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Sleep Disturbance Implications for Modern Military Operations

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Abstract

As is evident from current military operations that are happening around the globe (e.g., Iraq, Afghanistan, Korea), today's military is being called on in numerous new and innovative ways (e.g., Foster & Lindsay, 2011). One of the primary forces behind this change is the pervasiveness of enhanced information systems. In fact, the concept of networked warfare is the basis of operations and doctrine for the armed forces (Wesensten, Belenky, & Balkin, 2005). With respect to Admiral Cebrowski's quote, it appears that this notion of information in warfare is going to continue to influence the way that we approach and conduct war for the foreseeable future. While this use of information and information systems have been used successfully in recent operations (Cammons, Tisserand, Williams, Seise, & Lindsay, 2006), it must always be considered with respect to the operational context. This context is made up of the military's primary weapon system (the individual solider) and the features of the operational environment in which they are expected to perform.

Within the context of current military operations, the individual combatant is experiencing demands never before seen by predecessors. While deployments and warfare are certainly not new to military personnel, expectations regarding the use and processing of information during these operations is at an unprecedented level. These changing expectations regarding information processing have virtually transformed the soldier into a "cognitive platform". While this platform is certainly the most capable the world has ever seen, there are factors which limit this platform's warfighting capability. These include such factors as nutritional or caloric deficiencies, dehydration, psychological stressors, carrying excessive loads, and hypothermia (Lieberman et al., 2005; Meyerhoff et al., 2000; Wesensten et al., 2005). Another key factor is sleep. While sleep is a basic physiological need that is usually regulated by the individual, in a military environment conditions often dictate how much sleep is obtained (and the quality of that sleep), independent of the individual military member's personal needs or desires. Somewhat absent, however, is a critical examination of the impact of sleep loss on this "new" cognitive platform in today's military environment. While some research has been done to address pieces of this issue (Wesensten et al., 2005), there are still many gaps that remain. Therefore, the purpose of this review is to briefly examine what is known about the effects of sleep and predict the implications of restricted sleep and sleep loss in this informationally-enhanced environment. In order to do this, three areas need to be examined in greater detail: the current operational military environment, the amount of sleep required, and sleep loss and its subsequent effects on cognitive functioning and resulting decision making in such an environment. Finally, implications in light of this information and attempts at mitigation are suggested.

> What we are seeing, in moving from the Industrial Age to the Information Age, is what amounts to a new theory of war: power comes from a different place, it is used in different ways, it achieves different effects than it did before. During the Industrial Age, power came from mass. Now power tends to come from information, access, and speed. We have come to call that new theory of war network-centric warfare. It is not only about networks, but also about how wars are fought—how power is developed.
>
> — Vice Admiral (Retd) Arthur K. Cebrowski (Office of Force Transformation, 2005)

The Current Operational Military Environment

Operational demands of US military forces are at an all-time high. One can virtually take an atlas of the world, blindfold oneself, throw a dart at it, and it is likely that anywhere the dart lands, military operations are either taking place or have

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recently taken place there. Gone are the days where large stationary bases consisting of large numbers of military personnel are the norm, as was the case during the Cold War. At any given moment, there are tens of thousands of American military members scattered around the globe on missions ranging from direct combat operations to humanitarian relief.

Indeed, the whole military establishment has undergone radical changes. This is evidenced by recently established organizations such as the Office of Force Transformation, created by the Department of Defense. This organization was established in 2001 to focus on examining what the future of the military and warfare should be, and how to get there. One of the major thrusts in the transformation of the military is with regard to network-centric warfare. Under this concept, "network-centric warfare broadly describes the combination of strategies, emerging tactics, techniques, and procedures, and organizations that a fully or even a partially networked force can employ to create a decisive warfighting advantage" (Office of Force Transformation, 2005). Put another way, "network-centric operations are characterized by information-sharing across multiple levels of traditional echelons of command and control. This information-sharing is made possible by networking the entire force down to the individual level" (Wesensten et al., 2005, p. 94). When taken together with the previous quote by Admiral Cebrowski, it is obvious that the future of the military will involve not just traditional military weapon systems, but also a significant amount of technology and complex information processing in order to effectively wage this network-centric warfare. These demands on modern combatants render them particularly vulnerable to environmental and internal disruptions which may decrease their performance (i.e., cognitive functioning). Among the most potentially devastating and common factors likely to produce reduction in performance efficiency is sleep disruption and deprivation.

