



2024 Emergency Services Foundation Scholarship



Investigating the Impact of Sleep Disturbance on Emergency Service Personnel.

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Executive summary

Emergency service responders' health is negatively impacted through sleep disruption due to their roles within the sector. Sleep has been identified to negatively impact nearly every component of the human body, with disruption to circadian rhythm caused by shift work being classified as "probably carcinogenic to humans". Due to sleep disruption, there are high rates of sleep disorders within the sector. The nature of the emergency service sector requires 24-hour response, and consequently elimination of sleep disruption is unattainable. A collaborative approach to this complex problem is needed. This report identifies learnings from academia and attendance of First Responder Sleep Recovery Train the Trainer Retreat. Practical tools are provided for individuals and agencies to implement to minimise the impact of sleep disruption. Firstly, to address the problem you must understand it, and a greater emphasis needs to be placed on providing sleep awareness and education. This report provides recommendations for organisations, and individuals, to reduce the impact of sleep disruption. Yoga Nidra has been identified as a valuable mechanism to improve first responders' sleep recovery and should be implemented as part of a comprehensive sleep awareness and recovery program. Emergency service personnel's sleep disruption affects and is affected by family life. Sleep awareness and recovery programs must be inclusive of emergency service personnel's families.

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Introduction

Emergencies don't sleep and never do emergency service personnel as they experience sleep disruption through shift work coverage, or emergency response. The magnitude of shift work's impact on employees' health cannot be understated, with the International Agency on Research on Cancer classifying disruption to circadian rhythm caused by shift work as "probably carcinogenic to humans" ⁽¹⁾. Disruption to circadian rhythms due to shift work significantly impacts an employee's mental and physical health ⁽²⁾. Notably, natural killer cells which are a crucial part of the immune system (providing protection from viral infection and cancer cell production) have a 72% reduction in production when individuals are restricted to four hours for a single night ⁽³⁾. Notably, it is not uncommon for emergency service personnel to have a four-hour limited or disrupted nightshift.

The impact of sleep disruption within the Emergency Services sector is highlighted in a study where over 40% of police officers screened positive to a sleep disorder ⁽⁴⁾. These results were similar in a firefighting setting where it was identified that in excess of 37% of firefighters have a sleep disorder ⁽⁵⁾. Due to potential errors and inconsistencies of the study, there are estimates that this percentage is significantly higher. The extent of disruption of the circadian rhythms from shift work is highlighted with the medical condition "Shift Work Disorder", which involves chronic sleep deprivation and ensuing health problems ⁽⁶⁾.

Emergency Service personnel with sleep disorders have an increased likelihood of chronic physical health problems (cardiovascular disease and diabetes) and mental health issues ⁽⁷⁾. A correlation has been identified between high Epworth Sleepiness Scale scores and increased ill health as measured by healthcare utilisation ⁽⁸⁾. The leading causes of on-shift fatalities for firefighters have been identified as cancer, heart attack, and suicide, and importantly research has identified a correlation between sleep deprivation and these conditions ⁽⁶⁾.

It has been identified that Emergency Service personnel, specifically firefighters, cannot obtain restful sleep due to the anticipation of incident alert tones, resulting in a lack of the beneficial REM and deep sleep ⁽⁹⁾. REM sleep is important in the processing of emotional memories ⁽³³⁾, and due to emergency service personnel attending traumatic incidents this lack of emotional processing may significantly be impactful.

Undeniably, sleep disruption negatively impacts an individual's health and with sleep disruption unavoidable within the emergency service sector, there is a necessity to provide resources that minimise the impact. This report is aimed at increasing the awareness of the severity of the situation and to provide tangible outcomes that will assist all emergency service agencies, their personnel and families. These recommendations are aligned with recommendations outlined in the Australian Government's House of Representative Inquiry into Sleep Health and Awareness in Australia ⁽¹⁰⁾. This report identifies that collaboration is needed, and highlights both employers' and employees' responsibilities to manage fatigue under Work Health and Safety. The report specifies that employers must provide a safe work environment and monitor the health of workers to prevent illness or injury arising from the undertakings of their work. This report aligns with the recommendation of working in partnership with key stakeholders to develop and implement sleep health awareness campaigns.

