need to nap or acknowledged duty impairments due to short sleep. The impact of insufficient sleep may exist long after active military service has concluded. Faestel et al. reported that veterans exhibited short sleep duration more often than non-veterans (34.9 % vs. 31.3 %) [11].

The prefrontal cortex, which mediates ethical decisions, complex planning and execution, is one of the areas of the brain most sensitive to sleep loss [12] Given that sleep deprivation is associated with impaired cognitive functioning particularly as it relates to higher-order executive processes, this is of grave concern when one considers the nature of the work being performed.

There is no optimal coping strategy for insufficient sleep and a balanced work-rest cycle is the only way to maintain peak performance. Caffeine is one of the most widely abused substances in the military. When used as a wake-promoting agent, the minimum effective dose should be ingested only when adequate sleep cannot be obtained and only for a brief period of time. Even with caffeine use, performance is decreased. A study conducted by the National Transportation Safety Board (NTSB) found that plasma caffeine levels were highest in drivers involved in fatigue-related crashes. Clearly, even large amounts of caffeine cannot overcome the need to sleep. Additionally, the NTSB found that fatal sleep-related accidents exceeded fatalities due to alcohol and illicit drug use combined [13]. A very effective but under-utilized strategy is called sleep banking. In essence, if there is an upcoming mission and the military commander can predict that the unit is going to receive less sleep than usual, a few days of increased sleep prior to the mission can improve performance [14]. Table 1 summarizes these and other recommendations.

Table 1 Sleep management in the deployed environment: recommendations for leaders

1. Importance of pre-mission sleep time (at least 8 hours for 7 days prior to continuous operations) [114, 115].
2. Promote sleep whenever the mission allows- avoid critical tasks for at least 5 minutes after awakening.
3. Pharmacologic countermeasures may be employed. Caffeine immediately upon awakening has been shown to be effective in reducing sleep inertia [116, 117].
4. Avoid situations where the entire unit, to include the command group, is sleep deprived at the same time [118].
5. Recovery sleep should be tempered by the risk of worsening circadian disorders or developing psychophysiologic insomnia. Multiple days with sleep extension to 10-12 hours is preferable to one prolonged recovery period as this sets up a cycle of binge-purge related to sleep.
6. Avoid non-productive activities during periods of sleep restriction or continuous operations (i.e., video games)

Shift work Sleep Disorder

Military life is characterized in large part by early start times, late working hours, and other non-traditional work schedules. National security requires around-the-clock attention, and military personnel are often required to work a non-traditional schedule. When deployed and in the U.S., 12-hour and 24-hour shifts are not uncommon. Because humans have evolved to be diurnal creatures, alternate work schedules can result in misalignment between the body's natural rhythm and professional demands. As a result, many ADSMs suffer shift work disorder (SWD).

Characterized by excessive sleepiness or insomnia for greater than one month's duration in a habitual shift worker [15], SWD is the most common circadian rhythm disorder. Although prevalence estimates for SWD have not been systematically assessed in the military, data has shown that the most frequent cause of disturbed sleep during deployment results from night-time operations. Approximately one in ten workers in the general population suffer from SWD [16], and this may be higher in the military. More recently, Di Milia et al. studied a random sample of community-dwelling adults (N=1163) and found the prevalence of SWD to be 32.1 % among night workers and 10.1 % among day workers [17]. Among police officers working the night shift, the prevalence of SWD has been found to range from 14.5 to 54 % [18], and 23 % of oil-rig workers who worked shifts meet criteria for SWD [19].

Shift workers get less sleep than their day-work counterparts, and a number of reports have suggested that SWD is associated with significant negative health consequences. The best studied are cardiovascular disease, gastrointestinal problems, cancer, and psychiatric sequelae [20, 21]. In addition, persons with SWD are at significantly increased risk for accidents, workplace errors, depression, and missing days of work as well as family recreational activities [16].

Because shift workers are chronically sleep-deprived, the most important clinical recommendation after maintaining safety should be to obtain sufficient sleep. This will invariably require a problem-solving and motivational approach. In our clinical practice, this typically includes involving family members and military commanders in treatment planning, thus securing buy-in for a time-limited “behavioral experiment.” We have found that patients are much more likely to commit when they know that the purpose of this experiment is to gather data (e.g., sleep diary) for review, not to make an indefinite lifestyle commitment.

All shift workers should be counseled on proper sleep hygiene, especially optimizing the sleeping environment and avoiding sleep-interfering behaviors and substances close to desired bedtime. Minimizing the frequency of shift changes is one of the easiest and most powerful options available to military leaders. If rotating shifts are required, ADSMs should be kept on the same shift for at least 2-4 weeks before being required to change their sleep schedule. Other behavioral recommendations include maintaining as much of a consistent sleep schedule as is feasible on days off, at minimum ensuring that several hours of sleep always overlap on both work and non-work days. Taking a planned nap prior to night shifts, using bright light (2500 to 10,000 lux) during the early part of the shift, avoiding bright light in the later part of the shift and wearing sunglasses if driving home during bright morning hours are also encouraged.

When behavioral recommendations are insufficient, medications can be utilized to aid in adapting to shift work. Caffeine increases alertness during the shift work period. Low-dose melatonin administered prior to the sleep period can also be beneficial. Hypnotic sleep aids can be considered to improve sleep during the desired sleep period. Further, two wake-promoting medications are FDA-approved for sleepiness associated with SWD: modafinil and armodafanil. These medications have been associated with reduced subjective symptoms as well as decreased objective sleepiness, fewer motor vehicle crashes on the way home from work, improved self-reported functioning, productivity, and quality of life [22]. Methamphetamine has not been evaluated in SWD but has been studied in the military for sustained operations. Due to significant side effects, it should be considered a last resort. No medication should act as a substitute for sleep, however, and military commanders must be aware that they cannot rely on pharmacotherapy as a long-term solution to SWD. Table 2 lists these specific recommendations.

Table 2 Management of shift work in the military

Behavioral strategies:
1. Self-monitoring via a sleep diary
2. Ensuring proper sleep hygiene (optimizing the sleeping environment and avoiding sleep-interfering behaviors and substances close to desired bedtime).
3. Minimizing the frequency of shift changes to less than once per month.
4. Maintaining as much of a consistent sleep schedule as is feasible on days off, and maintaining a period of overlapping sleep on both workdays and non-workdays.
5. Take a planned nap prior to the shift, using bright light (2500 to 10,000 lux) during the early part of the shift, avoiding bright light in the later part of the shift and wearing sunglasses if driving home during bright morning hours are also encouraged.
Stimulant medications:
1. Caffeine
2. Modafinil
3. Armodafinil
Sedating medications:
1. Low-dose melatonin
2. Hypnotic sleep aids

Insomnia

The most common sleep disorder among adults, as well as ADSMs, is chronic insomnia. Insomnia is characterized by difficulty initiating or maintaining sleep, including early morning awakening. Thirty percent of adults experience occasional insomnia, and between 9 and 12 % of the adult population suffer severe chronic insomnia [23, 24]. In primary care settings, prevalence estimates for chronic insomnia center range from 32 to 34 % [25, 26]. Insomnia was once thought to be simply a symptom of an underlying disease, but it is now recognized as an independent condition warranting treatment [15, 27].