The US armed forces are utilizing technological advances that provide more data and more information to the individual combatant. As this pace of providing current warfare information continues to increase, the operational tempo naturally places more emphasis on continuous 24/7 operations. These technologies are designed to run continuously without regard to day or night. Yet, the human solider utilizing such technology requires a substantial amount of rest at specific times in order to operate effectively. In fact, the deleterious effects of sleep deprivation and sleep disruption are well documented (e.g., Shay, 1998).

Central to this discussion is the question of whether there are operational constraints that will act to limit the effectiveness of individual combatants to accomplish their mission? The demands of new technological warfare and the limitations of human functioning (as well as the biological composition of human beings) necessarily place limits on human performance in deployed and combat operations. We now turn our attention to one of these significant constraints: the amount of sleep a soldier needs versus what they actually receive.

Amount of Sleep

Fundamental to good health, and certainly critical to military performance and readiness, is adequate sleep. While this seems like an obvious statement, there are many factors which influence and curtail one's ability to obtain optimal sleep, such as workload, environmental conditions (weather, noise, etc.), and stress. This is evident through recent studies that indicate many Americans receive less than six hours of sleep per night (e.g., Bonnet & Arand, 1995; Jean-Louis, Kripke, & Ancoli-Israel, 2000; Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002; National Sleep Foundation, 2002). This is in contrast to the 8 hours that are necessary for optimal sleep in adults (Belenky et al., 2003). While this lowered amount of sleep is often used to justify getting more done, it comes at very tangible costs. This is evidenced through decrements in health, performance, and other outcomes (Belenky et al., 2003; Pilcher & Huffcutt, 1996; Van Dongen, Maislin, Mullington, & Dinges, 2003).

However, the idea of sleep loss is not as straightforward as it may first appear. Several considerations must be made in order to examine what is meant by sleep loss. The first consideration involves examining how sleep loss is measured. One way in which this is described is total sleep deprivation. Total restriction is usually examined in a laboratory for precise experimental control and is the best way to examine large decreases in performance over a relatively short period of time (Belenky et al., 2003). In fact, studies have examined sleep deprivation ranging from one night to over 70 hours of total sleep loss, with predictable decreases in performance as the length of the sleep loss increases (e.g., Harrison & Horne, 1999; Heuer & Klein, 2003; Horne & Pettitt, 1985).

A relatively new approach in sleep science is to examine partial sleep restriction. This type of sleep loss refers to less than necessary periods of sleep for the individual every night for a period of time (Carskadon & Dement, 1981; Dinges et al., 1997; Dinges et al., 1999). This type of sleep loss, while less frequently studied, is more common than total sleep deprivation, and seems to be quickly becoming a regular cost of the normal adult lifestyle (Belenky et al., 2003; Dement & Vaughn, 1999). While most individuals, for one reason or another, have missed a night of sleep, it is more typical for an individual to get less than the required amount of sleep on a repeated basis.