This study is the merger of academic research, and the practical learnings provided through the First Responder Sleep Recovery Train the Trainer Retreat in Moffat Colorado, United States June, 2024. This program was the only identifiable sleep recovery program designed specifically for emergency service responders. The facilitators Lieutenant Sean Toomey of the Denver Fire Department, and a

Captain of Operations of Clear Creek Fire Authority and Jacqueline Toomey, a first responder sleep specialist are both keynote speakers at international firefighter conferences and have delivered numerous specialised programs to the emergency service sector to over 5,000 first responders across 18 states and 3 Canadian provinces over the last decade. The program has been developed through lived experience as a career and volunteer firefighter. The First Responder Sleep Recovery program is designed to optimize mental, physical and emotional well-being through holistic health-based practices. This program is focused on evidence-based practices for the prevention of the top causes of death for emergency service responders.

Sleep

Scope of the study

This report is intended to provide resources and education to emergency service agencies and personnel. This report should not be used to diagnose sleep disorders or undertake pharmaceutical intervention without medical advice/supervision.

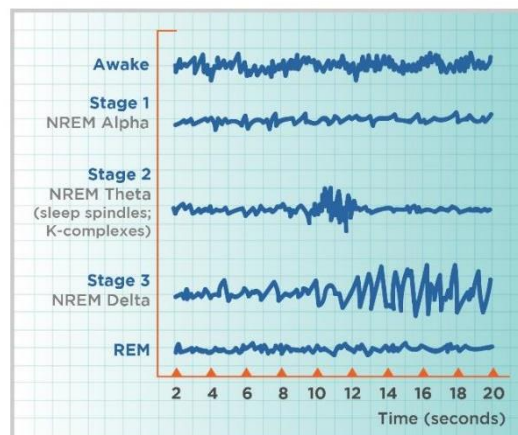
Sleep surveys are screening tools that may be beneficial in identifying sleep disorders, however in a presentation by Joel Billings, PhD.,⁽¹¹⁾ he identified that the unique response requirements of emergency service responders requires a unique screening tool. The Emergency Service Sleep Diary is a unique sleep screening for emergency service responders that specifically accounts for disruption by emergency response. The Emergency Service Sleep Diary was identified to have greater correlation with actigraphy than compared to a Modified Pittsburgh Sleep Quality Index or Pittsburgh Sleep Quality Index. It is recommended that emergency service personnel utilise the Emergency Service Sleep Diary in conjunction with other sleep screening tools when evaluating sleep.

With the high rates of sleep disorders within emergency service responders^(4, 12), Sean Toomey identified that the Denver Fire Department provides firefighters with take-home sleep apnoea screening devices to identify sleep disorders. The provision of this service within the Victorian Emergency Service sector would align with the Australian Government House of Representative Inquiry into Sleep Health and Awareness in Australia report⁽¹⁰⁾ recommendation of considering sleep health screenings for shift workers.

What is Sleep?

The importance of sleep cannot be understated, it is a process that humans devote one-third of their life to. Sleep is not a passive process, but rather an active recovery process both physically and mentally. As you sleep you transition through five stages of sleep: four non-rapid eye movement (NREM) stages Stage 1 NREM, Stage 2 NREM, and Stage 3 NREM, and one x rapid eye movement (REM) stage. Note: Previous classifications had 5 stages of sleep, with the current sleep science modelling combining Stages 3 and Stages 4 of non-rapid eye movement stages into Stage 3 NREM. These stages are determined by the brain wave activity and measured through electroencephalography (EEG). The brain activity for the sleep stages are as follows:

EEG RECORDINGS DURING SLEEP



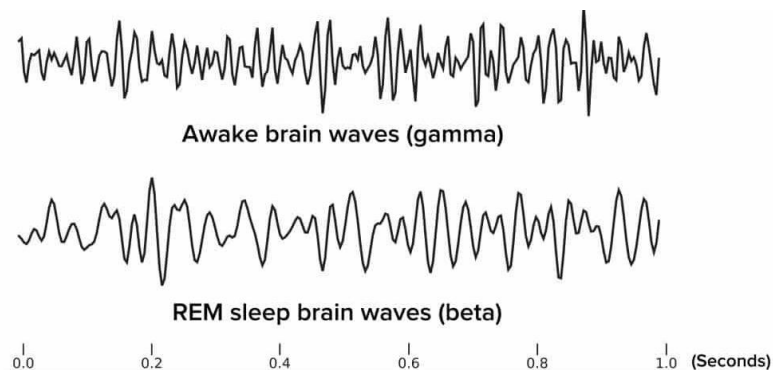
Source: Lumen Learning. EEG Recordings during sleep. Stages of Sleep: Lumen Learning, p.
<https://courses.lumenlearning.com/waymaker-psychology/chapter/stages-of-sleep/>.

The body will cycle through these stages 4 to 6 times on a typical night, with the cycle being approximately 90 minutes in duration.

Whilst all stages of sleep are important, this report will concentrate on NREM Stage 3 and REM sleep.

NREM Stage 3 sleep is also known as slow-wave or deep sleep and is characterized by delta brain waves. Importantly this deep sleep stage is associated with physiological repair. This sleep stage is important to emergency service personnel due to the physical demanding requirements of the role.

Within REM sleep your brain is very active and the brain activity looks like the awake state. REM is associated with dreaming. Within REM sleep there is a normal body paralysis that prevents the acting out of activity within dreams. REM sleep is important for emotional processing of memories. With emergency service personnel being exposed to traumatic incidents, it is crucial that sufficient REM sleep is obtained.



Source: Snore Lab. Awake vs REM brain wave. The Architecture of Sleep2019. Accessed 19/7/2024.

Mechanisms of sleep.

Circadian Rhythm

The Circadian Rhythm is the body's 24-hour body clock and is heavily influenced by light exposure. As light is an external synchroniser of an individual's circadian rhythm, light exposure to the eyes is an important technique to understand. Light exposure, especially blue light omitted from the sun, increases cortisol levels and this impacts melatonin release due to their inverse relationship. The identified disrupted circadian rhythms caused by shift work or sleep disruption results in hormone release interference with melatonin being one of the hormones affected by desynchrony of circadian rhythms caused by working night shift⁽²⁾. Melatonin is a regulator of the "circadian clock", influencing sleep cycles, and it is heavily influenced by environmental stimuli, specifically darkness and light⁽¹⁵⁾. Notably, melatonin has significant antiapoptotic (cancer prevention) and antioxidant properties⁽¹⁶⁾.

Emergency service personnel should attempt to get blue light exposure, ideally from the sun, early in the morning and avoid this light wave late at night to allow for synchronisation of an individual's circadian rhythm. Sean Toomey identified that he utilises blue light blocker safety glasses when responding to incidents at night⁽¹⁷⁾. Emergency service could also utilise glasses/goggles with different tints depending on the time of the day to minimise circadian disruption⁽²⁾.

Circadian rhythm disruption is exemplified when emergency service personnel undertake night shift. This results in being awake when during the normal nocturnal melatonin peak, and then attempting to take a daytime sleep when their melatonin levels will be low⁽²⁾. Employees who work night shift identify difficulty in achieving adequate daytime sleep quality and quantity, and it has been identified shift workers accumulate a sleep debt caused by workers skipping sleeps⁽²⁾.

