The effects of sleep deprivation on cognition and behavior in physicians in training

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Introduction

A physician assistant must be made aware of the negative consequences that sleep deprivation has on the mind and the body. The nature of the Physician Assistant (PA) program is conducive to increased fatigue, anxiety, depression and a high frequency of nights of inadequate sleep. There is minimal research on the effects of sleep deprivation in students in PA programs, which makes it even more important to fully understand the detrimental consequences of sleep deprivation among interns and residents.

It has been well documented that interns, residents in training and attending physicians are over-worked and asked to work prolonged shifts without adequate sleep. It was William Stewart Halsted, the first surgeon-in-chief at Johns Hopkins Medical School in the 1800s, who introduced the concept of intense apprenticeship around the clock without work-hour regulations. It was during this period that residents literally lived in the hospital and worked around the clock with minimal opportunities for sleep and rest (Avidan, 2013). One study alluded to the “tradition” of training in medicine as a rite of passage and in 1981 the term “House Officer Stress Syndrome” was created that consisted of cognitive impairment, chronic anger, family discord, and pervasive cynicism, all of which were exacerbated by sleep loss (Vorona, Chen, & Ware, 2009). One of the key components in the Libby Zion case, which will be discussed later in this review, was that the house staff had been working more than 24 continuous hours (Kramer, 2010). It was reported in one study that among physicians the desire to avoid call is cited as the most common reason for early retirement (Eddy, 2005).

The quantity and distribution of work hours can affect sleep, productivity and safety (Barger et al., 2005: Comondore, Wenner, & Ayas, 2008). Studies have found that numerous domains are affected by fatigue including increased risk of depression, heart disease, deficits in professionalism and errors in completion of complex mental tasks (Belayachi et al., 2013). One study found there to be an increase of motor vehicle collisions (MVC) among interns working extended work shifts (Barger et. al., 2005). Current research has suggested that sleep deprivation affects critical decision making (Mountain, Quon, Dodek, Sharpe, & Ayas, 2007; O'Brien et al., 2012; Stratton, Furey & Hogan, 2014). In spite of the work restrictions implemented for physicians in training, which will be brought to attention later this review, recent research has demonstrated that they are not sufficient to promote adequate rest. The review will demonstrate the number of hours residents spend sleeping has not changed despite their decrease in amount of hours worked (Pulliam, Weinstein, Malhotra, Macklin, & Berkowitz, 2012).

There has been extensive research in the last twenty-five years examining the effects that sleep deprivation has on cognitive ability such as reaction time and on mental health like depression and burnout. One study showed that burnout among interns increased from 4.3% to 55.3% from the beginning to the end of their internship (Rosen, Gimotty, Shea & Bellini, 2006). It is also known that physicians manifest symptoms of major depression and encounter suicidal ideation during their intern year and that the typical resident as well experiences trouble with depression, inhibition, indifference and hostility (Kiernan, Civetta, Bartus, & Walsh, 2005). The combination of these two variables (major depression and suicidal ideation) poses a significant risk factor not only to the providers themselves but also to the patients for whom they are providing care.

The report will also illuminate and demonstrate the importance of sleep as it pertains to physiological homeostasis and it will also reveal the main event that led to the changes made to better suit interns and residents. The final portion of the paper will be the application to the PA profession and how this information will affect the care of patients by PAs. The first topic to be covered will provide fundamental information on the components of sleep, its physiological importance and how it is regulated.

Sleep background

This section will illustrate the following pieces of information: the anatomy of sleep, the effects of different types of sleep deprivation and the amount of sleep needed to function at an optimal level.

Sleep is an innate repetitive function of the brain that restores energy and maintains mental and physical health. During a normal night, slow wave restorative sleep (SWRS) accounts for three-quarters of total sleep and the remaining one-quarter is composed of rapid eye movements (REM). It has been shown that SWRS is characterized by a regular occurrence of local and global slow cortical oscillations, which are visible on the EEG as slow waves. Throughout SWRS sleep, especially during its lighter stages, it begins to move to REM sleep, where another type of activity is apparent, so-called sleep spindles. The spindles involve the thalamus and dynamic corticothalamic interactions. During REM sleep, the brain is nearly as active as it is in while we are awake (Vyazovskiy & Delogu, 2014).

The ventrolateral pre-optic nucleus of the anterior hypothalamus is critical for the initiation of sleep whereas wakefulness relies on a system of the ascending brainstem and hypothalamic neurons. The position of the sleep-wake cycle is controlled by the circadian clock that is influenced through a complex network of molecular timers in the brain in addition to regulatory genes (McGrady & Moss, 2013). As a result, these variables control the oscillating patterns of neurons and other peripheral clocks, such as the PER1 protein, in the body. An individual's internal body clock is located in the area of the brain called the suprachiasmatic nucleus (SCN) and light is the main regulator of the SCN. The PER1 protein is expressed in the circadian pattern in the SCN and encodes components of the circadian rhythm of motor activity, metabolism and behavior (Olson, Drage, & Auger, 2009).