The second consideration is that sleep is different for every individual. In addition to the host of factors that can influence sleep amount and sleep quality is the fact that sleep requirements also vary as a function of age

(Carskadon, Wolfson, Tzischinsky, & Acebo, 1995; Wolfson & Carskadon, 1998; 2003). For example, research shows that while adults need approximately 8 hours of sleep per night, an adolescent in their late teens or early twenties requires about 9.25 hours of sleep per night for optimal performance and daily functioning (Carskadon, 1990; Carskadon, Vieira, & Acebo, 1993). Of particular interest to the military is the fact that a significant portion of military members are below the age of 26. For example, 39% of United States Air Force military personnel are under this age (45.7% of enlisted and 12.8% of officers: Air Force Personnel News Service, 2006). Considering that the accession of military members starts at the age of 18, a large portion of the military force is at a time in their development where sleep requirements are at an increased level. As a result, there has been recent research targeted at examining these "newest" military members and their sleep habits in the different services of the armed forces. While there are obvious differences between the cultures of the various armed forces in the United States (Mastroianni, 2005), issues such as sleep habits tend to be remarkably consistent.

A recent study examined the sleep habits of military personnel undergoing Navy Basic Training (Miller, Dyche, Andrews, & Lucas, 2004). At Recruit Training Command (RTC), the training organization responsible for Navy basic training, "lights out" occurred at 2200, while reveille sounded at 0400, for a total sleep time of six hours. This schedule was in place from the 1970s. However, early in 2002, RTC extended the sleep time by two hours by pushing back the reveille time to 0600. Therefore, recruits were able to get 8 hours of sleep. Results from RTC demonstrated significant improvements on graduating test scores, attrition being cut in half, and significantly reducing the number of sick calls at the recruit medical clinic simply by changing the sleep duration of recruits. These results benefit both the individual military member as well as the organization.

This research has not been limited to the Navy. There are currently ongoing sleep studies at both the United States Military Academy (USMA) and the United States Air Force Academy (USAFA). Using a combination of sleep diaries, self report, and actigraphy (wrist worn devices that measure sleep duration), researchers are attempting to determine the actual sleep demographics of future military members in a demanding environment. At USMA, researchers found that cadets are receiving far less than the eight hours of sleep that is recommended (Carskadon, 1990). Studies show that cadets sleep on average, 4.83 hours on week nights and 6.53 hours on weekends (Miller & Shattuck, 2005). In a related effort, it was found that cadets were sleeping on average 4.86 hours per night on week nights and 6.56 hours per night on weekends, for an average of 5.32 hours per night (Kenney & Neverosky, 2004). These data indicate that, even on weekends, when cadets have less formal activities and a small amount of discretionary time, they are still unable to get to the recommended level of sleep or to catch up for sleep lost during the week.

The data are similar at the United States Air Force Academy. In a study by Lindsay et al. (2005), it was demonstrated that cadets, on average, were obtaining less than six hours of sleep during the night, and that 10 percent of these students were receiving less than 3.7 hours per night (see also Miller et al., 2000). More recently, a comprehensive examination of sleep at USAFA has been initiated. Using both surveys and actigraphy, several studies have indicated that cadets are receiving from just under five hours to 5.5 hours of sleep per night during the academic week, similar to West Point (Dyche, Hoggan, & Lindsay, 2006; Lindsay & Dyche, 2005; Lindsay, Lee, & Dyche, 2006).

In light of these results, one might argue that sleep is restricted because these are training environments and, therefore, not "typical" of a traditional military environment. However, it could also be argued that they are more like an actual deployed environment, where demands typically exceed resources and there are unrestrained expectations regarding an individual's time. One of the traditional sayings in the military is to "train like you are going to fight". If this is the case, then these training environments are more typical of the actual type of environment that military members will face when accomplishing their wartime mission. As one of the authors can attest after having been recently deployed to Afghanistan, this is certainly the case. Therefore, these data indicate that military members are often in a sleep-deprived state during training or when accomplishing the mission. When added to the fact that sleep loss is often associated with decreased cognitive functioning and decision making, what are the resultant effects on training programs? Does that mean that individuals are not able to get as much out of the training as they could have if they were well rested? More research needs to be done in this area to see how sleep deprived trainees learn complex material (such as network-centric warfare technology), and the subsequent effects on actual performance in extreme environments.

