A Sleep Primer for Military Psychologists

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If you are a psychologist working with the military, there will likely come a time when you must address the issue of sleep. Problems with falling asleep or daytime sleepiness affect approximately 35–40% of the US adult population annually and are a significant cause of morbidity and mortality (Hossain & Shapiro, 2002). To what extent does the US military mirror the civilian prevalence rates? A comprehensive study of sleep in the military conducted by the RAND Corporation sampled 1,851 service members across all branches of the military, excluding only the Navy Reserve (Troxel et al., 2015). The results of this survey indicated that 31.4% of the respondents were in the "extreme short sleeper category" (five or fewer hours of sleep per night). This level of sleep duration has been associated with increased comorbidity with a host of other physiological and psychological maladies (Troxel et al., 2015). In this same study, 48.6% of the respondents scored above the cut score associated with clinically significant sleep problems (i.e., 5 or higher) on the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). With the exception of disturbing dreams of a traumatic or stressful experience, there were no significant differences between deployment status and high and low combat exposure (self-reported) in the RAND sample with respect to the PSQI scores, nor for self-reported hours of sleep per night. This latter finding counters the popular notion that poor sleep is primarily due to the

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stressors of combat, as it is at near epidemic levels across the entire military (Troxel et al., 2015).

Another study of sleep, utilizing data from a large joint-service sample (Seelig et al., 2010), tracked sleep over time (up to 5 years) in three subsamples: a baseline sample that had never deployed (n = 30,190), a sample that submitted a follow-up survey within 2 weeks of returning from deployment (n = 1,771), and a sample that submitted their follow-up survey at least 2 weeks after deployment (n = 9,224). It should be noted that this study failed to describe whether or not the deployment was to an active combat zone or represented regularly scheduled support deployments such as those on-board ships. The average sleep times did not differ between these three samples, respectively (6.56, 6.46, and 6.47 h); however, predeployment symptoms of psychiatric disorders such as post-traumatic stress disorder (PTSD), depression, anxiety, and panic were the strongest predictors of sleep problems in samples that had returned from deployment. This finding is consistent with a diathesis–stress interpretation: preexisting vulnerabilities (i.e., psychiatric conditions) interact with environmental stressors (i.e., deployment) to increase the odds for sleep problems rather than a simple causal model in which deployment alone is the causal factor irrespective of preexisting vulnerabilities. Based on these two studies, it appears that sleep quantity is less than ideal in the military as a whole, regardless of deployment.

Despite the clear need for military mental health providers to be trained in sleep medicine, psychology as a profession has not taken a leading role. The authors are not aware of a documented history of sleep health programs in the US military that actively involve psychologists which precedes the post-9/11 era. Unfortunately, one reason is that graduate programs in psychology provide little or no training to prepare psychologists to assess or treat sleep problems. Results from a survey of 212 American Psychological Association approved clinical psychology programs indicated that just 6% of the programs offered formal coursework in sleep, with 41% of respondents not offering any clinical training in the assessment, diagnosis, or treatment of sleep disorders (Meltzer, Phillips, & Mindell, 2009). While postgraduate training is available for an individual to become certified in behavioral sleep medicine, in 2009, there were only 93 psychologists who had attained this credential by attending one of the nine accredited programs, passing an exam administered by the American Academy of Sleep Medicine, and completing 1,000 h of supervised training (Peachey & Zelman, 2012). The degree to which other psychological disciplines outside the clinical domain (e.g., cognitive, educational, industrial/organizational, neuropsychology) offer formal training related to the assessment, diagnosis, mitigation, and study of sleep is also unclear. Considering the paucity of military psychologists with formal education and training in sleep, this chapter is designed to provide an overview of the different milieus in which psychologists working with military populations might encounter sleep issues in their patients.

Overview of Sleep Regulation

Despite the limited scope of this chapter, it is nevertheless important for psychologists working with the military to have a basic understanding of key physiological processes that control the sleep/wake cycle in humans. Multiple subcortical brain areas are involved in the generation of sleep and wakefulness states. Complex and coordinated patterns of activity within and between these brain areas are under the control of two distinct biological processes, called the two-process model of sleep regulation, and regulate the many aspects of sleep including its timing, duration, stages, and quality (Borbély, 1982; Harrington & Lee-Chiong, 2012; Saper, Scammell, & Lu, 2005). One of these biological processes, called sleep homeostasis, is a drive for sleep that increases with time awake and dissipates with time asleep. An individual will normally feel tired and struggle to stay awake when the buildup of homeostatic sleep drive reaches high enough levels, such as on a typical day after 16 or more hours spent awake or even sooner if prior sleep was insufficient. Greater homeostatic sleep drive is reflected by slowed brain activity, and can therefore be measured by the levels of synchronized and slow-frequency activity present in cortical electroencephalography (EEG) signals. The other process in the two-process model of sleep regulation is the circadian rhythm, which is the endogenously driven ~24-hour biological clock that synchronizes the timing of sleep and wakefulness (and associated physiology and behavior) to occur with regular changes in our environment. Various hormones (most notably melatonin) and core body temperature are direct physiological outputs of the circadian clock and can be measured to indicate internal timing. Thus, though these two processes are physiologically distinct, when aligned the processes interact to promote consolidated periods of sleep during darkness at night and wakefulness during the day (see Fig. 15.1).

As displayed in Fig. 15.1, the propensity to sleep at a given time is regulated by the interaction of two physiological processes, the homeostatic sleep drive and the circadian rhythm. The homeostatic sleep drive reflects the amount of time an individual has been awake, with the propensity (or drive) to sleep increasing with accumulated time spent awake. Once homeostatic sleep drive reaches high enough levels (e.g., typically after being awake for 16 or more hours, depicted at 22:00), sleep is more easily initiated. Sleep then dissipates the homeostatic sleep drive to lower baseline levels by the beginning of the following day (e.g., after 8 or more hours of sleep, depicted at 06:00). Homeostatic sleep drive will remain high and not be fully dissipated when an individual is awake for extended durations and/or when sleep is insufficient (which affects daytime alertness). The circadian rhythm is an endogenously driven near-24-hour rhythm that regulates internal timing of various biological processes and cycles, such as hormone release and core body temperature. Sleep and wakefulness have higher propensities at certain times within the circadian rhythm; sleep is promoted during the "biological nighttime" which normally occurs during environmental nighttime, when melatonin is secreted and core body temperature is lowest. Sleep is best achieved when