Human sleeping patterns are controlled by homeostatic mechanisms that increase sleep pressure in response to time spent awake and the circadian body clock that promotes wakefulness and sleep at their respective usual times (Sugden et al., 2012). Sleep deprivation can be defined as either the number of hours of missed sleep or the duration of the deprivation. The effects of prolonged wakefulness can lead to development of microsleeps, which are defined as 20-30 seconds of dozing off (McGrady & Moss). Microsleeps have important consequences specific to cognition for interns and residents such as mistakes made in surgery, missing diagnoses, misinterpreting labs and radiologic imaging findings. As a result, microsleeps have the potential for lethal outcomes for patient care (Mushtan et al., 2013).

According to the National Sleep Foundation, the average sleep duration of an adult is between seven and eight hours, however this number varies from person to person (Mushtan et al., 2013). Adults who get fewer than five hours of sleep will show a decline in peak alertness (Eddy, 2005) and those who obtain four hours of sleep can experience hyperalgesia, an abnormally high sensitivity to pain, the following day (McGrady & Moss, 2013). Within five to ten days of chronic sleep loss, cognitive decline, altered mood, poor motor skills, decreased motivation and lack of initiative are observed (Eddy, 2005).

Acute sleep deprivation results in dose-dependent impairments of mood, cognitive performance, and motor skills within 30 hours of continued wakefulness. A web-based survey administered to over 2,000 interns found that with every extended work shift, the monthly risk of motor vehicle collisions increased by 9.1% (Barger et al, 2005). It was also determined that the risks of a near miss incident was significantly greater ($p<.01$) if they were driving home from work after an extended shift (Barger et al., 2005). Based on the information listed above, not only are the patient's lives at stake, the safety of these physicians as well as the other drivers on the road are jeopardized.

When time awake is extended beyond a critical length and homeostatic drive is resisted, there is an observed decay in neurocognitive performance that is comparable with the effect of alcohol intoxication. An individual awake for more than a 24 period experiences an intoxication effect that is greater than the legal drinking limit (.10 v. 08) (Sugden et al., 2012). It was also reported that between 10 and 26 hours of wakefulness, there are hourly declines in cognitive psychomotor performance, which are similar to those observed with a gradual increase of 0.004% in blood alcohol concentration (BAC) (Commondore, Wenner & Ayas 2008). It is hypothesized that the relationship between wakefulness and cognitive dysfunction may be the result of a buildup of synaptic connections in the brain when awake (Sugden et al., 2012). However, if the individual is able to sleep the amount needed after being awake for a prolonged period of time, there is a reduction in number and size of these connections. It is also suggested that depression and other negative mood states have direct and reciprocal relationships with the sleep system and as a result, dysregulation of the system can decrease one's quality of life. Individuals who report continuous high quality sleep suffer less intense pain and are better equipped to cope with negative life events, thereby demonstrating the importance of being rested (Shea et al., 2014).

Total sleep deprivation is defined as a complete lack of sleep while partial sleep deprivation refers to less sleep than usual. Acute continuous and chronic partial sleep deprivation intensifies the impact of the sleep homeostatic process and impairs neurobehavioral process; both have different effects on the body. There are a variety of circumstances that lead to acute and chronic sleep disturbances such as moonlighting, working extended shifts and experiencing concurrent sleep disorders. There was nearly a five-fold increase in sleep deprivation among interns from the beginning to the end of the year (9 v 43%) (Rosen, Gimotty, Shea, & Bellini, 2006). One study found that one to two weeks of chronic sleep deficiency is just as dangerous for waking performance after one to two days of acute sleep deprivation (Anderson et al., 2012). The literature has shown that residents do not develop tolerance or adaptation to chronic sleep loss over time (Avidan, 2013).

Physicians who work during the night are performing at the circadian peak of sleep propensity placing their waking function in jeopardy. Sleep inertia is characterized by the desire to return to sleep on awakening and feelings of "grogginess", which exerts a significant role in cognition (Comondore, Wenner, & Ayas, 2008). The effects of sleep inertia are most apparent during the initial 10-15 minutes of being awoken and it can take hours for these effects to dissipate. These effects are more prevalent with sleep deprivation and when awoken during the early morning hours (Comondore, Wenner & Ayas, 2008).

History of sleep loss and fatigue in physicians in training

This section will encompass the initial research done on sleep deprivation among physicians in training and reveal the inciting event that led many to question the overwhelming training demands placed on trainees. It will highlight the changes made for work-restrictions for interns and residents and show its advantages and disadvantages.