In terms of etiology, insomnia is most often conceptualized within a biopsychosocial framework. Certain physiologic abnormalities, such as increased activity in the CNS and hyperarousal of the hypothalamic-pituitary axis (HPA) and proinflammatory cytokines, predispose individuals to insomnia. Similarly, personality traits such as anxious temperament place individuals at higher risk for negative reactions to stress, the most common precipitating cause of chronic insomnia. Individuals who experience acute sleep disturbance, for example during deployment, develop maladaptive compensatory behaviors such as “trying harder” to sleep, spending excessive time in bed, napping, or overusing stimulants including caffeine. Through repetition, these sleep behaviors contribute to the development of a chronic condition [28]. In spite of the well-documented pathophysiologic abnormalities associated with chronic insomnia, it should be noted that insomniacs tend to attribute their insomnia to cognitive, rather than physiologic, arousal [29]. Harvey has proposed a cognitive model of insomnia, in which insomniacs become overly attuned to perceived sleep-related threats and engage in daytime avoidance or “safety” behaviors, for example, excessive emotional restraint (i.e., suppressing appropriate emotional responses to daily life) [30]. These inhibitions can exacerbate hyperarousal and lead to cognitive rumination, prolonging insomnia.

Patients with insomnia are at increased risk for medical consequences such as cardiovascular disease and mortality as well as psychiatric sequelae [31, 32] , and diminished quality of life [33, 34]. Importantly, insomnia is also common among suicide attempters [35]. Up to 85 % of insomnia occurs within the context of another medical, psychiatric, or sleep disorder. In terms of the military specifically, the incident rate of insomnia among ADSMs increased nearly 20-fold between 2000-2009 [36]. Insomnia was the most common complaint of returning OIF/OEF veterans and was associated with the development of post traumatic stress disorder (PTSD) [37]. Pre-existing sleep complaints can worsen the impacts of combat. For example, data from the Millennium Cohort surveys (N>15,000) found that even after controlling for past mental health history and combat trauma, Soldiers who reported symptoms of insomnia pre-deployment were more likely to develop anxiety, depression, and PTSD during deployment than were Soldiers who did not report these symptoms [38].

In addition to these medical and psychiatric sequelae, the individual and societal costs of insomnia are many and varied, ranging from treatment-related expenses to absenteeism and decreased productivity in the workplace. Direct treatment costs of insomnia have been estimated at $13.9 billion, with total treatment costs estimated at $77 to $92 billion per year [39]. When indirect costs such as accidents and lost workplace productivity are considered, total annual costs from insomnia exceed $100 billion [40].

Multiple studies suggest that treating insomnia enhances quality of life and improves not only sleep but also health-related outcomes in comorbid conditions, including depression [41], PTSD [42], chronic pain [43], and alcohol dependence [44].

Although a number of FDA-approved medications for insomnia exist, the "gold standard" treatment for insomnia is cognitive-behavioral treatment (CBTI). Behavioral treatment of insomnia is cost-effective, leading to reductions in hypnotic use as well as healthcare utilization [45]. Four head-to-head randomized controlled trials have found CBTI to be equally effective as pharmacotherapy acutely, with gains significantly better maintained over time [46–49]. Based on these empirical findings as well as six meta-analytic reviews, the National Institutes of Health [50] and the American Academy of Sleep Medicine (AASM) [51] both recommend CBTI as first-line treatment for chronic insomnia, including insomnia occurring in the context of other medical, psychiatric, or sleep disorders. Specific behavioral patient preferences that can be used to tailor treatment have been identified within a military population [52].

Despite this data, the most common treatment for insomnia remains monotherapy with sedative-hypnotic medication. This is in large part due to a shortage of trained behavioral sleep medicine providers, particularly in the military. Some reports estimate that as many as 15-20 % of all deployed Soldiers have been given a psychoactive medication to aid with sleep initiation. Off-label use of anti-depressants, anti-psychotics and anti-histamines are also very common. The Veteran's Administration reported an increase in the use of quetiapine, an anti-psychotic used off-label to treat insomnia, by more than 700 % between 2001 and 2010, becoming the second largest single drug expenditure in 2010. All medications have the potential for side effects, and potential risks of sedative hypnotics are well-documented. For example, hypnotic use has been associated with infection [53], motor vehicle accidents [54], falls [55], and mortality [56]. Further, some medications can limit deployability. We recommend that behavioral interventions be included in any chronic insomnia treatment regimen.

Obstructive Sleep Apnea

Sleep disordered breathing is increasingly recognized as a significant source of disability in ADSMs. Poor quality sleep, regardless of the etiology, can adversely impact daytime function. This concept has a great deal of relevance to current military operations. The Army Surgeon General's recently established Performance Triad [57•] focuses on the importance of sleep, nutrition, and activity. In addition, there has been increasing recognition of the importance of subspecialist sleep medicine evaluations and clinical research to evaluate sleep disordered breathing and other sleep disorders in the military.

Rates of obstructive sleep apnea syndrome (OSAS) in ADSMs are dynamic, due to marked increases in awareness of sleep disorders in patients and healthcare providers, the availability of sleep disorder specialists and sleep laboratories within military medical centers. Prevalence estimates in the U.S. civilian population range from approximately 2.5 % of females and 4 % of males overall [58]. Estimates in U.S. veterans hover around 3 %, based on a sample of 4-million older males within the Veterans Health Administration (VA) [59]. Among ADSMs, rates of diagnosis have increased dramatically over the past decade. Between 2001–2009, the number of cases of OSA increased from 3563 to 20,435. Among males older than 40 years old the prevalence was 7 %. This was a sixfold increase in incident diagnoses, with an eightfold increase among those over the age of 40 years, and a fourfold increase among those aged 20–24 [60, 61]. Among those returning from deployment that are screened in sleep disorders centers for nonspecific symptoms such as fatigue and depressed mood, the rates of OSA vary from 50 to 62.7 % [62•, 63•].

The most frequent comorbidities of OSAS in ADSMs are hypertension, non-specific respiratory complaints, obesity, and tobacco use. This is similar to the VA population and civilian databases [59, 64]. Rates of congestive heart failure and diabetes appear to be less frequent among active military members when compared to VA and civilian databases, likely because the ADSM population is younger and more physically fit at baseline. During the wars in Iraq and Afghanistan over the past 13 years, observational research conducted in military sleep disorders centers has noted associations amongst sleep disorders, PTSD and traumatic brain injury (TBI) among recently deployed veterans [8, 62•]. Nearly 40 % of patients in one such cohort were found to have comorbid insomnia and OSA [63•],often referred to as "complex insomnia," [65], which can be challenging to treat.