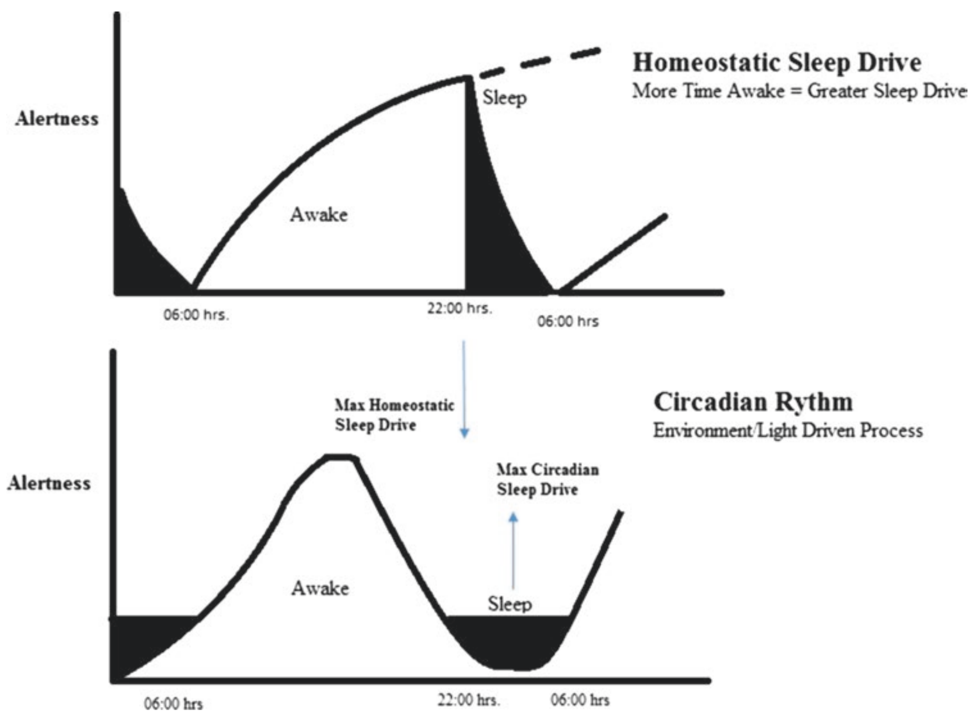

Fig. 15.1 The two-process model of sleep regulation

the two processes are aligned to promote sleep at the same time, as in Fig. 15.1. The regulation of the two processes can also be affected by various stimuli, such as light exposure; however, effects will depend on the stimulus type, timing, intensity, and duration.

A number of factors can impact the homeostatic and circadian processes and consequently affect regulation of sleep patterns. As mentioned above, environmental light has the largest effect on circadian rhythm timing, and light exposures timed very early or very late will input into the circadian clock, causing circadian timing to shift and become out of sync with one's environment and habitual sleep pattern (Khalsa, Jewett, Cajochen, & Czeisler, 2003; Wright, Bogan, & Wyatt, 2013). This is termed circadian misalignment, and it disrupts sleep regulation. A simple example of this is demonstrated by jet lag, where there is a mismatch in internal circadian timing of sleep promotion with the environmental light/dark pattern in the new time zone. Initially, this causes difficulty sleeping; however, with each successive day of light exposure in the new environment, the circadian clock uses the light input to adjust internal circadian timing to match that of the new environment and subsequently improve sleep regulation. Also, napping and irregular sleep and wake times associated with shift work can disrupt both sleep homeostasis and the circadian clock (Wright et al., 2013).

Although the exact function(s) of sleep is debated in the field, sleep is known to play a vital role in a number of physiological and psychological domains that have implications for health, behavior, and performance. The functional roles of sleep are often exposed after examining how disrupted sleep patterns affect one or more such domains. Findings from experimental and epidemiological studies have shown that acute or chronic sleep loss causes impairments in domains such as learning and memory (Stickgold & Walker, 2007), neurobehavioral performance (Banks & Dinges, 2007), emotion regulation (Gruber & Cassoff, 2014), quality of life (Taylor, Bramoweth, Grieser, Tatum, & Roane, 2013), energy metabolism (Knutson, Spiegel, Penev, & Van Cauter, 2007), and immune function (Opp & Krueger, 2015). Thus, healthy sleep is necessary to maintaining optimal health and functioning and will be discussed later in the chapter.

Sleep Assessment and Stages

Sleep is a state that is generated by the brain, and thus a technique that records the electrical activity from the brain provides the most direct assessment of sleep. The gold standard in sleep research and clinical practice is a technique termed polysomnography (PSG), which incorporates brain and muscle electrical activity signals from electrodes placed on the scalp and face, in order to determine sleep and sleep stages. For suspected sleep disorders such as sleep apnea, narcolepsy, and periodic limb movement disorder, additional diagnostic sensors are placed on the body (e.g., to measure respiration, limb movements, oxygen saturation levels (Kushida et al., 2005)). Clinical practice guidelines, however, dictate that PSG is not necessary for the diagnosis of other sleep disorders such as insomnia, nightmares, and restless legs syndrome which can be reliably diagnosed through clinical interviews.

In clinical situations where PSG is not indicated, however, objective information on sleep summary outcomes and overall sleep patterns is helpful, and a technique termed actigraphy is often used. Actigraphy consists of a device worn on the wrist that contains a triaxial accelerometer which provides behavioral information on inactivity/activity patterns derived from body movements (Sadeh, 2011). This technique is capable of multiple night recordings and requires less technical expertise than PSG. Although not capable of discerning sleep stages, the actigraph can provide important information on sleep timing and light exposure (in some models), and provides reliable estimates of sleep summary endpoints (e.g. onset and offset of rest periods (including naps), total sleep time, sleep onset latency, and sleep efficiency). This information can be used to support psychologists and physicians in the diagnosis of insomnia and circadian rhythm sleep disorders. Actigraphy is also a reliable way to provide an objective measure of adherence to treatment recommendations.

Sleep is categorized into stages of nonrapid eye movement (NREM) sleep and rapid eye movement (REM) sleep (Harrington & Lee-Chiong, 2012). NREM sleep is further subdivided into three stages, based on the aspects of the EEG signal in the PSG that reflect the level of slowed and synchronized brain activity: N1 (transitional/light sleep), and N3 (deep sleep). N2 (loss of conscious awareness, short bursts of brain activity, sleep spindles and K-complex EEG signals). REM sleep is a state of relatively active brain activity when vivid dreams occur and is also determined by certain aspects of the PSG signals. Several ~90 min cycles of alternating NREM and REM stages occur during a typical overnight sleep episode; however, the composition of stages is not the same in all sleep cycles. Cycles toward the beginning of the night contain more N3 (deep) sleep while cycles toward the end of the night contain more REM sleep. The different sleep stages are generated through activity changes in distinct and complex neural networks. All sleep stages generally serve important restoration and recovery functions for the brain and body, and individual stages likely play distinct roles to aid in those functions such as memory consolidation (Stickgold & Walker, 2007). Although there may be individual differences based on age, sex, medications, and health status, the average percentage of time spent in each sleep stage over a typical overnight sleep episode is termed sleep architecture, and for a healthy, nonmedicated adult, it is as follows: N1 (5%), N2 (45%), N3 (25%), and REM (25%) (Harrington & Lee-Chiong, 2012). Large and sudden unexplainable changes in sleep stage architecture may reflect an underlying sleep, medical, or psychiatric disorder.

