Patient Safety: Fatigue, Sleep, and Work Schedule Effects

Formerly Position Statement Number 2.17

The growing need for surgical services coupled with rising complexity and anesthesia professional shortages has put ever increasing demands on Certified Registered Nurse Anesthetists (CRNAs) to deliver timely, evidenced-based, anesthesia care. Mounting scientific evidence reinforces long-standing beliefs regarding the physiologic need for sleep and the crucial role fatigue plays in human performance. Healthcare professionals are not exempt from the effects of workload, work duration, and work intensity leading to sleep deprivation and fatigue. Anesthesia professionals are routinely expected to provide high-quality anesthetic services to facilitate patient surgical, therapeutic and diagnostic procedures at any hour 365 days per year. CRNAs are often required to be on 24-hour call with unpredictable case loads and irregular work hours based on facility and patient needs. Continuous clinical observation, sustained vigilance and assessment of patient responses to anesthesia and/or surgical intervention forms the basis of safe and effective anesthesia delivery. Nurse anesthetists recognize their ethical responsibilities to patients and co-workers for maintenance of safe and acceptable work behaviors; however, the growing patient acuity and persistent high-intensity work demands, contributing to provider fatigue, necessitates scheduling considerations that can include shift scheduling adjustments and/or work hour limitations.

In 2008, Fletcher et al. conducted a survey of hospitalized patients to assess their feelings about healthcare provider fatigue and any resulting discontinuity of care. Twenty-seven percent (27%) of respondents were concerned about fatigue in residents and 45% believed that having their regular doctor fatigued would lead to problems. Half of those surveyed believed that work hours should be limited for both residents and nurses. The Institute of Medicine (IOM) reported on a 2001 National Sleep Foundation poll indicating that 65% of patients would feel anxious for their safety if they knew their surgeon was on duty for 24 consecutive hours and 45% would ask for another doctor in this case. In a 2003 survey of surgical residents and faculty regarding work hour limitations in surgical training programs, 57% of residents felt that their cognitive abilities had been severely impaired by fatigue and a significant number of residents (64%) and faculty (39%) believed that duty hour restrictions should be adopted to promote safety. More recently, in a 2011 survey of 1,284 active CRNA respondents, Biddle and Aker found that 25% of respondents reported fragmented sleep and 68% claimed to be excessively tired during the day. The authors concluded that their findings indicate that all healthcare professionals (not only interns and residents) are affected by the behavioral consequences of sleep deprivation and extended shifts.

The American Association of Nurse Anesthetists (AANA) is committed to promoting and promulgating patient safety strategies to prevent or reduce errors in healthcare. The purpose of this position statement is to provide guidance to AANA members and healthcare practitioners regarding sleep deprivation and fatigue as they relate to human performance and well being. Work schedule concepts that include erratic shift scheduling, 24-hour continuous operation, extended work periods, and employee sleep-response unpredictability are all variables to be considered.

The AANA recommends that healthcare facilities have written policies to address fatigue and work-rest schedules to promote patient safety and employee health. As such, this document will present scientific evidence and outline fatigue countermeasures as well as best evidence work schedules that promote provider performance and well being. The AANA embraces the following practices in this document for planning and improvement efforts, recognizing that there may be extenuating circumstances (e.g., mass casualty incidents) that may require greater flexibility.
Circadian Clock, Sleep and Rest

The human circadian rhythm is an approximate 24-hour internal clock that fluctuates in regular and predictable cycles corresponding to human physiological, behavioral, and psychological processes. Sleep deficiency is characterized as a deficit in sleep quantity or sleep quality needed for optimal health and performance often resulting from prolonged wakefulness, inadequate sleep duration, sleep fragmentation or a sleep disorder. Circadian rhythms exist independently of the duration of prior sleep. Light is known as one of the major factors in the sleep/wake cycle that triggers alertness during the day and rest at night. Furthermore, internal body temperature correlates with the circadian clock whereby low body temperature is often observed between 0300 and 0500 corresponding with lower alertness and a need to sleep.

