Top 10 evidence-based countermeasures for night shift workers

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ABSTRACT

Emergency edicine providers are responsible for ensuring the emergency department is staffed 24 hours a day. As such, providers must efficiently transition between day, swing and night shift on an almost weekly basis. There is no formal education in medical school or residency on how to approach the transition to and from night shift, remain alert and productive and maximise sleep during the day. There are a multitude of blogs and online sources discussing night shift, but few, if any, provide an evidence-based approach. This article will provide the top 10 evidence-based recommendations to increase sleep, maximise performance, decrease fatigue on shift and improve quality of life outside the workplace.

INTRODUCTION

Frequent transitions between day and night shift is a challenging task many emergency medicine providers face during their career. Night shift and subsequent sleep deprivation is known to result in higher procedural complications, jeopardise patient safety and have detrimental effects on provider's health and wellness. Here we provide the top 10 evidence-based recommendations to increase sleep, maximise performance, decrease fatigue on shift and improve quality of life outside the workplace.

SCHEDULE FOR CIRCADIAN RHYTHM

Providers whose schedule rotates in a clockwise fashion (phase delay), have fewer large magnitude transitions, fewer shift transitions and who are allowed to choose their own night schedule have higher levels of satisfaction, better performance and higher levels of alertness.

Changing bedtime and wake-up time are disruptive to human circadian rhythms. Moving to a later bedtime and wake-up time is called phase delay, while shifting to an earlier bedtime (eg, night to the afternoon) is called phase advance.[1–4] Human circadian rhythms phase delay faster than phase advance, making a clockwise schedule more advantageous.[1–4] Studies show transitions to night shift result in decreased performance.[1–4] However, this decline in performance can be mitigated by following a clockwise rotation in order to phase delay, that is, morning, afternoon, then night rather than a counterclockwise rotation (phase advance), that is, morning, night, then afternoon.[1–4] Smaller magnitude transitions (6 or fewer hours from the current shift) are less disruptive to circadian rhythms than large magnitude (greater than 6 hours from the current shift) or frequent shift transitions.[1 3] This is because large magnitude shifts disrupt the circadian rhythm more, resulting in a longer length of time required to adapt to a new schedule.[1]

Furthermore, sleep debt accumulates over consecutive night shifts regardless of phase advancing or phase delay. Therefore, the number of consecutive night shifts worked should be limited to two or three, but single night shifts in isolation should be avoided (due to the disruption of circadian cycles).[1–5] The night shift duration should not exceed 8 hours[3 5] as longer night shifts are associated with significantly higher levels of medical errors.[6]

Providers are at their lowest level of performance after 04:00 a.m. Therefore complex or administrative tasks during these vulnerable hours should be minimised and shifts should not extend beyond their scheduled end time.[1 4]

Lastly, physicians who were allowed to choose which nights they work had higher levels of satisfaction and reported lower levels of stress.[3] Tucker *et al* found work time control (allowing physicians control over their schedule) decreased the effects of night shift on circadian disruption, sleep quantity, sleep disturbance and found physicians reported less fatigue.[4]

NAP PRIOR TO YOUR NIGHT SHIFT

Napping prior to shift is recommended. Multiple studies have demonstrated the efficacy of naps prior to shift in reducing fatigue during night shift.[3 7 8] Kosmadopoulos *et al* performed a small study that showed a 1-hour nap prior to the first night shift was sufficient to decrease the accumulation of sleep debt.[9] Schweitzer *et al* studied a total of 121 individuals in both laboratory and field testing. Authors concluded napping prior to shift significantly improves performance and alertness.[8] Additionally, the best results occur with napping between 14:00 and 16:00 p.m., during the 'siesta period', before starting the first night shift.[3 8] Ultimately, the timing of the nap is less important than having additional sleep, as long as it takes place prior to acquiring sleep debt.[8]

MAXIMISE BRIGHT LIGHT ON SHIFT

Increase exposure to high intensity bright light, preferably blue light, during night shifts.