The impact of sleep disorders among patients with TBI is well established. Sleep disturbances following TBI have been reported in up to 72.5 % of patients [66–68]. The estimated prevalence of sleep disordered breathing in TBI is between 23–36 % [66, 69]. Among recently deployed ADSMs with TBI who were evaluated in a military sleep disorders center, the rate of OSAS was 34.5 %, and mechanism of injury was linked to the type of sleep disturbance, with significant associations between OSAS and blunt trauma, and insomnia/anxiety and blast injury. Blunt trauma was found to be a significant predictor of OSAS in this population [62•].

Among military cohorts, deployment related PTSD was a frequent comorbidity. Numerous studies have shown that rates of OSAS are increased among those with PTSD, with rates ranging from 40–91 % [62•, 63•, 70, 71]. OSAS has also been shown to worsen cognitive functioning and mental health outcomes in veterans with PTSD [72]. While the treatment of OSAS with CPAP has been shown to improve symptoms in PTSD [73, 74], efficacy is limited by lower CPAP adherence in this group [75, 76] potentially impacted by high rates of comorbid insomnia [77]. Near universal polypharmacy with medications that fragment sleep, diminish upper airway tone, or have sedative effects may also impact treatment in this population.

Numerous studies in the civilian literature have assessed the adverse impact of OSA on cognitive function. Based on the majority of the available literature from structured systematic reviews and meta-analysis, OSA adversely impacts attention, vigilance, visual-spatial and constructional abilities, and executive function [78]. The ability to respond appropriately to visual targets in the periphery is negatively impacted by OSA, and although disease severity based on apnea hypopnea index does not appear to have an impact, the magnitude of hypoxemia does. The diminished ability to respond to peripheral targets in a simulator may reflect an inability to effectively process complex information from the environment [79]. This type of cognitive function is critical in combat operations (driving vehicles in chaotic conditions, directing weapons systems to the appropriate target). CPAP therapy has been shown to improve performance in a driving simulator but it may not return to normal [80, 81]. As such, OSA patients are likely impaired in settings that require a high degree of vigilance and attention to complex environmental stimuli.

Although there is a significant body of literature evaluating OSAS prevalence, clinical consequences, and impact of PAP therapy, the reason for the increased prevalence of OSAS in the military is unclear. There are several factors that may have contributed to the rise in diagnosis rates. Increased awareness about OSAS, availability of subspecialty testing, and focused attention by military leadership, are all likely contributors. Notably, the increase has occurred over the past decade, during sustained combat operations in Iraq and Afghanistan. Over this period of time, there have been marked increases in physical injury from war-trauma and combat associated mental illness. Two of the hallmark diagnoses from this period are traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD). Both are associated with increased rates of sleep-disordered breathing. The long-term sequelae of war related conditions (chronic pain, anxiety, insomnia), are associated with poly-pharmacy utilizing medications that have the potential to cause daytime sedation, fragment nighttime sleep, and decrease upper airway tone. In patients with PTSD, chronic sleep fragmentation has also been postulated to contribute to decreased upper airway tone [82]. Whether chronic insufficient sleep (from sustained combat operations or the long-hours and shift-work common to military life) contributes to the pathophysiology OSA is a potential theory, although not validated in clinical research. Many of the variables above impact younger ADSMs in particular (combatants), which may account for the dramatic rise in diagnosis rates in ADSMs who are in their early 20s. Despite this increase, however, a number of ADSMs do not seek treatment due to concerns about deployability. For CPAP in particular, there must be adequate access to electricity to ensure adequate treatment. This is not always guaranteed in austere environments. As such, some wait until they are about to retire from active service before they seek treatment.

Restless Legs Syndrome

Restless legs syndrome (RLS) is defined as by the presence of specific clinical features: (1) an uncomfortable urge to move the legs, often with an unpleasant or tingling sensation, (2) worse with lying down, inactivity, or sitting, (3) partially or completely relieved with movement, and (4) occurring at night (circadian pattern to symptom onset). These symptoms should not be the result of another known medical condition or side effect of therapy, and should cause significant concern or distress to the patient [83]. RLS is not well understood by medical providers, and often is difficult to elicit from patients, many of whom may present with a primary complaint of insomnia.

The prevalence and clinical impact of RLS in the military is not well documented. One published case report reviewed the impact of RLS in pilots, primarily as an educational piece for aerospace medicine physicians [84]. Another study evaluated survey data in older veterans and found that among nearly 1000 respondents, 19.4 % appeared to be at high risk for RLS [85]. This was significantly higher than prevalence estimates based on U.S. and European survey studies that estimated the prevalence between 2–5.5 % [86–88], , and probably reflects the limitation of surveys to discern RLS-mimics such as neuropathic pain from true RLS.

Current standard medical therapies include dopamine agonists such as pramiprexole, ropinirole, and α2δ–ligands such as gabapentin (in addition to other medications including levo-dopa, rotigotine, pregabalin, opiates, and benzodiazepines). While these medications have demonstrated efficacy, numerous limitations of medical therapy exist. The α2δ–ligands, which are typically used as anti-epileptics and for atypical pain, can cause significant sleepiness and fatigue, and dopamine-agonists are associated with augmentation and risk for impulsivity and compulsive behaviors [89–91]. As such, the medications used to treat RLS can be unattractive to ADSMs who require peak alertness to complete their duties.

In the military, uncomfortable sleeping conditions in austere environments, and the potential for long periods of immobility in tight surroundings (overseas air-travel) are common, and may exacerbate RLS. Unfortunately, many ADSM patients evaluated in sleep disorders centers in the military have comorbid insomnia and other conditions such as radiculopathy, chronic pain, and leg cramps), which can confound the diagnosis. Clinical mimics of RLS can hinder diagnosis, as well as impact the validity of prevalence rates from survey instruments that are based on the classic four symptoms listed above. Hening et al. identified features that can assist in differentiating some of these "mimics" from RLS: symptoms should be persistent (not fleeting), provoked by rest more than position, be compelling/irresistible, and include a complaint of poor sleep that is specifically attributed to the leg symptoms [92]. After sustained periods of deployment where diet may be restricted, the initial evaluation should include testing for iron deficiency (serum ferritin). In addition, ADSMs who are evaluated in military sleep centers may be taking medications that can be used in both the treatment of RLS and chronic pain (such as gabapentin or opiates), as well as medications that can exacerbate RLS symptoms (anti-depressants or dopamine blocking agents). A thorough understanding of a patient's medications, and elimination of any that are unnecessary, is an important part of caring for patients who potentially have RLS. Future research that establishes prevalence rates of valid diagnoses of RLS, in light of the complexity of diagnosis, will help to better define the impact of RLS in the military.

Parasomnias

Parasomnias are abnormal and unintentional activities that occur during incomplete transitions between sleep stages, during the transition from sleep to wake, or during the transition from wake to sleep. They are often described as an oscillation or dissociation between wake and sleep states, or more commonly referred to as a "partial arousal" from sleep [83, 93, 94]. While many unusual events that occur during sleep can technically be called parasomnias, this term is primarily used for abnormal behaviors resulting from partial awakening from either stage N3 slow wave sleep (SWS) or rapid eye movement (REM) sleep. While often difficult to distinguish, there are epidemiologic, clinical, and phenotypic characteristics that can aid in differentiating between non-REM (NREM) SWS parasomnias from REM sleep parasomnias.