Sleep Impacts on Physiological and Mental Health

This section reviews research that has consistently found that inadequate duration and/or disrupted sleep (poor sleep quality) has adverse effects on our physical and mental health. This is relevant to psychologists who practice within and provide care for the military community where sleep cannot always be prioritized and sleep disruption is often a consequence of operational engagement.

Physiological Health

The American Academy of Sleep Medicine and Sleep Research Society recently published a consensus report recommending that adults obtain 7–9 h of sleep per night (Watson et al., 2015). Sleep durations below the recommended amount, and/or poor sleep quality, have been associated with a range of negative health consequences. Inadequate sleep is linked to metabolic disruption. For instance, in epidemiological studies, shorter durations (below the recommended amount) are consistently shown to be associated with an increased risk of obesity and diabetes when compared to sleep durations within the recommended range (Patel & Hu, 2008; Tobaldini et al., 2017). These well-described associations are supported with laboratory findings from controlled experiments showing continuous days of short sleep resulting in dysregulated food intake (Brondel, Romer, Nougues, Touyarou, & Davenne, 2010; Calvin et al., 2013; Markwald et al., 2013; Nedeltcheva et al., 2009), weight gain (Markwald et al., 2013), and insulin resistance (Buxton et al., 2010; Rao et al., 2015; Spiegel, Leproult, & Van Cauter, 1999).

Sleep is important to cardiovascular health. Sleep disturbances, such as sleep apnea and insomnia, are consistently associated with an increased risk of heart failure and coronary artery disease (Gottlieb et al., 2010; Sofi et al., 2014). In a meta-analysis that examined the relationship between sleep duration and morbidity and mortality from coronary artery disease, stroke, and total cardiovascular disease, it was found that short sleep duration (independent of sleep disturbances) is a predictor of cardiovascular outcomes (Cappuccio, Cooper, D'Elia, Strazzullo, & Miller, 2011).

Sleep is involved in the health and reactivity of the immune system. Disrupted sleep increases levels of proinflammatory cytokines, increases cortisol levels in the evening before bed, and increases susceptibility to the common cold. In separate studies, people were administered nasal drops containing a rhinovirus and were then monitored for the presence of illness. In both cases, those sleeping below the recommended quantity were 3–4.5 times more likely to develop the cold, even after controlling for other mediating factors (Cohen, Doyle, Alper, Janicki-Deverts, & Turner, 2009; Prather, Janicki-Deverts, Hall, & Cohen, 2015). Clearly, insufficient sleep is a stressor to the body, exacerbating pathways that have negative effects on our physiological health.

Mental Health and Well-being

Sleep disorders encompass a wide variety of issues including dyssomnias (such as insomnia), parasomnias (such as sleepwalking), and sleep disorders comorbid with mental health conditions, physical conditions, and substance-induced conditions (American Psychiatric Association, 2013). One of the more comprehensive studies to date regarding the various sleep disorders encountered in military medicine examined the medical records of 725 active duty service members who were seen in a military medical treatment facility for diagnostic polysomnography after referral from primary care or behavioral health specialists (Mysliwiec et al., 2013). The most commonly occurring sleep disorders, in order of prevalence, were: mild obstructive sleep apnea (OSA; 27.2%), insomnia (24.7%), moderate-to-severe OSA (24%), behaviorally induced insufficient sleep syndrome (8.9%), snoring (5.3%), and paradoxical insomnia (5.1%). The most relevant psychological comorbidities in this sample were depression (22.6%), anxiety (16.8%), PTSD (13.2%), and mild traumatic brain injury (12.8%). With respect to PTSD, some studies have noted that 70–91% of patients diagnosed with PTSD subjectively report sleep disturbances (Maher, Rego, & Asnis, 2006).

Sleep disturbances are associated with depression, as well. Multiple studies have found that insomnia at baseline predicts depression risk 1–3 years later (Riemann & Voderholzer, 2003). Importantly, sleep issues can similarly be a consequence of depression (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010) and should be considered an indicator of depression. Anxiety is similarly associated with sleep disturbances. One study reported that an anxiety disorder preceded insomnia in 73% of the cases (Johnson, Roth, & Breslau, 2006). In the general public, sleep disturbances are commonly reported in individuals with post-traumatic stress disorder (PTSD) (Lamarche & De Koninck, 2007). In military contexts, service members who endorse symptoms of PTSD, depression, or anxiety are more likely to have sleep difficulties (Plumb, Peachey, & Zelman, 2014). Although they are best managed as comorbid, rather than "secondary" syndromes, sleep problems are a symptom of anxiety, PTSD, and depression (American Psychiatric Association, 2013).

Several research studies have demonstrated that sleep disruption is associated with mood state. For instance, greater positive affect has been associated with higher quality sleep (Steptoe, Dockray, & Wardle, 2009). Further, the trait of positive affect has been associated with better sleep (morning rest and overall quality), but greater variations in positive affect (reactivity) are detrimental to sleep (Ong et al., 2013). Among military personnel, poor sleepers are 23 times more likely to have scored in the lowest quartile for emotional health, as measured by the Army's Global Assessment Tool (Lentino, Purvis, Murphy, & Deuster, 2013) compared to healthy sleepers. Poor sleepers were also more likely than their healthy sleep counterparts to have scored in the lowest quartile for family and social health (Lentino et al., 2013). In another study, the relationship between deployment status and reported sleep issues were in part mediated by mental health symptoms (Seelig et al., 2010) calling attention to the importance of monitoring both behavioral health and sleep within the context of deployment. Collectively, these study findings may have implications for mental health treatment of service members, as sleep complaints may be both an antecedent and a consequence of other psychosocial concerns and may also be military-relevant, making them, therefore, a high-value target for intervention.

Psychological Treatment of Insomnia

Pruiksma et al. (2016) studied PTSD symptom prevalence before and after mental health treatment for 108 active duty US Army veterans of Iraq and Afghanistan. Of that sample, 92% reported insomnia at the beginning of treatment, and 74–80% reported insomnia after treatment, making insomnia the most frequently reported PTSD symptom both before and after treatment in that study population. Insomnia, especially as it relates to treatment for PTSD, is quite persistent and may require specialized interventions above and beyond general psychotherapy and psychopharmacological intervention.