Healthy adults who receive less than five hours of sleep per night have an increased need for sleep and demonstrate diminished cognitive performance. Czeisler et al. found that when sleep was chronically restricted to seven or less hours per night, the ability to sustain attention, maintain cognitive performance and prevent attentional failures were all diminished. A 2009 IOM report chronicles three sleep-dose response experiments, each demonstrating decreased cognitive functioning in subjects after chronic sleep restriction of less than 7-8 hours per night. The IOM recommends that adequate actual sleep should consist of 7-8 hours of sleep per night. Furthermore, the report reveals that the quantity and quality of sleep obtained may contribute to fatigue as performance demands increase secondary to work intensity, duration, and time. Acute sleep loss is described as beginning when wakefulness goes beyond 16 hours.

Factors contributing to fatigue include, but may not be limited to, time on task, time and duty period duration, time since awake when beginning the duty period, acute and chronic sleep debt, circadian disruption, multiple time zones, and shift work. Shift work is shown to produce physical symptoms of fatigue and is characterized as discontinuous, slow or fast paced, occasional, regular or irregular work with different start and finish times. Adaptation to night-shift work can happen, but this occurs over several cycles during the adaptation phase. An internal desynchronization may take place if adaptation does not occur. For night and irregular shift work, it is this desynchronization that is postulated to cause adverse effects on health. A study aimed at understanding whether anesthesia residents can predict the onset of sleep was performed in a simulated environment. Researchers found that individuals varied in their ability to predict sleepiness and sleep onset. Anesthesia residents who were not aware of the physiological and cognitive warning signs of sleep deficiency were poor predictors of sleep onset and would in fact fall asleep when they thought sleep was highly unlikely. More importantly, over the course of the study, some individuals learned to predict physiologic and cognitive markers of sleep indicating that education regarding sleep recognition and circadian factors are essential in understanding fatigue.

Effects of Sleep, Wakefulness, Age and Health on the Human Condition

In a randomized control trial of sleep deprivation among healthy adults, Von Dongen and colleagues demonstrated a dose dependent deficit of cognitive impairment after strict sleep periods of 4-6 hours per day over 14 days equivalent to two nights of total sleep deprivation (24 hours of sustained wakefulness). The authors note that chronic sleep loss over time has neurobiological effects during wakefulness that are exhibited by poorer cognitive function. In 1997, Dawson and Reid reported that 17 hours or more of wakefulness was equivalent to a blood alcohol concentration (BAC) of 0.05% and 24 hours of sustained wakefulness was equivalent to a BAC of 0.10% as evidenced by a significant decrease in hand-eye coordination.

When comparing work performance with age and time of shift, Reid et al. reported that older research subjects (mean 43.9 years, range 35-56) demonstrated a greater decrease in performance during the night
shift compared to younger subjects (mean 21.2 years, range 18-30).\textsuperscript{21} Vulnerability to sleep loss can be influenced by prior sleep-wake history (narcolepsy, sleep apnea, shift work insomnia), age, trait and potential genetic differences, infectious diseases (e.g., common cold, mononucleosis, hepatitis), chronic pain, nocturnal asthma, and primary sleep disorders.\textsuperscript{15} The literature is rich with evidence demonstrating that more automobile driving errors occur when the driver is fatigued after working long hours, particularly at night.\textsuperscript{22,27}