Sleep Loss, Cognitive Functioning and Decision Making

As previously stated, sleep loss affects individuals in a host of different ways and results in significant negative outcomes. For example, sleep deprivation has been tied to numerous disasters such as Chernobyl, Three Mile Island, and the Space Shuttle Challenger (Mitler et al., 1988). In 1988 alone, the economic cost of accidents related to sleep was estimated somewhere between $43 and $56 billion (Leger, 1994). These results show that sleep is important and has very real consequences besides just being tired during the day. At the individual level, research has shown that sleep loss affects cognitive functioning, decision making, performance, memory/learning, and general day-time sleepiness (Belenky et al., 2003; Caldwell & LeDuc, 1998; Harrison & Horne, 1999; 2000; Heuer & Klein, 2003; Philip et al., 2005; Pilcher & Huffcut, 1996; Wyatt & Bootzin, 1994). As an example, one study showed that just one night of sleep deprivation tended to decrease cognitive performance by 30 to 40 percent, whereas two nights of sleep deprivation resulted in 60 to 70 percent decline in performance (Buguet, Moroz, & Radomski, 2003). Due to the very nature of global, world-wide military operations, when these effects of sleep loss are translated into a military context, the results are literally a matter of life or death.

One manner in which sleep loss has been characterized is through the term sleep debt. This term "refers to the increased pressure for sleep that results from an inadequate amount of physiologically normal sleep" (Van Dongen, Rogers, & Dinges, 2003). When an insufficient amount of sleep is received over a prolonged period of time, it is often referred to as chronic (Dement & Vaughn, 1999). While this idea is widely known, little is known about its effects on cognitive and behavioral processes. Recent research concluded there was evidence that this type of chronic sleep loss does indeed affect individual functioning (Pilcher & Huffcutt, 1996).

In an effort to try and determine the effects of chronic sleep loss on accumulating sleep debt, researchers conducted a study to see how performance changed over a two week period of time for those who received four, six, and eight hours of sleep per night and another group who received no sleep for three days (Van Dongen et al., 2003). They found that neurobehavioral function decreased as the amount of sleep lost per night increased so that those with only four hours of sleep per night over the study performed worse on tasks than those with six or eight hours per night. Moreover, Van Dongen discovered that performance of the moderate sleep loss group (six-hour group) after two weeks was not different from the total sleep deprivation group after two full days. This demonstrates that even moderate sleep loss over time amounts to severe neurobehavioral deficits akin to 48 hours sleep loss.

In a related study, Drake and colleagues not only examine this idea of sleep debt, but studied how sleep debt is accumulated (Drake et al., 2001). They compared one night of total sleep deprivation (eight hours of sleep loss) versus losing two hours per night over four nights and four hours per night for two nights (for a total of eight hours of sleep debt in each of the three groups). Results indicated that the total sleep deprivation condition performed worst, followed by the four-hour condition and the six-hour condition. In total, all sleep loss conditions indicated poorer performance on memory and vigilance tasks, as compared to baseline measures. This is critical, since sleep debt, even when accumulated slowly over time (two hours per night) still impacts performance. Therefore, it is not only the loss of sleep that can affect performance, but also the effects of that sleep loss over time (i.e., sleep debt). Of particular interest for military members is that, while there may be periods of total sleep deprivation in deployed or wartime environments, it is more likely that chronically restricted sleep will occur more commonly, due to adverse conditions and environmental constraints. As the previous results indicate, this restricted sleep will have performance consequences.

Other research has been conducted that focuses specifically on cognitive performance with military personnel. Banderet and colleagues studied soldier's performance on team tasks during periods of total sleep loss (up to 80 hours) (Banderet, Stokes, Francesconi, Kowal, & Naitoh, 1981). Their results indicated that, starting around 36 hours, soldiers lost track of critical tasks, failed to update maps with changing information, put off important tasks, and experienced the lack of ability to cope with unforeseen and rapid changes (Harrison & Horne, 1999; 2000). In fact, the soldiers gave up on the task after 45 hours without sleep.