There are several treatment options for disrupted sleep such as insomnia. Although pharmaceuticals may be indicated for short-term use, nonpharmacological interventions, namely, cognitive behavioral therapy for insomnia (CBT-I), are now recommended as the first-line treatment (Qaseem, Kansagara, Forciea, Cooke, & Denberg, 2016). CBT-I incorporates a structured program with several individual components that assist with identifying and replacing thoughts and behaviors that cause or worsen sleep problems with habits that promote sound sleep. The behavioral intervention aspect of CBT-I alone, including components of sleep restriction and stimulus control therapies, has been shown to be effective in addressing insomnia (Troxel, Germain, & Buysse, 2012). Although few military psychologists may have had graduate-level training in behavioral sleep medicine, the dissemination of these behavioral therapies for insomnia to nonsleep specialists is feasible (Koffel & Farrell-Carnahan, 2014; Manber et al., 2012). In terms of the expansion of clinical treatment modalities, stepped care approaches seem to show promise in terms of both effectiveness and compatibility with primary care settings, where most military members and veterans initially seek care for sleep concerns (Germain et al., 2014). With the publication of the RAND report on sleep in the military (Troxel et al., 2015) and the increasing number of studies demonstrating a link between sleep and psychopathology such as PTSD, there is reason to believe that psychologists will begin to play a greater role in identifying sleep disorders and elevate the level of care when necessary.

An approach to understanding and treating insomnia developed within psychology is based on Harvey's cognitive model of insomnia (Harvey, 2002), which postulates that insomnia is the result of cognitive beliefs and safety-seeking behaviors. In this model, beliefs and behaviors generate excessive negative cognitions that engender physiological arousal and cognitive distress that in turn lead to selective attention and monitoring of confirmatory sensory input, and ultimately a distorted perception of sleep deficits. At least two of these cognitive processes are reciprocal in that both selective attention/monitoring and distorted perceptions of sleep debt reinforce excessive negative cognitions and safety behaviors. The end result of this process is an increase in psychological and physiological reactivity, which prevents individuals from falling or staying asleep, leading to serious sleep deficits. Harvey's cognitive model for the maintenance of insomnia has influenced cognitive behavioral therapy for insomnia (CBT-I) which has been widely disseminated by the Veterans Administration (Manber et al., 2012). A thorough review of psychometric assessments to support the evaluation of the various cognitive processes in Harvey's model, as well as a review of the evidence which supports this model, was provided by Hiller, Johnston, Dohnt, Lovato, and Gradisar (2015). Some initial pilot studies regarding the use of CBT-I in the treatment of sleep problems for patients diagnosed with PTSD indicate subjective increases in sleep time and reductions in sleep latency and time awake after sleep onset, but a failure to replicate those findings in the same sample when measured with actigraphy (Gellis & Gehrman, 2011).

Sleep Problems and Deployment to Iraq and Afghanistan

Despite the prevalence of sleep problems in the military as a whole, there is abundant evidence that deployments to Iraq (OIF) or Afghanistan (OEF) exacerbate the situation. According to Peterson, Goodie, Satterfield, and Brim (2008), 74% of deployed military personnel in Afghanistan rated their quality of sleep as significantly worse during deployment than at home. A survey of Navy Sailors serving on the ground in OEF reported that 56% of service members were considered to be sleep-deficient (Taylor et al., 2014). Plumb et al. (2014) studied the self-reported sleep and mental health outcomes of 375 service members who had previously deployed to OIF/OEF. They found that 21.4% of the sample slept less than 4.5 h a night, and 89% scored higher than 5 on the PSQI, indicative of clinically significant sleep problems. Interestingly, combat exposure, while initially predictive of sleep problems, was no longer predictive of PSQI scores after self-reported depression and PTSD were added to a hierarchical regression model, suggesting again that combat exposure in and of itself is not sufficient to cause sleep problems, but that disrupted sleep likely requires, at the least, the combined experience of combat trauma and psychological health problems. A study of 245 OIF/OEF veterans receiving treatment from the VA reported that difficulty in initiating and maintaining sleep increased with the severity of other nonsleep PTSD symptoms, and that nightmares in particular were worse in those with loss of consciousness following a head injury, depression, and alcohol abuse/dependence (Gellis, Gehrman, Mavandadi, & Oslin, 2010). Another study investigating sleep post deployment reported that 41% of the veterans surveyed from OEF and OIF complained of sleep difficulty (McLay, Klam, & Volkert, 2010). Furthermore, Amin, Parisi, Gold, and Gold (2010) found that 64% of OEF and OIF veterans reported that they suffered from insomnia. The high prevalence of sleep problems in military deployment and operational contexts and the role of sleep disturbances (or alternatively, consolidated sleep in psychological and physical health) in many psychiatric disorders make sleep an increasingly important topic within the contexts of military behavioral health.

The 3P (i.e., predisposing, precipitating, perpetuating) model of sleep disorders provides (Fig. 15.2) a compelling approach to conceptualizing the impact of deployment on sleep problems. Adapted to describe post-deployment sleep problems associated with military deployments, the model acknowledges the role of predisposing factors such as adverse childhood experiences, pre-deployment shift work, genetic susceptibility to sleep problems, and circadian disrupting training that places service members at risk for acute sleep problems when exposed to precipitating events such as combat, family and social separation, shift work and irregular schedules, and jet lag (Bramoweth & Germain, 2013; Troxel et al., 2015). Third, perpetuating factors such as the use of alcohol to self-medicate for sleep, hypervigilance to threat, and social reintegration challenges work to turn acute sleep problems into chronic sleep problems which are the root cause of overall poor health and work performance outcomes after deployment.

Sleep in Operational Military Contexts

Sleep and Performance

The collective findings from a series of research studies examining the role of sleep in cognitive performance have provided compelling evidence that insufficient sleep produces degradations in performance that may have serious health and safety consequences. For example, under controlled laboratory conditions (either acute sleep deprivation or reduced sleep duration), sleep loss results in degraded neurobehavioral performance (e.g., attentional stability and response times), poorer judgment, ineffective learning, impaired memory, limited task-shifting ability, and compromised situational awareness (Balkin, Rupp, Picchioni, & Wesensten, 2008; Killgore, 2010; Lim & Dinges, 2010). These impairments can