The majority of parasomnias occur during SWS. The AASM defines these parasomnias as "incomplete awakenings" from NREM sleep characterized by reduced vigilance, impaired cognition, and variable motor activity. Motor activity can range from minimal, purposeless movements or vocalizations to frankly complex behaviors such as coherent speech, eating, driving, aggressive behavior, and sexual intercourse [95]. The most commonly reported NREM parasomnias are somnambulism (sleep-walking) and somniloquy (sleep-talking). These confusional arousals revolve around the three non-sleep primal drives: fear and anger (night terrors), hunger and thirst (sleep eating and drinking disorders) ,and sex (sexsomnia). During SWS, higher cortical processes are suppressed. Partial arousals from this deep state of sleep can lead to uninhibited manifestations of these primal drives. As such, they can lead to unintended and potentially violent activities during sleep. Somnambulism while deployed, on a military ship, or during field exercises is highly likely to cause danger to the ADSM or to those around him.

Parasomnias are likely under-reported even in the general population, and many may be unrecognized or misdiagnosed. In a population based study, Bjorvatn and colleagues reported that the lifetime prevalence of the different NREM parasomnias varied from 4 to 67 % [96]. Sleep talking was the most commonly reported parasomnia, with a lifetime prevalence of 66.8 %. Sleep walking was also common, with 22.4 % reporting an event at some point in their life. Confusional arousal and night terrors were also common, with a life time prevalence of 18.5 % and 10.4 %, respectively. Sexual acts during sleep (7.1 %) and sleep-related eating (4.5 %) were less commonly reported. Approximately 12 % reported experiencing five or more different parasomnias. In this study, depressed mood was associated with confusional arousals, sleep terrors, and nightmares. In our clinical experience, there has been a marked increase in sleep walking and disruptive nocturnal behaviors, consisting of vocalizations, combative behaviors, and nightmares in ADSMs during OIF/OEF. It is currently unknown if this is solely a manifestation of PTSD nightmares or a complex, trauma engendered parasomnia.

NREM parasomnias are more common in young children and usually resolve prior to adolescence. It is uncommon for primary parasomnias to present initially in adulthood and alternative medical and psychiatric diagnoses should be considered in these cases [97]. Individuals who experienced parasomnias as children may see a re-emergence during adulthood. Several precipitating factors, typically those that cause sleep fragmentation, can lead to the onset or re-emergence of parasomnias in adults. Medications, sleep-disordered breathing, recovery from sleep debt (with associated SWS rebound), and recreational drug or alcohol use may trigger these events in susceptible adults [98, 99]. Recent stress, sleep deprivation, or erratic sleep-wake schedules may also play a role in precipitating or exacerbating an event. For ADSMs, underlying precipitants must be treated to determine whether the parasomnia behavior is sufficiently disabling as to render the patient unfit for continued military service.

REM sleep parasomnias are significantly less common than NREM parasomnias. REM sleep behavior disorder (RBD) occurs in 0.5 % of the population. It is reported significantly more in men (80.8 %), with a mean age of 65.6 years, and is associated with neurodegenerative diseases such as Lewy body dementia, multiple sclerosis, multiple system atrophy, supranuclear palsy, and Parkinson disease. Secondary causes of RBD have been reported, typically occurring as a side effect of selective serotonin reuptake inhibitors (SSRIs), mirtazapine, selegiline, and cholinergic therapy.

There is limited data regarding parasomnias in military personnel and veterans, though a study assessing sleep in 24 OIF/OEF veterans reported that 38 % had either a NREM or REM parasomnia. Four of the participants were diagnosed with secondary RBD in the setting of injurious nocturnal behaviors and REM without atonia on their polysomnogram. All of the patients diagnosed with secondary RBD were taking SSRIs at the time of their diagnosis [100].

Several common clinical features can help differentiate NREM parasomnias from REM sleep parasomnias or other abnormal behaviors and events occurring during sleep. NREM parasomnias most commonly occur during the first three hours of sleep when most SWS occurs. Individuals are classically unaware of or engaged in their surroundings. They are difficult to arouse and are often confused when awakened. Retrograde amnesia is common and patients typically have no recollection or memory of these events. Individuals do not usually recall dreaming prior to their awakening. In contrast to events that emerge from SWS, individuals experiencing REM sleep parasomnias may appear more interactive with their surroundings and are usually easily awakened. They often have awareness of their actions with some memory of the event. Individuals may even realize they were physically acting out their dream and recall what they were dreaming about. Unlike NREM parasomnias, RBD typically occurs in older individuals, and because many dreams are violent in nature, RBD is more likely to result in injury to self or others.

Parasomnias pose a unique challenge to military personnel. In any setting, somnambulism or dream enacting behavior can result in injury to self or others. However, because of the inherently dangerous environments the military operates in, these events have more potential to result in harm. Because of this increased risk, individuals with a history of somnambulism that extends into the teenage years are not permitted to join the military. In addition, those who develop parasomnias while serving may be limited in what duties they are allowed to perform or they may be discharged from active duty. As stated, parasomnias are often precipitated by sleep debt or sleep fragmentation with incomplete arousals. Insufficient sleep and chronic sleep debt are common among ADSMs and sleep environments, especially in an operational setting, are not conducive to high quality, continual sleep. Given this, it would be expected that parasomnias might resurface among ADSMs who are predisposed to them.

Behavioral and environmental modifications are the mainstay of treatment for individuals with both NREM and REM parasomnias. In the general population, reassurance, avoidance of triggers, and promotion of a safe sleep environment provide adequate treatment. Obtaining sufficient sleep and the reduction of sleep debt should be encouraged as these can precipitate SWS events, but this is not always possible in the military. In addition, substances that can lead to sleep fragmentation or impaired cognition such as drugs and alcohol should be avoided. Medical conditions that fragment sleep or cause nocturnal awakenings, such as sleep apnea, GERD, and rhinitis should be treated to promote better sleep continuity. When possible, medications with the potential to cause sleep fragmentation or disruption of normal sleep architecture should be reduced or discontinued. Weapons, or objects that could be used as a weapon, should be removed from the bedroom and pads should be placed on the sharp corners of furniture. Door and bed alarms, locks, and heavy curtains can minimize the risk of patients leaving the bedroom.

When these interventions are insufficient, medical therapy to suppress these events may be necessary. Benzodiazepines, particularly clonazepam, may be effective for both SWS parasomnias and RBD. Melatonin may also be effective. Unfortunately, there is a paucity of high-quality evidence supporting its use. Both sodium oxybate and carbamazepine have been reported to decrease parasomnias, but these agents are not utilized as frequently as clonazepam and they are often unsuitable for ADSMs.