Another example involves British soldiers during an intense 10-week training program (May & Kline, 1987). Soldiers were evaluated after a two-day exercise in which they received no sleep. Significant decrements in performance were evident in the areas of visual encoding, scanning, and production of novel responses. In a military setting, these areas translate directly to tasks such as map reading, detecting camouflaged objects, encoding and decoding messages, using map coordinates, and flexible thinking. In addition, Kobbeltvedt and colleagues found in their study on military personnel that sleep deprivation led to longer task completion time versus those not sleep deprived (Kobbeltvedt, Brun, & Laberg, 2005). More comprehensive studies have also been undertaken to study sleep in a "realistic" military setting (Lieberman et al., 2005). Researchers examined elite Army soldiers involved in a live-fire training exercise who were exposed to multiple stressors (sleep loss, temperature, and limited food). Results indicated that, even in a highly-trained and experienced unit, substantial degradation in cognitive function, vigilance, reaction time, memory, and reasoning were experienced due to stressors such as sleep loss.

In the context of network-centric warfare, these results have obvious significant implications. In many cases the limiting factor in information dissemination is the human operator. Even under the best circumstances, it is possible to overwhelm individual soldiers with more information than they can handle. However, based on the above results, it is obvious that the amount of information may not be the critical choke-point. Instead, it may be the condition of the soldier who is responsible for handling that information. While it is readily apparent that losing one night of sleep will impact performance the following day, it is becoming clear that even partial sleep deprivation also affects performance. This partial loss of sleep is cumulative, and will continue to influence soldier performance until it is eliminated.

Impact

The environment in which we currently have US military forces varies depending upon their particular tasking. Certainly forces in support of ongoing military operations (i.e., Afghanistan and Iraq) will be significantly different than those supporting military operations other than war (MOOTW). As a result, the specific operational constraints on any given military member will differ depending on their particular role. However, the military reliance on information operations and networked systems is the process through which we conduct operations, and is consistent across the particular taskings in which military personnel are involved. Therefore, several general recommendations can be offered that transcend specific operational missions.

The first of these has to do with leadership. Commanders set the tone and to a large degree the operational tempo of their organization. While readiness of weapon systems and technology is crucial to proper functioning of a military organization, equally important, if not more so, is the readiness of personnel. The military has a tough guy/gal image, in which self-denial and pushing to the extremes are a normal part of day-to-day operations. In fact, many of the training practices and programs in the military are set up to "push" the individual soldier to their limits (e.g. Basic Training). While this has positive future implications for the soldier in terms of knowing what they can handle and where their individual limits are, it must also be tempered with a measure of responsibility from the soldier's chain of command. This responsibility entails understanding the role of the operational tempo on the unit. Since operational planning often dictates the tempo of an operation, commanders have some discretion as to the fielding of their forces. Obviously, when possible, this tempo needs to be managed to maximize soldier performance. For example, if day-to-day tasking is at such an accelerated pace that individuals are struggling to keep up (increasing sleep debt by falling behind on their sleep), then when it comes time to surge operations to meet a new threat or a change to an existing threat, there is no reserve left to give. Soldiers, due to their professionalism and dedication, will confront the challenge, but the soldier will not face the challenge at their best, and may be far from it. In the past, the physical requirements of the individual solider were paramount. However, today's military also requires cognitive fitness, and part of that fitness lies in getting an adequate amount of sleep. The leader plays the critical role in this effort. Research conducted at the Walter Reed Army Institute of Research in the area of leadership provides evidence that leadership is important in predicting the psychological consequences of stressors such as lack of sleep (Britt, Davidson, Bliese, & Castro, 2004).