A study published in the 1970s was one of the first to examine the effects of sleep deprivation on physicians, especially sleep deprived interns. The study showed that interns who slept an average of only 1.8 hours for a 32-hour shift were less likely to recognize cardiac arrhythmias on EKG strips. They also described cognitive impairments such as difficulty thinking and behavioral issues like depression, depersonalization, irritability and memory deficits. In 1975, one survey administered to house officers in England, Scotland, and Wales showed that over one-third believed long duty hours impaired their efficiency. It was not until the 1980s where research on sleep deprivation and physician performance was low and it was determined there was a need for re-evaluation (Vorona, Chen, & Ware, 2009). The limited research at this time kept the dangers posed to these physicians in training a secret and it created danger for both the patient and the provider. It was not until one infamous tragedy, which was made known to the public, that the medical community became aware of the over-demanding strain placed on future attending physicians.

The Libby Zion case in the early 1980s served as a catalyst for reform pertaining to resident and intern training. Libby Zion was an 18-year old patient who died in a New York City hospital within 24 hours of admission. Her father believed her death to be in part a result of the sleep deprivation encountered by the residents. He was quoted as saying, “You don’t need kindergarten to know that a resident working a 36-hour shift is in no condition to make any kind of judgment call-forget about life and death.” Her father was a reporter for the *New York Times* and wrote an article about what happened to his daughter. Ultimately, this lead to legislative reforms in New York pertaining to residents’ duty hours (Vorona, Chen, & Ware, 2009). This case began the discussions among physicians about how to change the existing working conditions so as to avoid tragic accidents as the case with Libby Zion.

There was support both for and against reform of residents’ working hours and thus, changes were not enforced immediately and if they were, they were implemented at slow rates.

The main argument made against the new ideas included the purpose behind the rigorous demands of the training was that it was merely the “tradition” of medicine. Potential inadequacies in training and problems with continuity of care were other ways the old guard of medicine saw problems with these new changes (Vorona, Chen, & Ware, 2009). One study stated that demanding schedules are necessary for learning and development of professionalism. The use of residents to provide inexpensive coverage became an important economical factor for teaching hospitals within the United States (Papp et al., 2004). It was not until 2001 where numerous groups petitioned the National Occupational Safety and Health Administration to establish and enforce a federal work hour standard for residents. The Patient and Physician Safety and Protection Act passed through federal legislation in 2002 based on the recommendations by the Accreditation Council for Graduate Medical Education. They announced that effective in July of 2003 that residency programs were required to meet new duty hour directives (Vorona, Chen, & Ware, 2009).

The stipulations of this act ensured that residents were not to be scheduled to work more than 80 hours of work per week and were limited to one overnight call duty every third night on average. In addition, they needed to have one out of seven days free of patient care responsibility and were to have a 24-hour limit of on-call duty with a follow up period of six hours of transfer of care or educational activities (Vorona, Chen, & Ware, 2009). The situation in Europe in terms of numbers of hours worked required is considerably lower than in the United States. In Europe, junior doctors were restricted to a 56-hour maximum workweek in 2007, and that was subsequently decreased to 48 hours in 2009 (Lefebvre, 2012). In 2005 and 2006 studies reported that residents felt more rested and were able to sleep more because of this new legislation. Other studies in the U.S in that same time period revealed reduced burnout in internal medicine residents and decreased burnout and improvement in quality of life in surgical residents (Shea et al., 2014). However there is still a limited amount of data on the effects of work-hour restrictions on medical training and quality of patient care.

There is some research on work-hour restriction to show there is considerable variation in hours worked in respective residencies through different ways in which the federal legislation was implemented (Ganju et al., 2012). It is thought that the restriction of resident duty hours with subsequent reduced experience may actually lead to more complications and a higher mortality rate under the current legislation. In addition, there have been studies showing no decrease in medical errors or complications after the implementation of resident-duty hour restrictions (Hoh et al., 2012).

Sleep loss and cognitive performance

The effects of sleep deprivation on cognitive performance in interns, residents and attending physicians will be the focus of this section. The majority of the evidence presented here will show its adverse effects, however, there will data presented to show that sleep deprivation does not in fact serve as a negative detractor for trainees.

Sleep deprivation has been demonstrated to negatively impact several aspects of neurocognition such as diminished attention, impaired memory and altered perception (Davies et al., 2012). Residents who report sleeping five hours or less per night are more likely to report having worked in an “impaired condition” and having made medical errors. A report looking at over 100,000 teaching and non-teaching hospital admissions for neurological complaints found more complications in the time period with work restrictions in teaching hospitals (Philibert, 2005). In addition to cognitive changes associated with sleep deprivation, motor function is impaired with acute and chronic sleep deprivation. Ayas et al. (2006) examined the risk of percutaneous injury such as exposure to body fluids or blood through a needle stick in a group of interns. Among the 448 self-reported injuries, fatigue was a contributing factor in 31% of the cases and interns were at a higher risk of experiencing a percutaneous injury during the day after working the previous night.