Emergency service agencies should modify controllable stressors to minimise the impact on emergency service responders. Modifiable stressors at an organisation level include distribution of call volume, shift scheduling and start time. Consistency of sleep times (ie. Sleep onset time and waking time) can be negatively impacted by shift scheduling and emergency service agencies must consider the impact of shift scheduling on sleep⁽¹¹⁾.

The body's core temperature is an important component of circadian rhythm, the body's temperature will start to descend as a trigger for pending onset of sleep and start to increase as a wake trigger. Joel Billings'⁽¹¹⁾ presentation identified the necessity to have the ability to adjust temperatures within a sleeping environment.

Sleep Pressure:

Adenosine is the main neurotransmitter responsible for sleep pressure, essentially the longer you stay awake the greater the accumulation of adenosine and the greater the sleep pressure. Sleep pressure occurs through the process when the adenosine molecule binds with adenosine receptors within the brain.

Caffeine and adenosine.

Caffeine (most commonly known in the form of coffee) is a central nervous stimulant drug. It prevents the sleep pressure by binding with the adenosine receptors and effectively blocking adenosine. Notably, caffeine sensitivity is linked to an individual's chronotype. Caffeine on average has a half-life of 5 hours⁽¹⁸⁾. Caffeine may be a useful tool for emergency service personnel if they understand the mechanism and their individual tolerance. Education resources would be beneficial within the emergency service sector specific to reframing caffeine as a performance enhancer rather than a fuel. Information should be provided about safe limits and timing of consumption.

Alcohol and sleep

It has been identified that the high stress on emergency service personnel, including exposure to trauma, may result in alcohol consumption as a coping mechanism⁽¹⁹⁾. Alcohol may also be used as a sleeping aid⁽²⁰⁾ however it is important to identify that alcohol is a sedative; it essentially sedates the frontal cortex. As sleep expert Matthew Walker states, "alcohol-induced sleep is not naturalistic sleep." Alcohol switches off the firing of brain cells and alters brain wave patterns. Alcohol consumption results in diminished REM sleep. As previously identified, the REM stage of sleep is important for emotional processing of memories. Further, alcohol has been identified to result in greater fragmented sleep due to activation of the sympathetic system and the physiology of consumption.

Nervous system arousal

The autonomic nervous system comprises both the sympathetic nervous system, the "fight-or-flight" division, and the opposing "rest-and-digest" parasympathetic system. The transition from wakefulness to sleep requires the down regulating of the sympathetic and greater activation of the parasympathetic system. Stress can be defined as the disruption of homeostasis from an external

factor that elicits an alarm response in the body and the activation of the sympathetic nervous system⁽²¹⁾. Activation of the sympathetic nervous system is beneficial when responding to acute stressors, however the presence of chronic stressors and activation of the sympathetic nervous system can negatively impact physical and mental health⁽²²⁾ and impede sleep.

Emergency service personnel are exposed to inherent occupational stressors⁽²³⁾, and provisions should be provided to eliminate controllable stressors, minimise the impact for unavoidable stressors, and facilitate parasympathetic reactivation post exposure.

Stress reduction and elimination.

Emergency service personnel have been identified to have an inability to completely switch off and relax, with career emergency service workers remaining hypervigilant to stimuli even on their rostered days off⁽²⁴⁾.

Sleep environments provided by emergency service agencies should be focused on minimising stressors on emergency service personnel⁽²³⁾. Lighting within the bedroom should be a low lux (brightness), with under lighting being beneficial compared to overhead. Sean Toomey⁽¹⁷⁾ identified that a practical and low-cost process employed at fire stations includes the changing of globes within the dorm area to redlights to avoid blue light exposure. Sound insulation should be provided in bedroom areas⁽¹¹⁾. With alert tones significantly increasing sympathetic response⁽²⁵⁾ Sean Toomey⁽¹⁷⁾ identified that their fire department have introduced an alerting system that is heavily reliant on lighting as opposed to audible alert tones. Their department has approximately just over 1,000 members. New alert systems allow for exclusive alerting of only necessary personnel, this would reduce avoidable and unnecessary stress response⁽¹¹⁾.