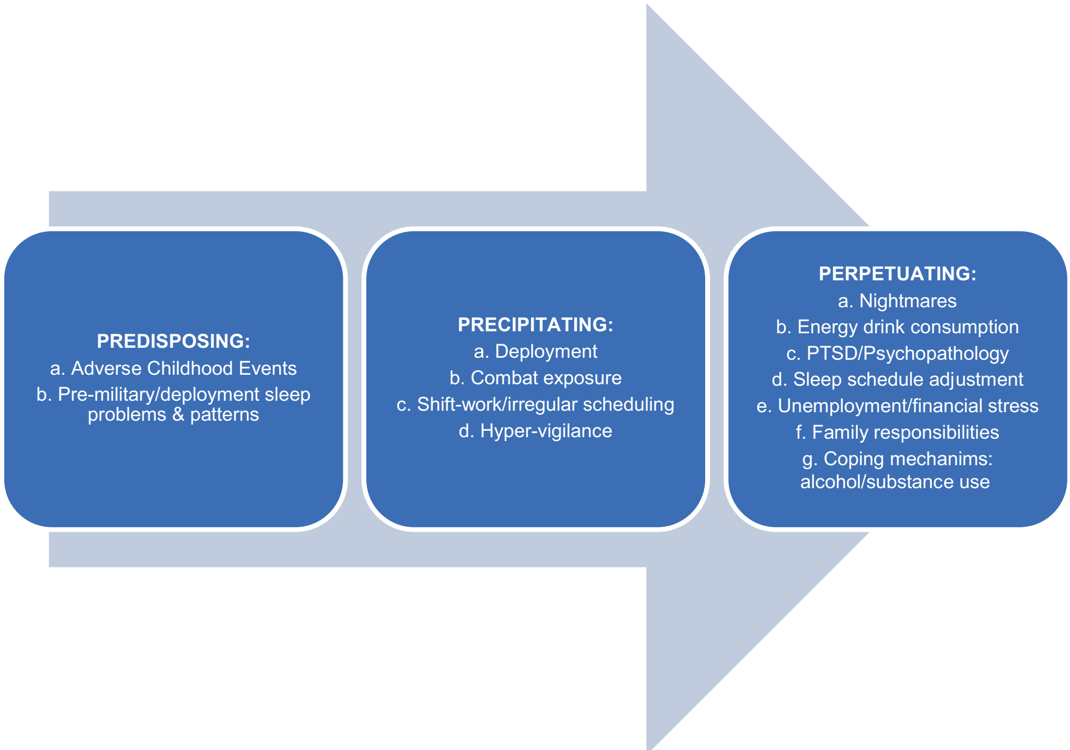

Fig. 15.2 The 3P model of insomnia for combat-exposed military personnel proposed by Bramoweth and Germain (2013)

span a number of higher order functions, for example, response latency to moral personal dilemmas during sleep deprivation is lengthened (Killgore et al., 2007). The importance of these findings becomes apparent when considering the number of military jobs that require vigilance, such as, pilots, air traffic controllers, convoy drivers, and security details. Further, data from the Naval Safety Center identifies fatigue from sleep loss as the Number 2 human factor responsible for accidents/mishaps in Naval Aviation (Naval Safety Center, 2008). These implications are not limited to job-related tasks but have consequences for the general population, such as drowsy driving which is implicated as a primary factor in approximately 83,000 on-the-road motor vehicle accidents per year in the United States (National Highway Traffic Safety Administration, 2011). One way to conceptualize the magnitude of cognitive performance impairment during sleep loss is to compare with alcohol intoxication. Several studies have found cognitive and motor performance impairments during total sleep deprivation that were equivalent to the impairments associated with legally significant levels of alcohol consumption. For example, staying awake beyond 16 continuous hours results in neurocognitive deficits equivalent to .05–.10 blood alcohol concentrations (Dawson & Reid, 1997; Horne, Reyner, & Barrett, 2003; Williamson & Feyer, 2000).

Sleep loss is also associated with reduced workplace productivity. In a study examining the impact of insomnia on absenteeism, it was found that insomnia resulted in increased absenteeism from work which was likely mediated through increased susceptibility to illness such as the common cold (Daley, Morin, LeBlanc, Gregoire, & Savard, 2009). Yet another study reported that sleep quality is linked to job satisfaction, which in turn increases prosocial work behaviors (Barnes, Ghumman, & Scott, 2013). Other

Key Psycho-educational Points about Sleep and Operational Military Performance

- Fatigue is a physiological problem that cannot be overcome by motivation, training, or willpower
- People cannot reliably self-judge their own level of fatigue-related impairment.
- There are wide individual differences in fatigue susceptibility that must be taken into account but which presently cannot be reliably predicted.
- There is no one-size-fits-all "magic bullet" (other than adequate sleep) that can counter fatigue for every person in every situation.
- Valid counter-fatigue strategies will enhance safety and productivity, but only when they are correctly applied

Fig. 15.3 Educational points recommended by the Aerospace Medical Association (adapted from Caldwell et al., 2009)

research related to leaders found greater weekend to weeknight change in sleep duration resulted in lower performance ratings from peers, but not supervisors (Gaultney, 2014).

Aviation Operations

Continuous operations (CONOPS) and sustained operations (SUSOPS) within the realm of military aviation demand high levels of human performance for success. Fatigue is a challenge to high performance, and sleep disruption is one of the several contributors to fatigue. Fatigue is especially relevant in light of CONOPS and SUSOPS, due to related performance and safety decrements and possible adverse outcomes in terms of mishaps (Caldwell, Chandler, & Hartzler, 2012). Even among healthy professional aviators, individual reaction to sleep deprivation varies widely on measures of both flight simulator performance and subjective fatigue rating (Van Dongen, Caldwell, & Caldwell, 2006). Thus, one-size-fits-all mission planning and work/rest scheduling may underestimate or overestimate an individual's true vulnerability to sleep deprivation. Within the unmanned systems community, sustained operations in a shift work environment may leave service members vulnerable to shift work sleep disorder. Rapid shift rotation, in particular, is associated with higher levels of reported fatigue than slower rotation, which may be attributable to chronic partial sleep deprivation (Thompson et al., 2006). Stimulant use by fighter aircrew during combat operations has demonstrated improved perception of alertness and decreased subjective postflight fatigue (Gore, Webb, & Hermes, 2010). Potential behavioral and environmental interventions could include the incorporation of actigraphy into flight scheduling, as it provides an objective measure of sleep time and patterns. With this quantitative data, highly personalized recommendations for sleep adjustment may be made by flight medicine personnel (Rabinowitz, Breitbach, & Warner, 2009). Readers interested in a detailed review of fatigue countermeasures for aviation are encouraged to read the comprehensive, multidisciplinary position paper on the topic prepared for the Aerospace Medical Association by Caldwell et al. (2009). The five central educational points promulgated in that paper are particularly relevant to military psychologists working in aviation as well as other operational platforms (Fig. 15.3).

Maritime Operations

The work environment of underway water operations is by necessity a 24-hour a day operation requiring constant vigilance to monitor propulsion systems, navigation, command and control, security, culinary services, and medical support. However, by necessity, the ship's company is limited with respect to the number of Sailors and Marines who can occupy limited ship's berthing; therefore, shift work is an unavoidable reality (Cordle & Shattuck, 2013). Shift work that is not aligned with the day/night, wake/sleep cycle is a well-known threat to psychological and physical health, often resulting in loss of sleep homeostasis—a pathological condition which can be diagnosed as shift work disorder (SWD) under the *International Classification of Sleep Disorders—2nd edition* (Wright et al., 2013). Some reports indicate that on an annual basis, a ship may lose up to 5% of her crew to stress-related issues, a situation often attributed to or made worse by sleep loss (Cordle & Shattuck, 2013).