There is literature to show that interns working frequent emergency room (ER) night shifts of twelve hours show significant deterioration in visual memory and psychomotor vigilance from the beginning to the end of the shift. (Saxena & George, 2005). Fatigue in doctors is associated with increased risks to personal safety at work and negative consequences for patient safety such as clinical errors and diagnostic mistakes (Morrow, Burford, Carter, & Illing, 2014). Vigilance and hand-eye coordination are the most sensitive to acute sleep loss as well as chronic partial sleep deprivation (Qureshi, Ali, Hafeez, & Ahmad, 2010). According to multiple studies, working continuous extended duration work shifts (EDWS) increases the risk of errors on clinical tasks, resulting in higher rates of medical errors and increases the risk of crashes as a result of driving drowsy (Anderson et al., 2012). OBGYN residents at The University of Emory Medical School were tested on word recall from pre to post call for a total of five trials. While it was noted that there was no difference between the first and the fifth trial separately, subjects recalled 3.5 words fewer when the two trials were combined (Halbach, Spann, & Egan, 2003).

Fechner et al. (2008) examined the difference between kidney transplant surgeries during the day and at night. The results showed that those patients who were operated on at night had a higher risk for graft failure and a higher total incidence of complications when compared to patients whose surgical procedures were performed during the day. In addition, there was a higher incidence of reoperation for night operations when compared to daytime operations.

The Weschler Memory Scale (WMS), a neuropsychological test designed to measure different memory functions in a person, was administered to a group of 32 pediatric residents after a 24-hour call period. The results revealed a decrease in retention of short-term memory, a decrease in response score after 24 hours and a decrease in scores for memory evaluation using pairs of words (Qureshi, Ali, Hafeez, & Ahmad, 2010). A battery of cognitive tests was administered to orthopedic surgery residents, fellows and attending surgeons who received less than 4 hours of sleep the night before the tests. The most sensitive test was the Running Memory test, which examines sustained attention, concentration and working memory. The results showed an 83% increase in the probability of making at least one error in the sleep deprived group. As a group, orthopedic surgeon residents who got fewer than four hours of sleep had 1.43 fold increase in probability in making one or more errors than those who got more than 4 hours of sleep (O'Brien et al., 2012).

Landrigan et al. (2004) found that interns who work a traditional extended shift schedule versus a modified schedule made 36% more serious medical errors, 21% more serious medication errors and 5.6 times more serious diagnostic errors when compared to the modified schedule (Olson, Drage, & Auger, 2009). Sugden et al. (2012) hypothesized that if there is total sleep deprivation or chronic sleep restriction, it will result in a linear decline in sustained attention. Sleep duration of four to six hours per day for a two-week time period leads to an equivalent performance decline as seen in one to two days of continuous wakefulness.

Davies et al. (2012) looked at the effect of sleep deprivation on neurology residents, pre and post call, in the University of Penn Health System using the King-Devick test (K-D test). This test involves reading a series of single digit numbers from left to right on three test cards. The purpose was to capture impairment of eye movements, attention and language. The results showed there was less improvement from baseline K-D times in residents taking call when compared to those who did not take call. In the post-call group, there were more errors among residents taking call both at baseline and at follow up. Benson et al. (2014) examined the effect of sleep deprivation on gastroenterologists pertaining to colonoscopy screening quality. The study found there was a 24% decrease in adenoma detection rates in those performing the procedure who had been on-call the night before. The average withdrawal time, the time from when the scope was inserted to when it was removed, for these procedures was longer then for the control group. In the colonoscopies where polyps were not found, the withdrawal time was longer after a call night when an emergent procedure was performed when compared to the group not on call.

Howard et al. (2005) showed that anesthesiology residents placed under acute sleep deprivation conditions demonstrated progressive psychomotor deficits in vigilance and memory and almost one-third fell asleep during cases. The results of the survey led to three separate publications associating work hours to motor vehicle crashes, occupational injuries and self-reported medical errors (Olson, Drage, & Auger, 2009). One meta-analysis showed that the effects of sleep loss on vigilance and clinical performance were greater than those for memory and cognitive function (Philibert, 2005). Gohar et al (2009) examined the working memory capacity (WMC) of internal medicine residents who were sleep deprived. WMC is defined as the ability to retain and manipulate information or perform multiple tasks, which is a combination of attention, concentration and short term memory. Wrist-worn actigraphy, as well as sleep logs and self-reported sleepiness levels, were used to monitor sleep duration and its subjective effect. During the call-rotation month, the residents recalled fewer letters per test, specifically their mean operation-word-span (OSPAN). The number of math errors, speed errors, and accuracy errors were greater when residents were on call. Maltese et al. (2016) examined the effect of night shift work on working memory capacity, speed of processing information, perceptual reasoning and cognitive flexibility, on a group of ICU residents and attending physicians. The results showed that the four cognitive areas tested were all worsened after a night shift.