Jonathan Shay stated that this notion of protecting our soldiers needs to start with the officer corps and that "It is time to critically re-examine our love affair with stoic self-denial, starting with the Service Academies" (Shay, 1998). However, as mentioned earlier, cadets at our Service Academies are getting less sleep than they need. Of particular importance to the current discussion is that there is evidence that this habit of getting less sleep at the Service Academies extends to active duty, and even to those in non-operational jobs (Pinchak, Kajdasz, & Dyche, 2006).

The second impact is more theoretical and, therefore, is offered in a series of questions. It has to do with degraded environments and their impact on all phases of our forces. This specifically applies to the types of technologies that are developed for use in the armed forces. If it is known that soldiers are often working at less than optimal capacity (due to truncated sleep and other operational conditions), how might this affect how we design technology to fit into the network-centric architecture of the future? In other words, what happens when technology is developed to be used in ideal conditions, only to find that, when it is actually used, those perfect conditions can't be found? Is it possible to develop technology that is more resistant to these types of cognitive limitations? For example, there is some research to support the idea that certain types of cognitive processing are fairly resistent to sleep deprivation, while others are not (Harrison & Horne, 2000). If this is the case, then maybe these known limitations need to be incorporated into the design process of network-centric technology. If one is unable to change the operational environment (as is usually the case), then why not approach it from the technology standpoint?

Next, what about the capacity of the military recruit? How might advancements in technology affect how we are recruiting our future military forces? For example, the architecture by which we recruit and assess future military members prior to their accession into the military has changed little over the past several decades, while the requirements of the individual have changed drastically. This leads to a potential discrepancy that must be made up in either training or on the job. Is this the most efficient way to do this? Finally, what are the results of sustained chronic sleep restriction? As previously mentioned, studies have examined restricted sleep over relatively short periods of time (between several days and several weeks). However, what happens when this chronic sleep restriction is maintained for substantially longer periods of time such as a six- or 12-month deployment? More research needs to be done in order to answer these questions.

The final impact deals with quality of life for the individual soldier. The military is among the most arduous professions, due to its oath to support and defend the

Constitution, and its constant mobility requirements (not just deployments, but changing jobs and stations every couple of years: see Sanchez, Bray, Vincus, & Bann, 2004). However, that does not mean that due care cannot be taken with the management of our forces. For example, the basic treatment of our military members affects organizational factors such as job satisfaction. This is important, since military members with higher job satisfaction are more likely to stay in the military, or report that they intend to stay (Becker & Billings, 1993; Kocher & Thomas, 1994; Prevosto, 2001). As another example, a relationship was found between lifestyle regularity and sleep quality, such that people with higher levels of lifestyle regularity reported fewer sleep problems (Monk, Reynolds, Buysse, DeGrazia, & Kupfer, 2003). Again, in a military context, this is not always possible. However, when in garrison, it quite often is possible. This fits back in with the first implication, that of leadership, since many of these issues are a result of the type of organizational climate developed by the individual commander.

Current Status

This issue of sleep loss and sleep restriction would be incomplete without a discussion of what this all means in an operational context. The previous section focused on the implications of limited sleep for the military and its personnel. With that in mind, it is important to examine what is currently being done in the military with respect to sleep loss/restriction. Two primary methods have been used to counter these sleep-loss effects. One of the primary means has been through pharmacological agents. In the past, amphetamines have been used to sustain wakefulness. However, they often have side effects, such as sleep and psychiatric disturbances, addiction, and cardiovascular problems (Westcott, 2005). Another alternative, caffeine, has also been examined, due to its lower potential for dependence, but with the side effects of tremors, irritability, and diuresis. Current research is more supportive of the benefits of caffeine. For example, it was found that moderate doses of caffeine improved cognitive function, including vigilance, memory, learning, and mood state among US Navy SEAL trainees under limited sleep conditions (Lieberman, Tharion, Shukitt-Hale, Speckman, & Tulley, 2002).