Despite the elevated risk for SWD and other sleep-related problems aboard military ships, there is a surprising paucity of literature in this domain with respect to the US Navy, a situation that possibly reflects a cultural belief that "sleep is a luxury" (Cordle & Shattuck, 2013). This situation is starting to change as a result of operations research conducted by the Naval Postgraduate School in which underway operations are evaluated using a combination of self-reports (e.g., PSQI, the Epworth Sleepiness Scale (ESS); Johns, 1991) and objective sleep measures (wrist-worn actigraphy) to evaluate the impact of various shift work configurations on cognitive performance indices (i.e., psychomotor vigilance task; PVT). For example, Shattuck, Matsangas, and Powley (2015) investigated the utility of the ESS to identify disrupted sleep aboard a US Navy Arleigh Burke-class destroyer. They found that ESS scores could be used to identify poor sleep health as well as deteriorations in cognitive performance. In this sample, the average PSQI global score indicated the average Sailor was above the threshold of 5 for clinically significant sleep problems, with just 8% scoring in the range of what could be considered "good sleepers", i.e., PSQI score < 5. The average duration of sleep was 6.72 h and ranged from 4.9 to 8.78 h. Sailors with high ESS scores demonstrated significantly poorer performance on several PVT parameters. A second study conducted aboard the USS Nimitz (aircraft carrier) evaluated the sleep health of 110 nuclear reactor crew, 9 medical department crew, and 12 supply crew (Shattuck et al., 2015). The percentage of the reactor crew with PSQI scores indicative of "poor sleepers" was above 91%, with 78% of the medical crew and 100% of the supply department scoring in that category. The primary reasons cited by the reactor crew (the focus of the study) for poor sleep was inadequate opportunity to sleep (88%), noise (77%), and temperature (56%). A variety of shift schedules were evaluated with respect to their impact on PVT, in particular the common 5/10 schedule in which Sailors are on-duty for 5 h, followed by 10 h off (-15-hour day). The 5/10 schedule results in rotating periods of scheduled sleep and wake that occur at different clock hours throughout the day–night cycle over a 72-hour period. The rotating shifts result in desynchrony between the sleep homeostatic drive and the internal circadian clock, and are highlighted by periods of sustained wakefulness at the ends of the schedule of between 20 and 22 h. The results indicated significantly poorer PVT performance for the 5/10 schedule compared to a schedule that aligned better with the natural 24-hour day and also provided the opportunity for the recommended sleep duration of 6/6 (6 h on, 18 h off) and 3/9 (3 h on, 9 h off). An issue raised in this study is the need to create schedules that protect sleep from the demands of other duties and needs for personal time, which further exacerbate poor sleep. From an organizational standpoint, the 5/10 shift schedule was associated with low psychological resilience, organizational commitment, and concerns about safety. The implication from these two studies is that military psychologists working with Sailors assigned to sea duty should strongly consider the role of sleep in evaluating clinical mental health as well as with regard to the role of various shift configurations, especially the 5/10 schedule, with respect to operational performance and mishap investigation.

It should be noted that the US Coast Guard developed a crew endurance management guide for operational leaders, which directly addresses topics such as sleep management, napping, circadian rhythms, and shift work (Comperatore & Rivera, 2003). However, there does not appear to be an extensive literature regarding sleep shipboard operations for the US Coast Guard shipboard operations.

Ground Operations

Psychologists serving in ground-based military operational contexts can provide direct recommendations to the commands they support by linking the benefits of sleep countermeasures to improved quality and quantity of sleep and enhanced operational performance. Sleep deprivation countermeasures involve: (a) the effective use of sleep banking, recovery sleep, (b) napping, and (c) tactical caffeine application, and are reviewed next.

To start, sleep banking or sleep extension (Mah, Mah, Kezirian, & Dement, 2011) is an often overlooked strategy for managing episodes of sleep deprivation in healthy, nonpsychotic individuals. Sleep banking involves obtaining more hours of sleep by spending more time in bed creating a metaphorical cognitive reserve. Allowing more time in bed benefits cognitive performance, alertness, accuracy, and vigilance (Mah et al., 2011), and speeds recovery from sleep restriction (Rupp, Wesensten, Bliese, & Balkin, 2009). Thus, it may be possible that service members can prepare for known episodes of sleep restriction by sleep banking. A similar approach was seen in a research study where adolescents' time in bed was incrementally increased by going to bed 5 min earlier each night (Dewald-Kaufmann, Oort, & Meijer, 2013). Two unresolved issues for sleep banking should be noted: first, how far in advance can one sleep bank? Second, when do the benefits of sleep banking expire?

Recovery sleep goes hand in hand with sleep restriction or sleep deprivation as this activity is necessary for the recovery of baseline cognitive functioning. It is important to differentiate between chronic sleep deprivation and acute sleep deprivation. Chronic sleep deprivation could be broadly described as getting less than needed core sleep for a week or longer. Acute sleep deprivation is likely to occur when service members are required to stay awake for 24-hour duty or mission outside of 09:00–17:00 duty hours. Recovery from acute sleep deprivation in terms of sleepiness tends to occur with recovery sleep, but full recovery in terms of cognitive performance was not evident with 8 h of sleep every night for 1 week (Pejovic et al., 2013). The brain appears to adapt and stabilize at lower levels of performance to cope with chronic sleep restriction (3 or 5 h of time in bed a night) but does not return to baseline functioning with 3 days of recovery sleep of 8 h' time in bed (Belenky, 1997). To fully recover, Belenky (1997) hypothesized that the brain likely needs sleep duration in excess of core sleep needed to produce higher levels of alertness and performance.

Napping should be used cautiously as it can interfere with a person's ability to sleep at night. The amount of time that should be dedicated to napping varies considerably according to task, job, environment, and an individual's ability to fall asleep. The National Sleep Foundation (2017) proposes three types of naps: planned naps, emergency naps, and habitual naps. Planned naps are taken in advance of becoming sleepy or when one will experience a time of sleep restriction. Emergency naps are taken when one is extremely tired and cannot continue to perform a task. This type of nap may be used when one becomes drowsy in high-risk activities such as driving or operating dangerous equipment or machinery. Habitual naps are routinely taken daily at the same time. Habitual naps may be considered "appetitive" naps (Cote, 2015), taken simply because it feels good.