Kelz et al. (2008, 2009) in a cohort study found that mortality was associated with start time for non-emergency cases between 9:30 PM and 7:30 AM. Similarly, there was an association between start time and morbidity in cases performed from 9:30 PM to 7:30 AM compared to operations between 9:30 AM to 1:30 PM and 5:30 PM to 9:30 PM (Asfour, Asfour, McCormack, & Attia, 2014). Ricci et al. (2009) examined the rate of complications and reoperations in the settings of intramedullary nail-fixation of tibial and femoral shaft fractures. When compared to daytime operations (6AM to 4PM), after hour operations (4PM to 6AM) required more unplanned operations then the day-time group. There was a nine-fold increase in removal of hardware in the after-hour femoral group then the daytime operations (Asfour, Asfour, McCormack, & Attia, 2014). Machi et al. (2012) examined the effect of sleep deprivation on cognition in emergency room physicians through several tests including the Repeatable Episodic Memory Test (REMT) that looks at immediate memory span, new learning, recognition and susceptibility to interference. The results showed the ER physicians total word recall decreased significantly after overnight shifts and there was a specific decrease in tendency to recall words from the middle of the list of words administered.

The results of the studies listed above demonstrate in great detail the multi-faceted effects sleep deprivation has on cognition. The spectrum of consequences presented should serve as evidence to implement perhaps even more work restrictions. The sleep deprivation residents and interns endure serves as a barrier for providing the best care to their patients. While it cannot be assumed that sufficient sleep will reduce all medical errors, it seems logical that it will help to decrease some that are preventable and lessen the severity.

While there is overwhelming evidence highlighting the harmful effects sleep deprivation has on cognition, there is also data to show sleep deprivation does not have a significant impact. There was not a significant difference in morality or intra-operative complications between sleep and non-sleep deprived cardiothoracic surgeons (Asfour, Asfour, McCormack, & Attia, 2014). Nine surgical residents were tested for their performance in a trauma simulation using the situational awareness global assessment technique (SAGAT). There was no significant difference in the score between the rested and post-call state, in spite of the average sleep of 2.5 hours. A study similar in design to the one previously mentioned found no significant impairment in psychomotor performance and cognitive performance in a group of seventeen surgical residents using a virtual surgery simulator (VSS) (Lehmann et al., 2010). A pilot study was conducted to investigate the effects of fatigue on psychomotor ability in neurosurgery residents. This was measured through different tasks such as grasping a virtual ring and placed them on highlighted pegs with a joystick. The results failed to show any difference in surgical skill performance between pre and post call states (Ganju et al., 2012).

Sleep and Wake Regulation and Physiological Effects on Health Care Professionals

It is well documented that sleep deficiency interferes with every physiological function in the body and moreover, sleep deprivation places individuals at a higher risk of adverse physiological consequences. The ramifications that sleep loss has on physiological homeostasis will be the main focus in this section as well as detailed information regarding its effects on the brain as well as different organ systems.

The physiology of fatigue begins at the level of the hypothalamus in the brain. The hypothalamic-pituitary axis (HPA) is involved in the stress response and sleep wake cycle and has several effects on sleep quality and quantity. It is normal to see a rise in cortisol to prepare the person for morning wakefulness, appetite stimulation and an increase in blood pressure and heart rate to prepare for physical activity. However when there is hyperactivity in the HPA, slow wave sleep decreases, and cortisol levels rise at inopportune times, which serves to disrupt sleep in a variety of ways. Sleep disorders, such as insomnia, are associated with further hyperactivity of the HPA (McGrady & Moss, 2013). Sleep deprivation also plays an important role disrupting our normal eating habits.

Sleep deprivation produces excess ghrelin, a hormone that stimulates hunger, and suppresses leptin, a hormone responsible for suppressing appetite. Appetite and satiety are maintained by neuronal centers in the hypothalamus that are adjunct to centers for internal time keeping. One study demonstrated that acute sleep and chronic partial sleep deprivation can cause a decreased in serum leptin and conversely, there is a noticeable increase in ghrelin in those with shorter periods of sleep (Mullington et al., 2003). Taheri et al. (2004) also found there to be a significant association between sleep loss and levels of ghrelin and leptin in those who slept less than 7.7 hours.

Mustahasan et al. (2013) demonstrated that multiple body systems are affected by sleep deprivation in 364 house officers and post-graduate trainees. Roughly 80% of men and women reported being sleep deprived and nearly 40% reported generalized weakness and 37% reported frequent cold infections. There is also some evidence that links chronic sleep deprivation to poor gastrointestinal and cardiovascular function as well as increased rates of breast cancer and early death.