**Effects of Wakefulness on Healthcare Professionals**

Studies have demonstrated that sustained wakefulness of 24 hours or more among medical residents and interns has contributed to decreased vigilance, lapses in concentration, and attentional failures.\textsuperscript{17, 23, 28-30} In a meta-analysis of sleep deprivation among medical residents, Philibert et al. found that the effects of sleep loss on vigilance and clinical performance were greater than memory and cognitive function when residents were awake for 24-30 hours.\textsuperscript{30} In a 2006 study of critical care residents examining the impact of a 24-hour extended-duration shift on medical errors and attentional failures, extended-duration work shifts were associated with an increased risk of significant medical errors, adverse events, and attentional failures in interns across the United States.\textsuperscript{29} Finally, in a simulation study of anesthesia residents exposed to both extended sleep (9.23 ± 0.85 hrs) and sleep deprivation (25-30 hours sustained wakefulness), Howard et al. found that individuals in both sleep states made clinical errors.\textsuperscript{17}

In addition to diminished clinical performance and attentional failures in healthcare settings, evidence reveals that extended wakefulness may also be harmful to healthcare providers. Ayas et al. reported in the *Journal of the American Medical Association* (2006) that percutaneous injuries (i.e., needle sticks) increased among interns during night shift and extended working hours (24 consecutive hours). The authors noted that lapses in concentration and fatigue were the two most reported factors for injury.\textsuperscript{28} Blum et al. found that for every extended work shift (more than 24 hours) worked in a month, the risk of interns having a car accident increased by 9.1% and the risk of having a car accident on the commute home after the extended shift increased by 16.2%.\textsuperscript{23} In addition to percutaneous injuries and motor vehicle accidents, regular sleep of less than five hours per night has been linked to impaired health. In a retrospective review of Centers for Disease Control and Prevention population data, Grandner and Pack found that regularly sleeping less than five hours increased the likelihood of subjects being obese (42%) or having diabetes (40%), hypertension (69%), high cholesterol (36%), stroke (62%) and heart attacks (152%).\textsuperscript{31} These findings demonstrate that prolonged wakefulness influences vigilance, clinical performance and cognitive function in healthcare professionals as well as increases a personal risk to self.

A 2004 report in the *New England Journal of Medicine* compared medical interns working a traditional extended work schedule (i.e., 24 hours or more) to interns working an interventional 16-hour shift schedule. The 16-hour shift group had significantly increased sleep time and decreased attentional failures during night work hours.\textsuperscript{32} Currently, the 2009 IOM report on resident duty work hours and the American Council of Graduate Medical Education (ACGME) 2011 core requirements recommend that continuous work should be limited to no more than 16 hours for medical residents.\textsuperscript{4, 33} In a 2009 review by Blum et al., authors synthesized the recommendations of an expert panel challenged with addressing the issue of resident work hours, supervision, and safety. Regarding scheduling, the expert panel mirrored the IOM 2009 recommendations that residents should work no more than 12-16 hours per shift and have a minimum of 10 hours off between shifts, and that schedules should be designed to adhere to sleep and circadian science principles.\textsuperscript{4, 23}

In a 2004 study of hospital staff floor nurses, Rogers et al. retrospectively examined the relationship between hours worked and frequency of errors. Of the errors reported, 58% of errors and 56% of near misses involved medication administration, 18% were related to procedural errors, 12% charting errors, and 7% transcription errors. The authors found that the odds ratio (likelihood of making an error) was
three times higher when nurses worked 12.5 hours or more. Furthermore, age, hospital size, and hospital unit were not found to be factors related to errors and reported overtime.

Research looking at intensity of clinical setting such as the intensive care unit or emergency department has called for further work hour restrictions. Czeisler et al. state that both the 2009 IOM resident duty work hour report and the 2001 recommendations by the Association for American Medical Colleges (AAMC) indicate that resident physicians should not work more than 12 hours in high-intensity work areas if necessary. In a matched retrospective study of surgical and OB/GYN attending physicians, researchers compared emergency nighttime procedures followed by normal day procedures with those who performed daytime procedures only to determine if sleep duration and extended shift had an effect on preventable surgical and OB/GYN complications. Results indicated that a statistically significant number of complications occurred among physicians performing post-nighttime procedures with less than six hours of sleep. Currently both the Association of periOperative Registered Nurses (AORN) and American College of Emergency Physicians (ACEP) have position statements recommending that work shifts be limited to no more than 12 hours.