Parasympathetic reactivation.

Breathwork is an effective mechanism to reactivate the parasympathetic system (the rest, digest and heal branch) through emphasis on slowing the breath and emphasising exhalation. The vagus nerve is the main nerve of the parasympathetic system, and due to its proximity to the larynx, further stimulation can occur through humming. Jacqueline Toomey introduced the bee-humming technique as a means for parasympathetic reactivation. There is a noticeable relaxation effect to this technique after just 5-7 rounds of humming breath.

Amygdala hijack

The prefrontal cortex is responsible for moderating emotional response and a disconnect with an overactive amygdala can result in irrational and hyperactive emotional reactions. Sleep deprivation results in the physiological process known as “amygdala hijack” where an overactive amygdala is disconnected with the prefrontal cortex. Amygdala hijack results in a greater sympathetic response to a non-threatening environment where sleep deprived individuals may be irrational and overly emotional^(26, 27). Bhanu Harrison⁽²⁸⁾ presented Polyvagal Theory which identifies the impact on individuals, and their family, when an individual is operating outside their window of tolerance. This component highlighted the need for greater resourcing and education on the mechanism of emotional dysregulation and sleep disruption.

The First Responder Sleep Recovery Practice & Yoga Nidra

Jacqueline Toomey ⁽¹⁷⁾ purposely designed a three-step protocol for first responders to experience enhanced sleep with shift work.

Stage 1. is Somatic, physical movement to shift the nervous system and provide tension release.

Stage 2. is trauma sensitive breathwork to further regulate the nervous system

Stage 3. is the capstone of the practice and it is Trauma Informed Yoga Nidra

Trauma Informed Yoga Nidra is a sleep recovery tool for emergency service responders as it is trauma-sensitive and is designed not to cause re-traumatisation. This type of Yoga Nidra provides the individual with ownership through invitation to undertake actions in a comfortable and safe environment. The language in the scripts differs from other types of yoga nidra out there. For example, many yoga nidra practices use the imagery of fire; while the general population may find a camp fire relaxation, this language can be disruptive to first responders' practicing yoga nidra. Trauma informed yoga nidra avoids any activating imagery and allows for a safer and effective experience for relaxation. These elements are extremely important when working with emergency service personnel.

Yoga Nidra is a restorative process that involves mind-body-breath awareness, guiding the individual into a naturalistic deep sleep state whilst aware. It is a systematic practice that allows a participant to enter sequential processes by exploring the sensations of the physical body and specific breath and awareness techniques. In data collected from over 4,000 first responders who completed the First Responder Sleep Recovery Program, over 90% of first responders found the practice to be highly effective in providing a deeply relaxing experience that often led to sleep or a felt sense of restoration and rejuvenation. Yoga Nidra is a form of mediation, however as opposed to other forms of mediations, individuals perform in a reclined position. PET scans on individuals performing Yoga Nidra identified that they were able to achieve Theta and Delta brain waves, previously thought to be unattained whilst awake ⁽²⁹⁾. Most other forms of meditation do not guide the participants into these deeper, restorative brainwave states. These Delta brain waves are associated with deep sleep and physiological repair. The importance of the prefrontal cortex has previously been identified in the process of amygdala hijack, and it is important to identify that Yoga Nidra increases the activation of the logic and reasoning prefrontal cortex ⁽³⁰⁾. Additionally, with emergency service responders being exposed to traumatic events it is noteworthy to identify that Yoga Nidra in armed service setting, branded as iRest, has been identified to be beneficial in the treatment of PTSD ⁽³¹⁾. While iRest uses language specific for military, Trauma Informed Yoga Nidra is part of the First Responder Sleep Recovery protocol that is designed specifically for first responders in mind.