The length of a nap must be based on the type of nap, work to accomplish, and the setting in which service members find themselves (Brooks & Lack, 2006). When nap lengths were compared to determine optimal length, 5-min naps produced very little benefits; 10-min naps were effective in improving sleep latency, sleepiness, fatigues, vigor, alertness, and cognitive performance (Brooks & Lack, 2006). These improvements lasted up to 155 min. Naps of 20 and 30 min were also effective, though increasing the length of the nap resulted in sleep inertia, as evident in 30-min naps. Horne and

Reyner (1996) advocate the use of 15-min naps, and also note the effectiveness of such naps persists for about 2-h.

The use of caffeine has positive effects on alertness, vigilance, and performance (Lieberman, Tharion, Shukitt-Hale, Speckman, & Tulley, 2002; Kamimori et al., 2015). For example, caffeine dosing reduced decrements in psychomotor performance and sustained vigilance during simulated ground operations during periods of sleep deprivation, as compared to placebo (McLellan et al., 2005). In addition, rifle sighting and shooting time was faster in Navy SEAL trainees given 200 or 300 mg caffeine after 72-h of sleep deprivation, versus those given only 100 mg caffeine (Tharion, Shukitt-Hale, & Lieberman, 2003).

The effect of caffeine consumption is impacted by several variables such as previously obtained sleep, the amount of caffeine consumed, and the manner in which it is ingested. Caffeine ingested orally typically takes around 30 min to take effect (Wundersitz & Baldock, 2008). Standard doses of caffeine, usually represented as coffee equivalents (e.g., 180 mg in a medium coffee), can be taken as a capsule or pill and can be prepared in an extended release format (Wundersitz & Baldock, 2008). Caffeine administered using caffeine gum formulation reaches peak blood concentration faster than when administered as a pill or capsule (Kamimori et al., 2002).

The mediating impact of prior sleep on the effectiveness of caffeine was investigated by Reyner and Horne (2000) who reported that drivers without a previous night's sleep had improvements in performance with caffeine intake, but for only the first 30 min, after which they could not safely perform the task of simulated driving. Those with limited amounts of sleep the night before (less than 5 h) benefited from caffeine use that lasted approximately 2 h. The effect of caffeine was not impacted by the user's typical caffeine consumption such that there was no difference between those who consumed caffeine up to the point of assessment and those who had no caffeine consumption up to 6 h prior to assessment (Hewlett & Smith, 2007).

While naps and caffeine were previously considered separately, is it possible for the two to be used together tactically and effectively? Horne and Reyner (1996) examined the effects of consuming 150 mg of caffeine prior to taking a 15-min nap, a "nappuccino" on the subject's ability to drive a simulator. The "nappuccino" group produced fewer errors than the control, nap-only, or coffee-only groups. While some participants had difficulty sleeping, dozing instead, they still derived the same benefits of caffeine use and napping. Other nap and caffeine research found this combination was more effective in computer task performance than combining napping and bright light or napping and face washing in mitigating sleepiness (Hayashi, Masuda, & Hori, 2003). When examining napping only in relationship to performance on learning tasks, researchers found that the "no nap" group's performance deteriorated on tasks in the evening when compared to the nap group (Mednick, Nakayama, & Stickgold, 2003).

Operational Stress Control and Sleep

There is a clear need for operational and field-based interventions to address sleep problems among deployed service members (Campbell & Koffman, 2014). These interventions could target environmental factors as well as service members' sleep-related behaviors (Peterson et al., 2008). The Warfighter Sleep Kit is an example of one such intervention. The sleep kit (a small package containing earplugs, an eye mask, small spiral book, and a CD designed to fit into the pocket of a uniform) was conceived as a tool for the Navy Mobile Care Team. This team of behavioral health clinicians and researchers traveled extensively through Afghanistan, executing combat stress control (Campbell & Koffman, 2014) and providing outreach, intervention, and psychoeducation for sleep health across a widely distributed, combat-deployed target population. The US Air Force Air Mobility Command played a key role in transitioning the concept of the sleep kit into operational practice, and in doing so, incorporated the Fatigue Avoidance Scheduling Tool (FAST; Eddy & Hursh, 2001) into the sleep kit CD; thereby increasing access to this tool which could be used to evaluate and predict the impact of operational tempo and sleep deprivation on human performance. Another promising technology-based intervention that could be applied in operational stress control takes the form of a mobile phone app developed by the Army Medical Research and Materiel Command. The application (called 2BAlert, and currently in a field-testing stage) establishes baseline information using psychomotor vigilance tests (PVT) to measure performance, monitor caffeine input, and conduct sleep scheduling. Together, these indices are designed to help individuals identify their performance across time and will provide recommendations for improving alertness based on the time of day. The goal is for individuals to use 2BAlert when mission planning to maximize human performance for the course of the mission.

The US Army Techniques Publication (ATP) No 6–22.5, *A Leader's Guide to Soldier Health and Fitness* (US Army, 2016), replaced US Army Field Manual 6–22.5, *Combat and Operational Stress Control* (US Army, 2009). The ATP is a leader's guide to assure leaders are aware of the support, services, and information that impact them and their soldiers' health, readiness, and performance. The ATP devotes a chapter to the "Performance Triad," of sleep, activity, and nutrition that are considered the basis of health and readiness. In Chap. 2, a section is devoted to each tenet of the triad. The sleep section provides information on sleep in the operational environment, sleep habits, countermeasures to maintain performance, sleep schedules, and night shifts. Also included in this chapter is information to support shift/work/duty scheduling (e.g., attempt to ensure 16 h off-time to support 7–8 h of sleep), recommendations for maintaining a healthy sleep environment (e.g., reducing ambient noise), ideas for applying countermeasures, such as caffeine to maintain performance including a caffeine dosing schedule, guidelines for recovery sleep following continuous operations (e.g., 12 h of recovery sleep after 2–3 days' nonstop operations), dealing with time zone travel (e.g., adapt to the new location's schedule immediately), and information to educate leadership with regard to expected degradation of performance following sleep deprivation. The Navy and Marine Corps Operational Stress Control doctrine (Department of the Navy, 2010) is vague when it comes to addressing the role of sleep, offering a cursory discussion of sleep in the context of other leadership functions.

Despite the attention that the Army provides to sleep health in their leadership manuals such as the *ATP 6–22.5*, the degree to which frontline commanders access and utilize this information is questionable given the results of a study by Miller, Shattuck, and Matsangas (2011) who surveyed a convenience sample of 49 Army officers attending Infantry Officer Advanced Course after recently returning from combat deployments. The results were stark: 80% of the samples were not briefed on a sleep management plan during their deployment. Furthermore, there was little evidence that these company-grade leaders understood the fundamentals of operational sleep habits, as 74% reported their unit never or rarely encouraged or monitored naps, 67% rarely or never designated dark or quiet areas for rest, and half the respondents had never or rarely attempted to maintain sleep schedules. Given the paucity of attention that sleep health receives in the training of operational line warfighters, a key role of military psychologists serving in Behavioral Health Officers or COSC roles is to serve as the subject matter expert for sleep health, provide education and consultation to unit leaders, and serve as a liaison to clinical sleep medicine when necessary.