Regarding 8-12 hours of continuous work, the IOM concludes that there is no compelling evidence that patient safety diminishes from 8-12 hours of shift work.

**Fatigue Countermeasures**

In 2001, Caldwell and Gilreath examined the work and sleep hours of U.S. aviation personnel on reverse cycle shifts. Researchers found that aviators demonstrated variable sleep quality depending on their bedtime and recommended that countermeasures such as medications to assist daytime sleep and light therapy to help circadian rhythms be employed to promote both alertness at night and better sleep during the day. Veasey et al. also noted that research of bright light therapy from 2 a.m. to 9 a.m. may activate the circadian system and possibly improve vigilance performance. In reviewing certain stimulants, these investigators reported that drugs such as high-dose caffeine, modafinil, and D-amphetamine may be effective in reducing sleepiness and enhancing vigilance; however, a health risk and benefit analysis needed to be considered when using these products routinely. In 2007, Lohi et al. studied the effect of caffeine on simulator flight performance of sleep deprived military pilots and found that 200mg of caffeine did not have a significant effect on flight performance after 30 hours of sleep deprivation; however, after 20 hours of sleep deprivation the aviators who received the caffeine subjectively felt that their flight performance was better than other simulations without caffeine.

Caldwell and colleagues recognized that individuals who worked nights were at risk for fatigue during their shift. They found that a 2-3 hour prophylactic nap before night work was shown to improve performance and four hour naps yielded the longest benefit. They postulate that prophylactic naps may help some individuals with performance during the night shift, but some individuals with significant circadian misalignments resulting in impaired wakefulness may require a sleep specialist intervention and additional therapeutics. In a study among marine pilots, Ferguson et al. concluded that regular use of frequent naps appeared to slow the accumulation of sleep deprivation and allow for sustained attention during extended pilot work hours. Similarly, naps as short as 15 minutes have been shown to significantly improve human performance decrements if provided at 2-3 hour intervals during 24 hour of sleep deprivation. In a randomized sleep trial among emergency department staff, results of a 40-minute nap showed that staff could maintain performance and demonstrate improved self alertness and mood. Some among the nap group demonstrated sleep inertia (i.e., sleep grogginess) after waking from the nap, indicating issues related to nap timing or duration. Rosekind and colleagues stated that the possible risk of sleep inertia needs to be considered against the improvements in alertness and overall performance because it can be detrimental if the provider is expected to respond rapidly to an emergency.
According to Buysee and colleagues in a 2003 report, medical healthcare professionals typically receive little education about sleep science and circadian rhythms. The authors also note that the overall goal of education is to increase awareness of sleep loss as a source of stress and fatigue, address adverse personal and patient outcomes, and create an environment that promotes optimal performance and alertness. In addition to learning the physiologic and cognitive warning signs of sleep, education should also promote methods to obtain healthy sleep. Caldwell et al. suggest that individuals should follow appropriate sleep hygiene techniques to optimize night and daytime sleep. The IOM believes that both information and interventions designed to help individuals acknowledge their own vulnerability to the cognitive effects of sleep loss could assist with developing a personalized fatigue management system. Howard and his colleagues support the IOM position noting that educational programs and institutional policies are needed to address this issue. Additionally, they conclude that strategies for managing alertness in healthcare should include naps, caffeine, good sleep habits, pharmacotherapeutics and light therapy. Moreover, sleep and fatigue education will require an alliance with stakeholders such as students, residents, program directors, hospital administrators, sleep specialists, and government/regulatory agencies.