Table 3 Ten effective sleep habits [102•]

1. Create a quiet, dark, comfortable sleeping environment. Cover windows with darkening drapes or shades (dark trash bags work as well), or wear a sleep mask to block light. Minimize disturbance from environmental noises with foam earplugs or use a room fan to muffle noise. If you can, adjust the room temperature to suit you. If you cannot, use extra blankets to stay warm. Use a room fan both to muffle noise and keep you cool.
2. Use the bedroom only for sleep and intimacy. Remove the TV, computer, laptop, and other electronic distractions from your bedroom. Do not eat or drink in bed. Keep discussions or arguments out of the bedroom.
3. Stop caffeine consumption at least 6 hours before bedtime. Caffeine promotes wakefulness and disrupts sleep.
4. Do not drink alcohol before bed. Alcohol initially makes you feel sleepy, but disrupts and lightens your sleep several hours later. In short, alcohol reduces the recuperative value of sleep. Nicotine, and withdrawal from nicotine in the middle of the night, also disrupts sleep. If you need help quitting drinking or using nicotine products, see your healthcare provider for options.
5. Complete your exercise by early evening. Exercising is great, just be sure to finish at least 3 hours before bedtime so that you have plenty of time to wind down.
6. Do not go to bed hungry. A light bedtime snack (e.g., milk and crackers) can be helpful, but do not eat a large meal close to bedtime. And empty your bladder just before you go to bed so that the urge to urinate does not disrupt your sleep.
7. Maintain a consistent, regular routine that starts with a fixed wakeup time. Start by setting a fixed time to wake up, get out of bed, and get exposure to light each day. Pick a time that you can maintain during the week and on weekends, then adjust your bedtime to target 7-8 hours of sleep.
8. Get out of bed if you cannot sleep. Only go to bed (and stay in bed) when you feel sleepy. Do not try to force yourself to fall asleep; it will tend to make you more awake, making the problem worse. If you wake in the middle of the night, give yourself about 20 minutes to return to sleep. If you do not return to sleep within 20 minutes, get out of bed and do something relaxing. Do not return to bed until you feel sleepy.
9. Nap wisely. Napping can be a good way to make up for poor or reduced nighttime sleep, but too much napping can cause problems falling asleep or staying asleep at night. If you need to nap for safety reasons such as driving, try to do so in the late morning or early afternoon, perhaps right after lunch, to take the edge off your sleepiness.
10. Move the clock from your bedside. If you tend to check the clock two or more times during the night, and if you worry that you are not getting enough sleep, cover the clock face or turn it around so that you cannot see it (or remove the clock from the bedroom entirely).

Conclusion

Servicemembers, like most adults, need approximately 8 hours of quality sleep per night to function at optimal levels and maximize operational readiness. There are some who require less sleep, and the military may even select for those who are genetically able to tolerate short sleep duration as early as basic combat training [101]. This creates a dynamic whereby the leader might not appreciate the physiologic requirements of those under their command. This has the potential to devalue the importance of adequate sleep, possibly hampering efforts to improve sleep duration or sleep quality. Some commanders truly do not understand the importance of adequate sleep, and an evidence-based educational program is often required to impart organizational change [102•].

The medical community, however, is increasingly recognizing that sleep disturbances are inextricably linked to psychiatric disorders, particularly PTSD depression and anxiety [103, 104]. Balancing occupational performance and the demand of military missions with ADSM health remains a difficult leadership challenge. It is essential for medical professionals to provide commanders evidence-based guidance pertaining to sleep.

Recent evidence suggests that disordered sleep may precede other PTSD symptom clusters [82, 105, 106]. Sleep architecture in PTSD is disrupted, and abnormalities in both REM and NREM sleep have been described [107, 108•]. Insomnia is a component of depressive and anxiety disorders, but also impacts the course of disease severity [109]. Sleep deprivation has been shown to be a risk factor for major depression in adolescents [110]. Given that approximately 20 % of the military is younger than 21 and over 60 % of the military population is below the age of 30, this becomes a very important consideration. In those with co-morbid sleep problems, PTSD and traumatic brain injury, each disorder worsens quality of life in an additive fashion [62•, 111, 112]. Some patients evaluated in military sleep disorders centers continue to struggle for years after redeployment.

It is well known that severe mental illness impacts the military through lost work days, decreased productivity, impaired social relationships, and even suicide. Given that sleep quality is related to outcomes for patients with mental illnesses, access to medical professionals with specific training in sleep disorders is therefore an integral part of a multi-disciplinary approach to military healthcare. Encouragingly, treatment of insomnia and nightmares has been shown to improve PTSD symptom severity as well as headaches in veterans with mTBI even if neurological deficits remain static [113]. Similarly, treatment of insomnia is known to improve depressive symptoms in those with co-morbid conditions [41].

The importance of sleep as a combat multiplier is increasingly recognized. The United States Army Surgeon General has acknowledged the interplay between inadequate sleep and impairments in other functional areas, and placed specific emphasis on sleep as part of the Performance Triad [57]. Table 3 summarizes some guidance from the Performance Triad Working Group. Efforts to improve soldier resiliency by decreasing physical and psychological sequelae of sleep related disorders will likely result in measurable outcomes; however systematic trials have not yet been conducted. Future research is required to develop evidence based practices to optimize the performance of ADSMs in operational settings as well as treat the complex sleep disorders they have developed after 13 years of war.

Compliance with Ethics Guidelines

Conflict of Interest Scott G. Williams, Jacob Collen, Christopher J. Lettieri, and Vincent Mysliwiec declare that they have no conflict of interest.

Emerson Wickwire is a shareholder in an educational and health care consulting firm. His participation in this review is voluntary and uncompensated.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Disclaimer The views expressed in this article are those of the authors and do not necessarily reflect the official views of the Department of the Army, the Department of Defense, or the United States Government.

References

Papers of particular interest, published recently, have been highlighted as:

- • Of importance

1. U.S. Army. Combat and Operational Stress Control Manual for Leaders and Soldiers. Chapter 4. Headquarters, Department of the Army. FM 6-22.5. Washington, D.C.: Government Printing Office, 18 March 2009.
2. Caldwell JL, Gilreath SR. Work and sleep hours of U.S. Army aviation personnel working reverse cycle. Mil Med. 2001;166(2): 159–66.
3.• Office of the Surgeon General: Mental Health Advisory Team 9 (MHAT 9), Operation Enduring Freedom (OEF), October 2013, 20-23. *This is an official report which looks at a number of variables which contribute to safety and readiness. Sleep disturbances have been highlighted as an area of focus.*
4. Van Dongen HP, Maislin G, Mullington JM, Dinges DF. The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep. 2003;26(2):117–26.
5. Miller NL, Tvaryanas AP, Shattuck LG. Accommodating adolescent sleep-wake patterns: the effects of shifting the timing of sleep on training effectiveness. Sleep. 2012;35(8):1123–36.
6. Miller NL, Shattuck LG. Sleep patterns of young man and women enrolled at the United States Military Academy: results from year 1 of a 4-year longitudinal study. Sleep. 2005;28(7):837–41.
7. Miller NL, Shattuck LG, Matsangas P. Longitudinal study of sleep patterns of United States Military Academy cadets. Sleep. 2010;33(12):1623–31.
8. Seelig AD, Jacobson IG, Smith B, et al. Sleep patterns before, during and after deployment to Iraq and Afghanistan. Sleep. 2010;33(12):1615–22.
9. Peterson AL, Goodie JL, Satterfield WA, Brim WL. Sleep disturbance during military deployment. Mil Med. 2008;173(3):230–5.
10. Luxton DD, Greenburd D, Ryan J, et al. Prevalence and impact of short sleep duration in redeployed OIF Soldiers. Sleep. 2011;34(9):1189–95.
11. Faestel PM, Littell CT, Vitiello MV, et al. Perceived insufficient rest or sleep among veterans: Behavioral Risk Factor Surveillance System 2009. J Clin Sleep Med. 2013;9(6):577–84.
12. Thomas M, Sing H, Belenky G, et al. Neural basis of alertness and cognitive performance impairments during sleepiness. I. Effects of 24h of sleep deprivation on waking human regional brain activity. J Sleep Res. 2000;9(4):335–52.
13. Czeisler CA. The Gordon Wilson Lecture: work hours, sleep and patient safety in residency training. Trans Am Clin Climatol Assoc. 2006;117:159–88.
14. Rupp TL, Wesensten NJ, Bliese PD, Balkin TJ. Banking sleep: realization of benefits during subsequent sleep restriction and recovery. Sleep. 2009;32(3):311–21.
15. American Psychiatric Association. The Diagnostic and Statistical Manual of Mental Disorders: DSM 5. New York, New York. 2013.
16. Drake CL, Roehrs T, Richardson G, Walsh JK, Roth T. Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. Sleep. 2004;27:1453–62.
17. Di Milia L, Waage S, Pallesen S, Bjorvatn B. Shift work disorder in a random population sample–prevalence and comorbidities. PLoS One. 2013;8:e55306.
18. Rajaratnam SM, Barger LK, Lockley SW, et al. Sleep disorders, health, and safety in police officers. JAMA. 2011;306:2567–78.
19. Waage S, Moen BE, Pallesen S, et al. Shift work disorder among oil rig workers in the North Sea. Sleep. 2009;32:558–65.
20. Matheson A, O'Brien L, Reid JA. The impact of shiftwork on health: a literature review. J Clin Nurs. 2014. doi:10.1111/jocn.12524.
21. Wang XS, Armstrong ME, Cairns BJ, Key TJ, Travis RC. Shift work and chronic disease: the epidemiological evidence. Occup Med (Lond). 2011;61:78–89.
22. Roth T. Appropriate therapeutic selection for patients with shift work disorder. Sleep Med. 2012;13:335–41.
23. Ancoli-Israel S, Roth T. Characteristics of insomnia in the United States: results of the 1991 National Sleep Foundation Survey. I. Sleep. 1999;22 Suppl 2:S347–53.
24. Ford DE, Kamerow DB. Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? JAMA. 1989;262:1479–84.
25. Alattar M, Harrington JJ, Mitchell CM, Sloane P. Sleep problems in primary care: a North Carolina Family Practice Research Network (NC-FP-RN) study. J Am Board Fam Med. 2007;20: 365–74.
26. Kushida CA, Nichols DA, Simon RD, et al. Symptom-based prevalence of sleep disorders in an adult primary care population. Sleep Breath. 2000;4:9–14.
27. Lichstein KL. Secondary insomnia: a myth dismissed. Sleep Med Rev. 2006;10(1):3–5.
28. Spielman AJ, Caruso LS, Glovinsky PB. A behavioral perspective on insomnia treatment. Psychiatr Clin North Am. 1987;10:541–53.
29. Lichstein KL, Rosenthal TL. Insomniacs' perceptions of cognitive versus somatic determinants of sleep disturbance. J Abnorm Psychol. 1980;89:105–7.
30. Harvey AG. A cognitive model of insomnia. Behav Res Ther. 2002;40:869–93.
31. Taylor DJ, Lichstein KL, Durrence HH. Insomnia as a health risk factor. Behav Sleep Med. 2003;1:227–47.
32. Taylor DJ, Mallory LJ, Lichstein KL, et al. Comorbidity of chronic insomnia with medical problems. Sleep. 2007;30:213–8.
33. LeBlanc M, Beaulieu-Bonneau S, Merette C, et al. Psychological and health-related quality of life factors associated with insomnia in a population-based sample. J Psychosom Res. 2007;63:157–66.
34. Leger D, Scheuermaier K, Philip P, Paillard M, Guilleminault C. SF-36: evaluation of quality of life in severe and mild insomniacs compared with good sleepers. Psychosom Med. 2001;63:49–55.