Future Directions

How does the military train its leaders to operate in a manner that minimizes the deleterious impact of mission-induced restricted sleep while simultaneously harnessing the power of sleep-restorative practices to maximize recovery to optimal performance? To start, measures of sleep quality and quantity designed for the layperson, but also rugged enough to survive in austere environments with limited Internet access, are needed to help unit leaders identify sleep-induced functional impairments. Military psychologists can play a vital role in the design and testing of these measures, as well as to support the adoption of such technology to augment clinical sleep medicine. As discussed in this chapter and elsewhere (Killgore, Estrada, Rouse, Wildzunas, & Balkin, 2009), actigraphy and more recent smartphone-based applications have the potential to serve the critical role of monitoring and alerting individual service members, their operational leadership, or even their therapist to the pitfalls of sleep-detrimental behavior. However, such technology must be scored in a manner that makes the data accessible and interpretable without great expense or time-intensive training.

With respect to recovery from insufficient sleep, we are not aware of any attempts to integrate sleep recovery/restoration into military training scenarios or training commands that impose sleep restriction. As a future direction, one can envision a training scenario, for example, three to five continuous days with 3 or fewer hours of sleep, after which the unit leader is expected to implement sleep recovery procedures (i.e., extended recovery sleep) such as monitoring unit member adherence to recovery sleep needs (duration and quality of sleep) and documenting a return to baseline/predeprivation cognitive performance. While it is important that warfighters learn how to operate in conditions of fatigue and sleep restriction, it should be equally important that leaders are taught how to identify thresholds for significant performance decline and then practice the necessary leadership actions required to restore their operators to full functional capacity, especially before re-engaging in operations. In this regard, military psychologists with a strong background in sleep can play an important role in developing the tools and training protocols necessary to make the US military a leader in the use of sleep monitoring and restoration to improve operational performance.

Military psychologists are also being asked to take part in campaigns to raise awareness of the importance of sleep with respect to overall human performance, namely, the US Army Surgeon General's Performance Triad, a public health campaign which aims to make sleep, along with activity and nutrition, a health priority for all soldiers. The goal of the Performance Triad is to have sleep and fatigue management strategies become second nature for soldiers engaged in sustained operations, 24-hour duties, or when planning training or other missions. The Performance Triad campaign is designed to be embedded across the training spectrum: from initial military training, command and staff colleges, within programs of instruction (POI), incorporated into warfighting doctrine, and integrated into the standards of evaluation applied by deployment readiness training centers.

Military psychologists also played a role in a sleep summit hosted by the US Army Surgeon General in December 2015 in an effort to improve dissemination of sleep information throughout the Army. An outcome of the summit was the recommendations of five different working groups that shed some light on future directions of sleep health in the military.

Garrison Environments This work group focused on changing how sleep is perceived and to help soldiers achieve more and better quality sleep. The group recommended leader engagement and command emphasis on seeing sleep as a weapon and force multiplier. To ensure a commonly understood measure, a link between Army safety incidents to sleep and fatigue is necessary to provide actionable information: a recommendation that was echoed by US Navy personnel attending a subject matter expert forum in support of the RAND report (Troxel et al., 2015).

Operational Environments This working group highlighted the need to integrate peak performance and fatigue management strategies into training guidance to enable optimal sleep within a unit's battle rhythm. In addition to education and training, it recommended soldiers and their leaders have tools to create training plans and aid in decision-making. These tools may be as simple as a matrix that identifies the level of risk associated with hours of sleep and appropriate countermeasures, to a laminated sleep tip card that may be carried in the pocket.

Primary Care The working group acknowledged an absence of adequate education and training for the assessment and management of sleep for primary care physicians, as well as limitations in the resources needed to fully address the high prevalence of sleep disorders in the primary care settings. Given the scarcity of psychologists with formal sleep education (Meltzer et al., 2009), it is not surprising. This working group recommended standardized training that targets primary care providers in Army Medical Home (AMH) teams and the development of specific AMH clinic resources to better identify and manage sleep problems, e.g., clinical practice guidelines.

Standardized Training and Treatment The working group identified significant variability in protocols used to evaluate treatment effectiveness. While CBT-I is the standard of care, it is not uniformly used nor is it fully implemented to address insomnia or other sleep problems. This working group recommended using an evidence-based, standardized, and preferably manualized, treatment protocol. Most Army Medical Home (AMH) clinics have Integrated Behavioral Health Consultants (IBHC) who would benefit from using a brief therapy approach, such as the Brief Behavioral Therapy for Insomnia (BBT-I; Germain et al., 2014). For Behavioral Health Officers (BHOs) working in behavior medicine clinics, in separate brigades, or serving as embedded behavioral health consultants (EBHC), training in manualized CBT-I is encouraged in situations where there was an identified champion who could provide clinical supervision and guidance. Of particular interest to military psychologists, the group noted that Behavioral Health Officers located in line units might benefit from learning and implementing both approaches. The Center for Deployment Psychology (CDP) provides training in both CBT-I and BBT-I and travels around the country to train behavioral health providers from all services. In addition to the CDP, the Army should consider providing similar training to its mental health clinics. Given the effort required to ensure the training of BHOs, IBHCs, and EBHCs, the work group recommended a central program evaluation to determine efficacy and fidelity of BBT-I and CBT-I protocols for military population.

Sleep Medicine Care In the Army, the working group noted that sleep medicine is not a recognized area of concentration or additional skill identifier; thus, all sleep medicine providers belong to a primary specialty such as family practice, pulmonology, psychiatry, or internal medicine. This structure tends to adversely impact the availability of sleep medicine specialists depending on the needs of the specialties. This work group recommended a hub-and-spoke model of stepped specialty care utilizing technology such as video teleconferencing to ensure consistent availability of care in all regions. The hub would host a standardized state-of-the-art sleep center and would support outlying hospitals or clinics.

In closing, the primary purpose of this chapter was to introduce some of the basic mechanisms of sleep to psychologists in conjunction with an overview of the various domains of the psychological literature in which sleep plays a key role such as health, behavior, and performance in both military and civilian domains. As the breadth of this literature implies, sleep is indeed an important construct for psychologists to address whether it be in research, operational support, or clinical medicine. We hope this chapter will intrigue psychologists and beckon them to engage in a thorough review of the sleep literature and pursue additional training in sleep health. Moreover, it is important for leaders within military psychology to consider the development of a formalized school or training programs devoted to the study and application of sleep medicine within the practice of military psychology. The scope of the problem and the importance of the topic in almost every domain of military health, behavior, and performance necessitate a deliberate strategic effort to improve the scope of formalized training in sleep medicine for the military.

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