The Joint Commission (TJC) publishes sentinel event alerts to describe critical events in patient care. In 2011, TJC issued an alert related to healthcare worker fatigue and patient safety. In it, the patient safety advisory group for TJC describes common underlying causes for fatigue and suggests relevant processes to consider for minimizing occurrences of patient safety lapses related to healthcare worker fatigue. The group also suggests that organizations perform fatigue-related risk assessments, review patient hand-off processes, invite staff to participate in scheduling, create a fatigue management plan, educate staff about sleep hygiene, and provide an environment for sleep breaks if appropriate. The group further suggests that organizations promote a safety culture by providing staff with opportunities to address fatigue concerns, encourage teamwork, and acknowledge fatigue as a potential patient safety issue.

**Research and Future Directions**

Tools to improve shift work management and address appropriate scheduling would be invaluable to those invested in minimizing work related fatigue. Predictive fatigue models have been reported to assist in understanding shift work and fatigue. Akerstedt et al. believe that appropriately designed predictive shift models can assist workers in optimizing sleep patterns and help guide administrators regarding the same. More research is needed to better understand vulnerable employees and possible interventions to minimize fatigue-related risks to public safety. The NIH National Center for Sleep Disorder Research acknowledges that more studies are needed to define the genomic, physiologic, and neurobiological impact of sleep on the human condition and believes that translational research is needed to enhance the transfer of scientific knowledge of sleep and circadian rhythm to clinical practice and society at large. Regarding anesthesia, more research is needed to understand duration and intensity of work and their effects on patient safety; the effects of fatigue countermeasures in anesthesia on ameliorating fatigue; surgical and anesthesia cultural perceptions regarding fatigue and sleep deprivation; and setting specific work schedule systems to counteract these issues. The AANA promotes and encourages further sleep research as it pertains to CRNAs, healthcare employees, shift work, and patient safety.

**Practice Recommendations**

The AANA is dedicated to protecting and facilitating CRNA professional practice and patient safety. Anesthesia care requires 24/7 services and the intensity of work, a known fatigue contributor, varies based on setting, case load, and patient acuity. The degree of variability of human sleep physiology and anesthesia care is currently unknown; however, chronic sleep deprivation and fatigue remain both an anesthesia professional and patient safety issue. As such, this position statement sets forth the following
recommendations for the implementation of work schedules, countermeasures, staffing and educational programs:

- CRNAs are ethically responsible for adhering to the AANA’s Code of Ethics by assuring that they are well rested and fit for duty.\(^1\)
- Organizations and institutional policies should improve their culture of patient safety by addressing the risks associated with employee fatigue and promoting a climate of supportive safe care encouraging teamwork and allowing staff to discuss fatigue concerns.\(^1\)
- Schedulers should incorporate staff input, acknowledge work intensity and recognize circadian rhythm principles when designing work schedules.\(^1\)
- CRNAs should not provide anesthesia patient care for more than 12-16 consecutive work hours within a 24-hour work period (i.e., scheduled on duty or on call) which must include adequate breaks for meals and respite to maintain appropriate physiologic function.\(^3\)
- Recognizing that there may be extenuating circumstances (e.g., mass casualty incidents) that may require greater flexibility in scheduling and implementation, exceptions to the 12-16 hour limit should be outlined within institutional policies.
- On-call service should be designated periods of time outside of scheduled operational hours during which CRNAs respond to unplanned urgent or emergent patient needs.\(^1\)
- Institutions should allocate proper staffing for round-the-clock operations as appropriate and specific to facility needs.\(^4\)
- CRNAs should be provided with break rooms for adequate rest breaks on scheduled rotations to assure alertness when on duty.\(^5\)
- Healthcare facilities should employ written policies to address fatigue and work-rest schedules to promote patient safety and employee health.
- Nurse anesthesia educational programs should provide education to their graduate students and clinical and academic faculty regarding sleep science, fatigue counter measures, circadian rhythm, fatigue, clinical performance and patient safety. In addition, these programs should consider sharing this knowledge with healthcare administrators in facilities where graduate students and faculty provide anesthesia services to promote safe work practices and patient safety.\(^6\)

### References