While pharmacological agents do have the ability to prolong wakefulness, the side effects could almost be argued as worse than the sleep loss itself. Therefore, research has focused on another agent, modafinil, as a way around many of these side effects. It does not have the addictive properties of amphetamines, and has the ability to increase wakefulness and improve cognitive performance during sustained military operations (Westcott, 2005). Preliminary research supports the benefits of modafinil on the attenuation of sleep deprivation with respect to cognitive processing (e.g., Caldwell, Caldwell, Smythe, & Hall, 2000; Wesensten et al., 2002).

The other method by which researchers have examined mitigating the effects of sleep deprivation is through the elimination of sleep debt. One way to do this is through naps. Research has shown that naps ranging from 10 to 20 minutes can ameliorate the effects of sleep restriction (Gillberg, Kecklund, Axelsson, & Akerstedt, 1996; Horne & Reyner, 1996). In fact, the converging evidence indicates that brief naps are recuperative and can be as effective as longer naps in dealing with sleep restriction (Tietzel & Lack, 2001). Another method is through recovery sleep. This involves receiving adequate amounts of sleep (8 hours or more) following periods of sleep restriction. A study at the Walter Reed Army Institute of Research tested this idea of recuperative sleep following sleep restriction (Belenky et al., 2003). Researchers examined individuals who had received three, five, seven, and nine hours in bed per night over a seven day period on several tasks. Then, individuals were allowed three nights of "normal" sleep (eight hours in bed). Initial improvements were evident after recovery for those who received three hours sleep per night. However, performance for all sleep-restricted groups (three, five, and seven hours) were still below baseline performance, even after the three nights of recovery sleep. This indicates that the brain is engaging in a limiting process that prohibits rapid recovery of performance back to the level prior to sleep restriction. In the case of the cadets at the Service Academies that were previously mentioned, their attempts to get more sleep in the weekends may have little actual impact on improved performance the following week.

These results have several direct links to military performance. While it has been shown that naps will help in cognitive performance following sleep restriction, this is a temporary measure at best. It may prolong work by the individual in the short term, but performance will eventually suffer as the sleep loss/restriction continues. The same is the case for recovery sleep. While it will help in the long run (by eliminating the accumulated sleep debt), short term benefits of recovery sleep are not borne out by the literature: it takes time to recover from sleep debt. This means that, as soldiers are continuing in this degraded sleep environment, their performance is predictably going to continue to suffer.

Conclusion

Sleep is important, and critically so in a network-centric environment. "Even in well-equipped, well-trained, highly motivated soldiers operating within cohesive units with good morale, sleep remains a critical factor for maintaining the operational capabilities enabled (and required) by a network-centric environment" (Wesensten et al., 2005, p. 100). As previous research indicates, sleep loss and restriction have many significant adverse effects for military personnel. In a network-centric environment, these effects are even more critical. First, overall performance will be degraded the longer the soldier is in this sleep-deprived or sleep-restricted state. Their readiness will be lower than what is needed in such an environment. Second, due to the sleep loss and other environmental factors, the soldier may not be able to process the myriad pieces of information that are available. Even if they are able to get the information, they may not be able to interpret it in the right way. Finally, the output of the individual soldier that is fed back into the networked system, and relied upon by others, will be impacted by this lowered performance, thereby affecting the entire networked system.

It has been the attempt of this paper to illuminate why something as simple as sleep can obstruct even the most technologically-advanced military forces the world has ever seen. If assumptions are made as to the ability and readiness of our soldiers, and then due to environmental situations and pressures they are not able to live up to that level of performance, who will ultimately pay the price? It is suggested here that the very networked environment that is used to wage war will be the same one that will pay the price of suboptimal performance. Put another way, the cognitive platform (the individual soldier) and not the technological platform could end up being the limiting factor. Not because of lack of ability, but because of something as simple as the lack of sufficient sleep.

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