35. Sjostrom N, Waern M, Hetta J. Nightmares and sleep disturbances in relation to suicidality in suicide attempters. Sleep. 2007;30:91–5.
36. Armed Forces Health Surveillance Center. Insomnia, Active Component, U.S. Armed Forces, January 2000-December 2009. MSMR 2010; 17:12-15.
37. McLay RN, Klam WP, Volkert SL. Insomnia is the most commonly reported symptom and predicts other symptoms of post-traumatic stress disorder in U.S. service members returning from military deployments. Mil Med. 2010;175:759–62.
38. Gehrman P, Seelig AD, Jacobson IG, et al. Predeployment sleep duration and insomnia symptoms as risk factors for new-onset mental health disorders following military deployment. Sleep. 2013;36:1009–18.
39. Martin SA, Aikens JE, Chervin RD. Toward cost-effectiveness analysis in the diagnosis and treatment of insomnia. Sleep Med Rev. 2004;8:63–72.
40. Stoller MK. Economic effects of insomnia. Clin Ther. 1994;16: 873–97. *discussion 854*.
41. Manber R, Edinger JD, Gress JL, et al. Cognitive behavioral therapy for insomnia enhances depression outcome in patients with comorbid major depressive disorder and insomnia. Sleep. 2008;31:489–95.
42. Talbot LS, Maguen S, Metzler TJ, et al. Cognitive behavioral therapy for insomnia in posttraumatic stress disorder: a randomized controlled trial. Sleep. 2014;37:327–41.
43. Vitiello MV, McCurry SM, Shortreed SM, et al. Cognitive-behavioral treatment for comorbid insomnia and osteoarthritis pain in primary care: the lifestyles randomized controlled trial. J Am Geriatr Soc. 2013;61:947–56.
44. Arnedt JT, Conroy DA, Armitage R, Brower KJ. Cognitive-behavioral therapy for insomnia in alcohol dependent patients: a randomized controlled pilot trial. Behav Res Ther. 2011;49:227–33.
45. McCrae CS, Bramoweth AD, Williams J, Roth A, Mosti C. Impact of brief cognitive behavioral treatment for insomnia on health care utilization and costs. J Clin Sleep Med. 2014;10:127–35.
46. Morin CM, Colecchi C, Stone J, Sood R, Brink D. Behavioral and pharmacological therapies for late-life insomnia: a randomized controlled trial. JAMA. 1999;281:991–99.
47. 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.
48. Sivertsen B, Omvik S, Pallesen S, et al. Cognitive behavioral therapy vs zopiclone for treatment of chronic primary insomnia in older adults: a randomized controlled trial. JAMA. 2006;295: 2851–58.
49. Morin CM, Vallieres 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.
50. Landry SH, Case LD, McCall WV, Dunagan DP, Haponik EF. NIH State-of-the-Science Conference Statement on manifestations and management of chronic insomnia in adults. NIH Consens State Sci Statements. 2005;22:1–30.
51. Schutte-Rodin S, Broch L, Buysse D, Dorsey C, Sateia M. Clinical guideline for the evaluation and management of chronic insomnia in adults. J Clin Sleep Med. 2008;4:487.
52. Epstein DR, Babcock-Parziale JL, Haynes PL, Herb CA. Insomnia treatment acceptability and preferences of male Iraq and Afghanistan combat veterans and their healthcare providers. J Rehabil Res Dev. 2012;49:867–78.
53. Joya FL, Kripke DF, Loving RT, Dawson A, Kline LE. Meta-analyses of hypnotics and infections: eszopiclone, ramelteon, zaleplon, and zolpidem. J Clin Sleep Med. 2009;5:377–83.
54. Farkas RH, Unger EF, Temple R. Zolpidem and driving impairment–identifying persons at risk. N Engl J Med. 2013;369:689–91.
55. Kolla BP, Lovely JK, Mansukhani MP, Morgenthaler TI. Zolpidem is independently associated with increased risk of inpatient falls. J Hosp Med. 2013;8:1–6.
56. Kripke DF, Langer RD, Kline LE. Hypnotics' association with mortality or cancer: a matched cohort study. BMJ Open. 2012;2: e000850.
57.• Office of the Surgeon General. Army Medicine 2020 Campaign Plan. Version 2. March 4, 2013, page 12. *This paper highlights the vision of military medical leadership and describes the role of adequate sleep as a driving force to improve the health of the Army.*
58. Lee W, Nagubadi S, Kryger MH, Mokhlesi B. Epidemiology of Obstructive Sleep Apnea: a Population-based Perspective. Ex Rev Resp Med. 2008;2(3):349–64.
59. Sharafkhaneh A, Richardson P, Hirshkowitz M. Sleep apnea in a high risk population: a study of Veterans Health Administration beneficiaries. Sleep Med. 2004;5(4):345–50.
60. Armed Forces Health Surveillance Center. MSMR 2010; 17.
61. Kennedy K (2010) Sleep Apnea Cases Soar in Past Decade. Army Times
62.• Collen J, Orr N, Lettieri CJ, Carter K, Holley AB. Sleep disturbances among Soldiers with combat-related traumatic brain injury. Chest. 2012;142(3):622–30. *This study looks at the overlap between sleep disorders and traumatic brain injury.*
63.• Mysliwiec V, Gill J, Lee H, et al. Sleep disorders in US military personnel: a high rate of comorbid insomnia and obstructive sleep apnea. Chest. 2013;144(2):549–57. *This study looks at the relationship between insomnia and obstructive sleep apnea amongst ADSM.*
64. Huang QR, Qin Z, Zhang S, Chow CM. Clinical patterns of obstructive sleep apnea and its comorbid conditions: a data mining approach. J Clin Sleep Med. 2008;4(6):543–50.
65. Krakow B, Melendrez D, Pedersen B, et al. Complex insomnia: insomnia and sleep-disordered breathing in a consecutive series of crime victims with nightmares and PTSD. Biol Psychiatry. 2001;49(11):948–53.
66. Castriotta RJ, Wilde MC, Lai JM, et al. Prevalence and consequences of sleep disorders in traumatic brain injury. J Clin Sleep Med. 2007;3(4):349–56.
67. Verma A, Anand V, Verma NP. Sleep disorders in chronic traumatic brain injury. J Clin Sleep Med. 2007;3(4):357–62.
68. Kempf J, Werth E, Kaiser PR, Bassetti CL, Baumann CR. Sleep-wake disturbances 3 years after traumatic brain injury. J Neurol Neurosurg Psychiatry. 2010;81(12):1402–5.
69. Webster JB, Bell KR, Hussey JD, Natale TK, Lakshminarayan S. Sleep apnea in adults with traumatic brain injury: a preliminary investigation. Arch Phys Med Rehabil. 2001;82(3):316–21.
70. Maher MJ, Rego SA, Asnis GM. Sleep disturbances in patients with post-traumatic stress disorder: epidemiology, impact and approaches to management. CNS Drugs. 2006;20(7):567–90.
71. Mellman TA, Kulick-Bell R, Ashlock LE, Nolan B. Sleep events among veterans with combat-related posttraumatic stress disorder. Am J Psychiatry. 1995;152(1):110–5.
72. Kinoshita LM, Yesavage JA, Noda A, et al. Modeling the effects of obstructive sleep apnea and hypertension in Vietnam veterans with PTSD. Sleep Breath. 2012;16(4):1201–9.
73. Krakow B, Lowry C, Germain A, et al. A retrospective study on improvements in nightmares and post-traumatic stress disorder following treatment for co-morbid sleep-disordered breathing. J Psychosom Res. 2000;49(5):291–8.
74. Youakim JM, Doghramji K, Schutte SL. Posttraumatic stress disorder and obstructive sleep apnea syndrome. Psychosomatics. 1998;39(2):168–71.