The human circadian rhythm is based on external environmental cues; the most important are light cues (zeitgebers) received by the suprachiasmatic nucleus (SCN).[10 11] Several studies have shown light cues, specifically blue wavelengths (450 to 490 nm), to be the strongest influencer in regulating the circadian rhythm. Circadian entrainment also depends on the strength of the

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zeitgeber.[10–13] Exposure of high intensity bright light (preferably blue light) during night shift aids in wakefulness and increases performance, however the specific lux, duration and frequency is highly individualised and requires further investigation. Most hospitals have fluorescent light that is a combination of white and blue with an average lux of 150.[10 11] Providers should advocate for their emergency departments to have high intensity blue wavelength light for night shifts. Providers can also purchase and bring their own high lux bright light lamp to night shift.[10 11]

A study from the New England Journal of Medicine investigated transitioning circadian rhythms with the use of bright light during night shift.[14] The study showed bright light (7000 to 12 000 lux) compared with ordinary light (150 lux) helped shift the participants' circadian rhythm within about 4 days. Dawson *et al* completed a study in which bright light was compared with melatonin and placebo. Pulses of bright light (4000 to 7000 lux) between midnight and 04:00 a.m. produced the largest phase shift in circadian rhythm and increased quality of daytime sleep. The light-treatment group shifted their circadian rhythm approximately 8 to 9 hours while the placebo and melatonin groups only shifted approximately 4 hours.[15]

The timing of light is important and should occur prior to the drop in core body temperature, generally 2 hours prior to the normal wake-up time, however there is significant inter-individual variability between circadian clocks so this timing will vary among providers.[11 16 17] Goulet *et al* showed individuals have unique circadian rhythms, with 'morning types' and 'evening types' having different peaks of alertness and performance throughout the day.[12] Some of the variability between individuals may be due to differences in light exposure during important phase shifting times in their circadian rhythm.[17]

TAKE A NAP IF YOU CAN

Evidence suggests napping on shift improves performance, mental agility and decreases total sleep debt. However, it is important for providers to consider sleep inertia as a downside to napping on shift.

Several studies have found napping while on shift reduces sleepiness and improves performance.[2 18] A meta-analysis by Ruggiero showed naps as short as 20 min between 02:00 a.m. and 03:00 a.m. were beneficial in improving alertness, decreasing sleepiness and increasing efficiency with no significant impact on daytime sleep.[19] When scheduled naps are used, time for recuperation should also be scheduled after the nap to avoid sleep inertia.[2] Sleep inertia is defined as the groggy period after waking from the nap and typically lasts 30 min.[2 18 20] There is concern that sleep inertia may be even more detrimental to performance than loss of sleep. Sleep inertia can potentially be reduced by taking naps less than 15 min[2] and scheduling them between 01:00 a.m. and 03:00 a.m. prior to the circadian nadir, the lowest level of alertness during the night.[19 20] Physicians will vary in the amount and duration of sleep inertia they experience, but it is important to remember a single nap is not sufficient to ameliorate the accumulated sleep debt and the nap could have potentially detrimental effects.[2 18 19]

Although the benefits and studies show impressive results, napping may be impractical in many emergency departments.[20] Alternative solutions include decreasing the duration of night shifts and rotating providers through a scheduled nap between 01:00 a.m. and 03:00 a.m. when volume is starting to decrease.

DRINK CAFFEINATED BEVERAGES EARLY IN THE SHIFT

Caffeine (4 mg/kg) optimises performance, alertness and cognitive function. Humans reach their lowest level of alertness and cognitive function between 03:00 a.m. and 04:00 a.m.[1 21] The most effective strategy appears to be to consume 4 mg/kg of caffeine between 12:20 a.m. and 01:20 a.m. This regimen has been demonstrated to decrease sleep tendency on the night shift, and enhance performance of subjects during the first two nights of a string of night shifts without disrupting daytime sleep.[3 21] However, caffeine should not be consumed within 4 hours of the end of shift to minimise any effects on sleep immediately following work.[3]

AVOID LARGE MEALS

Night shift workers should avoid large meals during their shift and replace them with small snacks. Food plays an important role in regulating the circadian rhythm through pathways involving leptin, ghrelin, glucose, insulin and fat.[22] Smaller portion sizes can minimise the surges in glucose, fat and insulin levels, resulting in an ameliorated effect on circadian disturbances.[22] Additionally, snacks higher in fat and protein were less associated with sleepiness than carbohydrates that result in rapid fluctuations in blood glucose.[23]

Meal size and timing can affect alertness and productivity during the night shift. Eating a large meal at 01:30 a.m. versus fasting during shift showed a decrease in attention.[21] Eating full meals at night may lead to delayed response time, cognitive impairment and increased errors.[21 23]