Sleep disruption's impact on family

Emergency Service responders' personal lives are intertwined within their role, consequently their families impact their sleep recovery opportunities and conversely their role can impact family members sleep⁽³²⁾. As previously identified, the physiological process of "amygdala hijack" through sleep deprivation can result in emotional dysregulation, accordingly the provision of employee support services is critical. As identified in the Australian Government's House of Representative Inquiry into Sleep Health and Awareness in Australia⁽¹⁰⁾, collaboration of stakeholders is necessary and this should include the provision of sleep awareness and recovery training for emergency service personnel's families. Sleep recovery and sleep environment strategies outlined above should be implemented in the home environment. Further research is needed to identify the outstanding impact shift work has on the circadian patterns of family members, as well as their mental and emotional wellbeing.

Conclusion

This study identified that sleep disruption negatively impacts nearly every component of the human body, and it identified that sleep disturbance in most cases is unavoidable in the emergency service sector. Using emergency service terminology, placed in a risk matrix, sleep disturbance likelihood/probability is “Almost certain”, the consequence/impact (carcinogenic, cardiovascular and suicidal risk) is “Severe/Catastrophic” resulting in the highest risk rating.

LIKELIHOOD ↑	5. Almost Certain	Medium	Medium	High	Extreme	Extreme
	4. Likely	Medium	Medium	High	High	Extreme
	3. Possible	Low	Medium	Medium	High	High
	2. Unlikely	Low	Low	Medium	Medium	Medium
	1. Very Unlikely	Low	Low	Low	Medium	Medium
		1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
		CONSEQUENCE →				

Strategies to mitigate the impact of sleep disturbance or deprivation requires a collaborative approach with all stakeholders; government, emergency service agencies, first responders and their families. This study was successful as it has provided strategies that minimise the impact of unavoidable sleep disturbance or deprivation to emergency service personnel.

Recommendations

- Provision of sleep awareness and education resources to all emergency service personnel
- Utilisation of the Emergency Service Sleep Diary in conjunction other sleep screening questionnaires
- Investigation into the provision of sleep health screening for emergency service personnel
- Provision of blue light blocking safety glasses
- Greater provision of, and improvement in the conditions of sleep environments.
 - Noise: Station design for placement of sleeping quarters, sound insulation, etc.
 - Temperature: Individual thermostats, ventilation, mattress covers.
 - Light: Blackout curtains insulation, replace light to red light, motion-activated, etc.
- Provision of awareness and education resources specific to caffeine and sleep
- Provision of awareness and education resources specific to alcohol and sleep
- Provision of Parasympathetic reactivation training (i.e. Breathwork)
- Provision of sleep awareness and education resources to all emergency service personnel family members, identifying the association of emotional dysregulation and sleep
- The inclusion of agency's employee support programs, and provision to family members, in all sleep awareness and education.
- Development of an education and awareness program specific to Trauma Informed Yoga Nidra (also known as a First Responder Sleep Recovery Practice)
- Provision of resources to allow for the facilitation of Trauma Informed Yoga Nidra (also known as a First Responder Sleep Recovery Practice) and to allow at 30–45 minute practice as a form of constructive therapeutic rest while on shift.

Educational Articles

This article addresses the Low- T epidemic we are seeing in the fire service, law enforcement and military as it relates to sleep deprivation: <https://www.firefighternation.com/health-safety/do-this-to-prevent-low-t-in-the-fire-service/#gref>

This article addresses cardiac health issues as it relates to shift work related sleep disruption: <https://www.fireengineering.com/health-safety/the-sleepless-heart-of-the-fire-service/#gref>

This article depicts the physiological correlation between sleep loss in the fire service and 3 ways it can lead to suicide:

<https://www.fireengineering.com/health-safety/ill-sleep-when-im-dead-firefighter-sleep-deprivation/#gref>

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