75. Collen JF, Lettieri CJ, Hoffman M. The impact of posttraumatic stress disorder on CPAP adherence in patients with obstructive sleep apnea. J Clin Sleep Med. 2012;8(6):667–72.
76. El-Solh AA, Ayyar L, Akinnusi M, Relia S, Akinnusi O. Positive airway pressure adherence in veterans with posttraumatic stress disorder. Sleep. 2010;33(11):1495–500.
77. Wickwire EM, Smith MT, Birnbaum S, Collop NA. Sleep maintenance insomnia complaints predict poor CPAP adherence: A clinical case series. Sleep Med. 2010;11(8):772–6.
78. Bucks RS, Olaithe M, Eastwood P. Neurocognitive function in obstructive sleep apnoea: a meta-review. Respirology. 2013;18(1): 61–70.
79. Tippin J, Sparks J, Rizzo M. Visual vigilance in drivers with obstructive sleep apnea. J Psychosom Res. 2009;67(2):143–51.
80. Antic NA, Catcheside P, Buchan C, et al. The effect of CPAP in normalizing daytime sleepiness, quality of life, and neurocognitive function in patients with moderate to severe OSA. Sleep. 2011;34(1):111–9.
81. Vakulin A, Baulk SD, Catcheside PG, et al. Driving simulator performance remains impaired in patients with severe OSA after CPAP treatment. J Clin Sleep Med. 2011;7(3):246–53.
82. van Liempt S. Sleep disturbances and PTSD: a perpetual circle? Eur J Psychotraumatol 2012;3.
83. American Academy of Sleep Medicine. International classification of sleep disorders. 3rd ed. Darien: American Academy of Sleep Medicine; 2014.
84. Marks FA. You're the flight surgeon. Restless legs syndrome. Aviat Space Environ Med. 2006;77(10):1094–5.
85. Mustafa M, Erokwu N, Ebose I, Strohl K. Sleep problems and the risk for sleep disorders in an outpatient veteran population. Sleep Breath. 2005;9(2):57–63.
86. Ohayon MM, Roth T. Prevalence of restless legs syndrome and periodic limb movement disorder in the general population. J Psychosom Res. 2002;53(1):547–54.
87. Allen RP, Stillman P, Myers AJ. Physician-diagnosed restless legs syndrome in a large sample of primary medical care patients in western Europe: Prevalence and characteristics. Sleep Med. 2010;11(1):31–7.
88. Allen RP, Walters AS, Montplaisir J, et al. Restless legs syndrome prevalence and impact: REST general population study. Arch Intern Med. 2005;165(11):1286–92.
89. Patrick LR. Restless legs syndrome: pathophysiology and the role of iron and folate. Altern Med Rev. 2007;12(2):101–12.
90. Silber MH, Becker PM, Earley C, Garcia-Borreguero D, Ondo WG. Willis-Ekbom Disease Foundation revised consensus statement on the management of restless legs syndrome. Mayo Clin Proc. 2013;88(9):977–86.
91. Garcia-Borreguero D, Kohnen R, Silber MH, et al. The long-term treatment of restless legs syndrome/ Willis-Ekbom disease: evidence-based guidelines and clinical consensus best practice guidance: a report from the International Restless Legs Syndrome Study Group. Sleep Med. 2013;14(7):675–84.
92. Hening WA, Allen RP, Washburn M, Lesage SR, Earley CJ. The four diagnostic criteria for Restless Legs Syndrome are unable to exclude confounding conditions ("mimics"). Sleep Med. 2009;10(9):976–81.
93. Oudiette D, Leu S, Pottier M, et al. Dreamlike mentations during sleepwalking and sleep terrors in adults. Sleep. 2009;32(12): 1621–7.
94. Ohayon MM, Priest RG, Zully J, Smirne S. The place of confusional arousals in sleep and mental disorders: findings in a general population sample of 13,057 subjects. J Nerv Ment Dis. 2000;188(6):340–8.
95. Pressman M. Disorders of arousal from sleep and violent behavior: the role of physical contact and proximity. Sleep. 2007;30(8): 1039–47.
96. Bjorvatn B, Grønli J, Pallesen S. Prevalence of different parasomnias in the general population. Sleep Med. 2010;11(10): 1031–4.
97. Mahowald M, Bundlie S, Hurwitz T, Schenck C. Sleep violence—forensic science implications: polygraphic and video documentation. J Forensic Sci. 1990;35(2):413–32.
98. Siclari F, Khatami R, Urbaniok F, et al. Violence in sleep. Brain. 2010;133:3494–509.
99. Provini F, Piazzi G, Tinuper P, et al. Nocturnal frontal lobe epilepsy: A clinical and polygraphic overview of 100 consecutive cases. Brain. 1999;122(6):1017–31.
100. Wallace DM, Shafazand S, Ramos AR et al. Insomnia characteristics and clinical correlates in Operation Enduring Freedom/Operation Iraqi Freedom veterans with post-traumatic stress disorder and mild traumatic brain injury: An exploratory study. Public Health Resources 2011. Paper 200.
101. Crowley SK, Wilkinson LL, Burroughs EL, et al. Sleep during basic combat training: a qualitative study. Mil Med. 2012;177(7): 823–8.
102.• Wesensten NJ, Balkin TJ. The challenge of sleep management in military operations. US Army Med Dep J 2013; Oct-Dec:109-18. *This article discusses the importance and challenges associated with creating an effective sleep health program for the military.*
103. Babson KA, Boden MT, Woodward S, et al. Anxiety sensitivity and sleep quality: independent and interactive predictors of post-traumatic stress disorder symptoms. J Nerv Ment Dis. 2013;201: 48–51.
104. Belleville G, Guay S, Marchand A. Impact of sleep disturbances on PTSD symptoms and perceived health. J Nerv Ment Dis. 2009;197:126–32.
105. Spoormaker VI, Montgomery P. Disturbed sleep in post-traumatic stress disorder: secondary symptom or core feature? Sleep Med Rev. 2008;12:169–84.
106. van Liempt S, van Zuiden M, Westenberg H, et al. Impact of impaired sleep on the development of PTSD symptoms in combat veterans: a prospective longitudinal cohort study. Depress Anxiety. 2013;30:469–74.
107. Ross RJ, Ball WA, Sullivan KA, et al. Sleep disturbance as the hallmark of posttraumatic stress disorder. Am J Psychiatry. 1989;146:697–707.
108.• Germain A. Sleep disturbances as the hallmark of PTSD: where are we now? Am J Psychiatry. 2013;170:372–82. *This is an excellent commentary on the relationship between sleep fragmentation and PTSD.*
109. Ohayon MM, Roth T. Place of chronic insomnia in the course of depressive and anxiety disorders. J Psychiatr Res. 2003;37(1):9–15.
110. Roberts RE, Duong HT. The prospective association between sleep deprivation and depression among adolescents. Sleep. 2014;37(2):239–44.
111. Macera CA, Aralis HJ, Rauh MJ, Macgregor AJ. Do sleep problems mediate the relationship between traumatic brain injury and development of mental health symptoms after deployment? Sleep. 2013;36(1):83–90.
112. Williams SG, Collen J, Orr N et al. Sleep disturbances in combat-related PTSD. Sleep Breath. 2014 Apr 22. [Epub ahead of print].
113. Ruff RL, Riechers RG, Wang XF, et al. For veterans with mild traumatic brain injury, improved posttraumatic stress disorder severity and sleep correlated with symptomatic improvement. J Rehabil Res Dev. 2012;49(9):1305–20.
114. Giam GC. Effects of sleep deprivation with reference to military operations. Ann Acad Med Singapore. 1997;26(1): 88–93.

115. Staff RT. Reserve, brain changes, and decline. Neuroimaging Clin N Am. 2012;22(1):99–105.
116. Van Dongen HP, Price NJ, Mullington JM, et al. Caffeine eliminates psychomotor vigilance deficits from sleep inertia. Sleep. 2001;24(7):813–9.
117. Newman RA, Kamimori GH, Wesensten NJ, et al. Caffeine gum minimizes sleep inertia. Percept Mot Skills. 2013;116(1):280–93.
118. Mackowiak PA, Billings FT, Wasserman SS. Sleepless vigilance: “Stonewall” Jackson and the duty hours controversy. Am J Med Sci. 2012;343(2):146–9.