MINIMISE LIGHT ON THE COMMUTE HOME

Limiting bright light exposure, both natural and artificial light, at the end of a night shift and on the commute home, helps maximise sleep during the day and minimise disturbances in circadian rhythm. The blue wavelength has the strongest influence on the SCN.[11 16] Coloured sunglasses that specifically block blue wavelength (dark or orange sunglasses) are recommended for the commute home.[11 13–16] Some of the most common studied methods include light lensed sunglasses (15% transmission), dark lensed sunglasses (2% to 5% transmission) and welder glasses.[3 13–15 24] Crowley *et al* showed dark lensed sunglasses to have a statistically significant difference over light lensed sunglasses in the effect on circadian rhythm. These authors recommend welder glasses if the commute does not involve driving and sunglasses with 2% transmission if driving.[24]

CONSIDER MELATONIN

Although data on melatonin as a sleep aid is inconclusive, its low side effect profile and potential benefit should be considered as an intervention to decrease the latency and improve the length of sleep. In a double-blinded, randomised, placebo-controlled, crossover study of 86 shift workers, Sadeghniiat-Haghighi *et al* showed 5 mg of melatonin taken 30 min before bed reduced sleep onset latency in comparison to the placebo group as well as the participants' own baseline. However, this study did not find a statistically significant change in total sleep time when compared with baseline and placebo.[25] A Cochrane review from 2014 evaluated 15 randomised controlled trials with a total of 718 participants. This review showed melatonin to increase sleep length during daytime sleep with a mean difference of 24 min and increase nighttime sleep by a mean of 17 min. No dose-response relationship was found.[26]

SLEEP IN A DARK ENVIRONMENT

Bright light is a powerful influencer of the circadian rhythm and can assist in phase advancing or phase delaying depending on the

Table 1 Personal and institutional recommendations for night shift workers

Personal	Institutional
Nap prior to shift[3 7 8]	Nap for 20 to 30 min during shift between 02:00 and 03:00 a.m.[2 18 19]
Caffeine on shift increases performance[3 8]	Bright light exposure on shift (blue wavelength, 4000 to 12 000 lux)[11 14 15]
Consume multiple small healthy snacks as opposed to one large meal[21–23]	Reduce length and number of consecutive night shifts[1–4]
Use sunglasses on commute home[3 13–15 24]	Schedules should follow a clockwise rotation (phase delay) (morning, afternoon, then night)[1 3]
5 to 10 mg melatonin may reduce sleep onset latency,[25] increase total sleep length[26] and has a favourable side effect profile[25]	Avoid extending shifts or scheduling duties after night shifts[1 4]
Use blackout curtains or a sleeping mask[14–16]	Avoid scheduling single nights shifts in isolation[1–5]
Maintain a cold sleeping environment during the day[15] with a warm water bottle at the feet[29]	Minimise the magnitude and frequency of transitions to and from night shift[1 4]
	Allow providers control over their schedule by selecting their own night shifts[3 4]

timing. Just as bright light on the commute home is detrimental to sustaining a night shift worker's circadian rhythm, light exposure in the bedroom also makes maintaining a night shift schedule challenging.[16 17] Blackout curtains and sleeping masks are shown to aid in sleep, recovery, mood and performance by modifying the circadian rhythm.[14–17]

SLEEP IN A COOL ENVIRONMENT

Sleep is promoted by rapid cooling and release of heat from the body's core through rapid warming of the periphery via vasodilation.[15 27–29] It is the rapid decline in core body temperature and heat loss via peripheral vasodilation that is associated with sleep initiation.[27] A cool sleeping environment can also aid in the rapid drop in core body temperature helping facilitate sleep initiation.[28 29] Some studies have shown sleeping with a warm water bottle (or other modality of warming the feet) induces this peripheral vasodilation leading to sleep induction.[29]

CONCLUSION

There is significant interindividual variability of circadian clocks among providers. Physicians will need to personalise their approach to minimise circadian disruption. While many of these recommendations can be implemented at an individual level, several require intervention at an institutional level. (table 1) However it is in the institution's best interest to maximise provider wellness, rest, performance and efficiency in order to protect patients and improve the care they receive. Further research is needed in the area of emergency medicine night shifts where decisions can be time sensitive and high risk.

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