Parshuram et al. (2004) examined acute markers of physiologic stress in senior fellows working in a pediatric critical care setting. They found that participants who wore a Holter monitor showed arrhythmias and other heart rate abnormalities during on call shifts extending beyond 24 hours. The study also revealed ketonuria in 21% of the participants in in shifts in which urinary ketones were measured and the mean specific urine gravity was 1.02. The mean urine specific gravity, which is a test that measures the density of urine compared to water, has a normal range between 1.002 and 1.030. Ketones found in the urine show that fat is being metabolized for energy, which leads to an acidotic state in the body. These results were likely a result of dehydration, early starvation or other metabolic stresses at play during extended on call shifts.

It was recently shown that after working 30-hour shifts in the ICU, residents had elevated levels of sleep-related cytokines and inflammatory markers such as interleukin-6 (Il-6) and C-reactive protein (CRP) (Mountain, Quon, Dodek, Sharpe, & Ayas, 2007). These elevated blood markers raise concern about long-term impacts of repeated episodes of acute sleep deprivation, especially due to the fact that the aforementioned markers can increase the risk of atherosclerosis and cardiovascular morbidity and mortality. One night of sleep restriction can lead to a change in catecholeamines, specifically a decrease in the following: thyroid axis hormones, cortisol, prolactin (PL), leutinizing hormone (LH), estradiol (E2) and glucose tolerance (Kramer, 2010). It is also known that insufficient sleep or multiple awakenings during the night have a relationship with mood disruption, particularly irritability, anxiety and depression (McGrady & Moss, 2013). The effects of sleep deprivation on mood will be discussed at length in the following section.

In contrast, there is some evidence to suggest that working prolonged shifts may show minimal adverse effects on doctors' health. Oberg et al. (2014) looked at the effect of sleep deprivation on exhaled nitric oxide (FeNO), on internal medicine residents at the University of Southern California (USC) taking night call. FeNO is an indicator of airway inflammation and is associated with sputum eosinophils and eosinophilic markers in bronchial biopsies. Eosinophils are a type of white blood cell type that become active in the presence of certain disease like asthma and allergen exposure. In spite of male residents showing higher levels of FeNO when compared to females, there was no significant correlation between FeNO and sleep deprivation.

Mood disturbances and sleep deprivation

The focus of the section will center on the anxiety, depression, burnout and other psychological effects that stem from sleep deprivation.

According to the established literature, depression or emotional impairment in resident physicians is more common that in the general population (Al-Maddah, Al-Dabal & Khalil, 2015; Lebensohn et al., 2013; Wali et al., 2013). During internship and residency, future physicians are vulnerable to different types of stressors that can manifest as psychiatric disorders such as depression and burnout (Kim, Sunhwa, & Choi, 2015). Research has consistently shown from the 1980s to present that there is a 27-30% prevalence of depression within one year of residency. Studies have shown that residents in Internal Medicine, OBGYN, Pediatrics and Otolaryngology have more than 70% burnout rate (Lefebrve, 2012). In one study, 20 out of 22 focus groups outlined a variety of adverse effects sleep deprivation had on their emotional wellbeing and psychological health, including irritability, impatience, anxious and short-tempered (Papp et al., 2004). The topic of burnout will be discussed next as it is a term used in daily conversation but few actually know what burnout actually means.

Burnout is defined as an occupational related syndrome of emotional exhaustion, depersonalization and low sense of professional accomplishment (Lebensohn et al., 2013). There have been several factors identified leading to this, many of which are associated with residency including the following: work overload, lack of control, lack of fair treatment and insufficient rewards (Sargent, Sotile, Rubash, & Barrack, 2009). Shea et al. (2014) conducted research by giving a five-hour protected sleep period to interns at two different Philadelphia hospitals when they were on call to determine what effects it would have on their mood, specifically depression, burnout and empathy. The protected sleep yielded lower levels of the emotional exhaustion and depersonalization component of the burnout survey as well as lower personal distress levels and higher perspective taking on the interpersonal reactivity index scale. It has been reported that disturbed sleep is likely considered a mechanism involved in the development of burnout syndrome symptomatology. This is in turn is understood as the chronic depletion of an individual’s energy resources (Vela-Bueno et al., 2008). The established range for burnout for specialists in oncology, surgery and neonatology ranges between 28-38% and the level of emotional exhaustion and depersonalization among practicing family physicians is nearly 50% (47.9% and 46.3% respectively) (Lebensohn et al., 2013). These previously mentioned studies help illustrate why burnout is important for the medical community to recognize and in turn how assist in minimizing these negative consequences.

One study found that depression among interns from the beginning to the end of their internship increased between five and ten-fold (3.9% to 25.7%) (Sen et al., 2010). It has been documented that physicians demonstrate many symptoms of severe depression and suicidal ideation during their internship and that the average resident has trouble with nervousness, depression, indifference and hostility. There have been studies demonstrating fatigue-related anger and depression can lead to detachment and lack of compassion for patients (Kiernan, Civetta, Bartus, & Walsh, 2005). Anger and detachment possess the ability to destroy good patient-provider relationships and in turn can deter patients from making treatment contact. One of the fundamental components of being a good health care provider is being a caring and compassionate professional, however, if internal strife develops, there is a higher probability of becoming indifferent towards the patient.

In a survey performed by Papp et al. (2004), 64% of residents agreed or strongly agreed "sleep loss and fatigue have a *major impact* on my personal life." One study included a survey among internal medicine residents at the beginning and the end of their internship and demonstrated a strong association of chronic sleep deprivation and moderate depression (Rosen, Gimotty, Shea & Bellini, 2006. Balch et al. (2010) found that those working more than two night calls per week had a 34% positive depression screening compared to 22.2% in those working less than 60 hours per week. Residents who are depressed are more likely to continue working despite the presence of continuing fatigue and have greater difficulty concentrating at work.

Depressed residents can potentially be at an increased risk of suicide because they are more prone to experience a failed sense of belonging, can experience feelings of burdensomeness and have the desire to harm themselves. The idea that residents not feeling a sense of belonging is believed to be a result of training environments that do not have sufficient levels of social support in place. OBGYN residents at Northwestern University Feinberg College of Medicine who reported feelings of dissatisfaction with their career choice were nearly twice as likely to be diagnosed with depression (55% v 30%) (Becker, Milad & Klock, 2006). A study performed by Aguocha et al. (2015) surveyed residents in training at a teaching hospital in the Enugu state of Nigeria and used non-resident physicians as a control. The results were such that the rates of depression in resident physicians were almost 17 times higher compared to non-resident physicians (17.3% v 1.3%).

One study included the use of the Beck Depression Inventory (BDI) and the Epworth Sleepiness Scale (ESS). There were significant correlations between acute sleep deprivation and depressive symptoms and a relationship between working night shifts and depressive symptoms. Of those who worked more than 24 hours, more than half (54.8%) reported mild depressive symptoms and 20% of those who worked 24 hours reported moderate to severe depressive symptoms (Al-Maddah, Al-Dabal & Khalil, 2015). Mustahsan et al. (2013) carried out surveys to postgraduates and house officers pertaining to sleep deprivation and its relationship to anxiety and depression. In the 364 individuals in the study, 68% of the participants reported anxiety and depression.

Kim, Lee and Choi (2015) looked at the relationship between occupational stress and depression in interns and residents at a Seoul hospital. Any participant with previous psychiatric disorders was excluded and similarly to the study performed by Al-Maddah, the BDI was given to measure depression prevalence. The results showed that interns and chief residents showed a higher degree of occupational stress than second and third year residents. Nearly 35% of interns reported having a severely depressive mood and 45% experienced some form of occupational stress. Of the 22 first year residents and 19 second year residents polled, high levels of severe depression were noted as well (18% and 17% respectively). Residents who were suffering from depression were six times more likely to make medication errors then those non-depressed residents (Lefebrve, 2010).

The evidence presented in this section illustrates the severe consequences sleep deprivation has on the mental health of physicians in training. A patient wants their provider to be someone that is compassionate, empathetic, attentive and mentally healthy. These attributes will not be present if their provider is feeling emotionally exhausted, severely depressed or experiencing undue anxiety. It is important to recognize and understand these negative ramifications in order to best serve not only the patient's best interest, but firstly their provider's health.

There is some conflicting evidence on the topic of 80-hour weeks and disturbances in mood. Kiernan et al. (2005) further examined the effect of sleep deprivation and the 80-hour work-week on mood in surgical residents, years one to five, in those post call, after a 24 on call period, compared to those nights off call. The results revealed no difference in average values of anger, depression, concentration, fatigue, tension or total score between the two groups through the profile of mood states (POMS). There was no significant relationship between acute sleep deprivation between the pre and post score.

Relevance to the physician assistant profession

The information presented in this paper is particularly relevant for PA students and practicing PAs. In spite of the differences in training, most notably length, between the PA and MD degree, the demands and stress placed on the students in the programs are similar. Medical students are obligated to complete 75 semester hours in the first two years followed by two years of clinical education. Physician assistant students must complete 73 semester hours in the didactic portion followed by 48 semester hours in the second year. As a result, a physician assistant student will likely experience the same difficulties with working prolonged hours in combination with insufficient rest as medical students, interns and residents.

A study published by the *Journal of Physician Assistant Education* in 2012 echoed the findings presented by the different studies about the stress and strain placed on interns and residents during their training. Electronic surveys were administered to all current members of the Texas Academy of Physician Assistants. The study used the Perceived Stress Scale (PSS) as the means to determine stress severity and frequency in study. The scores ranged from a score of one, which was “never” up to five, which was “very often.” They also used the Brief Cope Inventory (BCI) as a means of assessing the type of coping mechanisms used by those in the study. One of the sample questions from the BCI was “I have been trying to make the situation better by…” The results revealed that the physician assistants had higher PSS scores when compared to the general population. In addition, 68.6% of participants demonstrated using at least one unhealthy coping mechanism. The three most common coping techniques identified were self-distraction, venting and self-blame. Self-distraction is identified as a negative coping strategy because it changes one’s focus from the problem to something else, something potentially unhealthy. It is not helpful to rely on this technique for extended periods of time as this could lead to self-medicating with drugs like alcohol (O’Brien, Mathieson, Liefman & Rice-Spearman, 2012).

There still exists a fear of disclosure among medical students, interns and residents when answering questions for a potential job such as “do you have any mental or physical disabilities that interferes with your ability to take care of patients?” One study identified stigma as an explicit barrier to the use of mental health services by 30% of first and second-year medical students experiencing depression (Givens & Tjia, 2002). In addition, almost 40% identified lack of confidentiality and 24% cited fear of documentation in their academic record as barriers to treatment (Chew-Graham, Rogers & Nassin 2003). It is well documented that there is insufficient funding and lack of adequate resources for the general population with mental health issues; it is alarming to see these high percentages in those who will be providing direct patient care.

A study done in 2009 among medical students at the University of Michigan found that students worry that revealing their depression will make them less competitive for residency training positions or compromise their education. In addition, the researchers found that students with higher depression scores felt more strongly than did those with none to minimal depression that telling a counselor would be risky and that asking for help would mean the student's coping skills were inadequate. An important finding from this research was that 70-80% of those who reported having moderate to severe depression using the Patient Health Questionnaire (PHQ-9) reported no history of diagnosis or treatment (Schwenk, Davis & Wimsatt, 2010).

It has been a common occurrence for many in my class to study throughout the entire night without sleep and take a test that same day. I believe the research illustrates a deeper understanding of the health risks that sleep deprivation can cause for current and prospective PA students. It is important to have this knowledge to be able to recognize limitations in our ability to give the best care possible limitations as a result of sleep deprivation. It is hard to function in the classroom after prolonged periods of wakefulness and to have to assist in trauma surgery or managing a patient who may be actively having a heart attack is something that requires the highest level of focus and concentration.

There is minimal data pertaining to the effects that the PA program curriculum has on students' physical and mental health, which is something that needs further exploration. A better understanding of the amount of stress resulting in sleep deprivation and consequences identified in this review can better assist faculty members to design more achievable specifics of the curriculum for the students. It can be concluded based on this train of thought that students can achieve and maintain better mental and physical health, provided such changes are made. The limited literature pertaining to sleep deprivation on PA students might be because the profession is still not widely understood and is a relatively new profession compared to the traditional medical school. Some of the existing misconceptions about the profession include the idea that physician assistants have a role similar to that of a medical assistant in that they merely *assist* the physician. Instead, the physician assistant can prescribe medications, perform physical examinations, practice medicine autonomously under the supervision of a doctor, and much more.

Physician assistants must be honest with themselves. They need to seek help if needed, ask a mentor for an opinion and or have a mentor outside of the profession to ask for guidance. As a member of a team, those who are involved must know when to say something if they suspect someone is struggling because of sleep deprivation that is affecting their performance and quality of life. The PA who treats a broad range of patients should be particularly aware of the challenges that health care providers face. It is important to know which questions to ask during a mental health evaluation and to focus on the problem at hand. A more informed evaluation and the appropriate treatment must be administered based on that evaluation will allow them to return back to work sooner and will be better equipped to deal with difficult personal situations.

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Abstract

Objective: To examine the effects of sleep deprivation on cognition and behavior in physicians in training.

Method: Search of databases including PubMed, MEDLINE, and Google Scholar.

Results: The detrimental effects of sleep deprivation on physician's cognitive abilities were consistently documented by original research. Many key components of physician behaviors were negatively affected such as diagnostic accuracy, interpretation of lab results and avoiding complications during surgery. Similarly, there was a general consensus of psychological consequences exhibited as a result of sleep deprivation including depression, burnout, and anxiety.

Conclusion: The results of the literature review highlight the need to have more resources available for the safety and wellbeing of physicians in training. Being a skilled physician requires physical and emotional health, both of which are a necessity for a Physician Assistant (PA). There is limited research to suggest PA students experience disturbances in their mental and physical health during their training.