

On-call work and sleep: the importance of switching on during a callout and switching off after a call

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Abstract: Due to the unpredictable nature of working time arrangements, on-call workers experience regular disruption to sleep, particularly if woken by calls. Sleep disruption can impact long term physical and mental health, next day performance, and importantly, performance immediately after waking. To reduce the impact of performance impairments upon waking (i.e., reducing sleep inertia), research has investigated strategies to promote alertness (e.g., bright light, caffeine, and exercise). This review puts forth on-call workers who are likely to return to sleep after a call, it is also important to consider the impact of these sleep inertia countermeasures on subsequent sleep. Future research should build on the preliminary evidence base for sleep inertia countermeasures by examining the impact on subsequent sleep. This research is key for both supporting alertness and performance during a call (“switching on”) and for allowing the on-call worker to return to sleep after a call (“switching off”).

Key words: On-call, Stand-by, Work, Sleep, Performance, Emergency service, Sleep inertia

Introduction

On-call is a work arrangement where employees may be called to work outside of scheduled hours to provide 24/7 coverage¹. This is particularly common for personnel working in emergency services, healthcare, maintenance, military, and information technology². These workers are often required to respond to emergency situations around the clock, including being woken from sleep to attend a call

(either in person or from home)^{3, 4}. A main difference between on-call work and traditional shift work schedules is unpredictability, as workers often do not know if they will be called for work, and if so, when or for how long they will be required to work¹.

The unpredictable nature of on-call work can lead to disrupted sleep both pre-call and post-call. Before a call, workers may have disrupted sleep due to anxiety about receiving a call or missing a call^{5, 6}. Anxiety related to the unpredictability of on-call work can affect sleep even if the likelihood of receiving a call is low⁷. Post-call, the worker may be allowed to, or need to, return to sleep¹, however the quality and quantity of this sleep can be impaired. In a study by our group, 70% of on-call workers reported diffi-

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culty returning to sleep after a call⁸). This may be due to the nature of the call, with stress, rumination, and anxiety resulting in difficulty falling back to sleep^{4, 9}). Workers may also receive (or expect to receive) additional calls throughout the call period such that post-call sleep may also be interrupted (thereby becoming pre-call sleep). An additional consideration is that many on-call workers sleep at work, for example doctors, paramedics, and firefighters⁴) and thus workers may attempt to return to sleep in a compromised sleep environment (e.g., an environment with light or noise disruption⁸). Work by our group has also shown that on-call work can also adversely influence the sleep of other family members, including the partners of on-call workers¹⁰). Taken together, these findings demonstrate that pre-call and post-call sleep in on-call workers can be impaired due to the nature of the work schedule. The flow-on effects are an issue for a) health and well-being, b) workplace performance and productivity, and c) performance immediately after waking. This review firstly summarises the key findings on these flow-on effects (for more detailed reviews on these topics, see^{4, 11–13}), to provide context for the discussion on sleep inertia countermeasures and the importance of considering the impact on subsequent sleep.

There is some research to suggest that on-call work is associated with chronic physical and mental health problems that are likely influenced and exacerbated by shortened sleep²). For example, having fewer hours of sleep when on-call is associated with a greater number of physical health symptoms in junior doctors¹⁴). Further, in a sample of 414 general practitioners, being on-call was a predictive factor for poorer mental health, depression and anxiety¹⁵). Mental health remains a challenge for on-call workers, with recent studies also demonstrating a relationship between on-call work and mental health problems^{16, 17}).

Impaired cognitive function and work performance are acutely associated with inadequate sleep¹⁸) and such changes are evident in on-call populations^{1, 2, 6}). For example, inadequate sleep experienced by on-call workers has been linked to motor vehicle accidents, with 49% of a sample of 70 medical residents reporting incidents of falling asleep at the wheel when driving home, and 90% of these reported as occurring after a night on-call¹⁹). A study quantifying the economic cost of inadequate sleep of on-call workers in Australia estimated the cost of injury to be \$2.25 billion per year¹). This includes medical compensation, lost production, and staff turnover costs such as overtime and over-employment. Together, this shows that the workplace performance impacts of on-call work can be wide-reaching and range from personal safety to industry costs.

When an on-call worker is woken by a call, they are likely to experience sleep inertia, which refers to the transitional state between sleep and wake. Subjectively, sleep inertia is often experienced as ‘grogginess’ upon waking^{20, 21}). While the most severe symptoms typically last for 15–30 minutes post-waking, full recovery can take over an hour¹²). Sleep inertia is characterised by reduced alertness and performance on tasks involving memory, logical reasoning, reaction time, and problem solving^{22, 23}). Given these cognitive impairments, it is unsurprising that sleep inertia has been implicated in workplace accidents when employees must perform high stress and safety critical duties shortly after waking. For example, in an analysis of 400 United States Air Force accidents, pilot error was a contributing factor most commonly during the first hour after waking, when sleep inertia is likely impacting performance²⁴).

Sleep inertia is particularly problematic for on-call workers who are often completing safety-critical tasks upon waking. For example, medical staff may need to make critical decisions²⁵), or firefighters may be required to don safety equipment and drive to an incident within minutes of waking⁶). Sleep inertia-related cognitive impairments can be greatest during the biological night, when on-call workers are likely to be receiving calls, as sleep inertia is exacerbated by greater sleep and circadian pressures^{26, 27}). However it is also important to note that even with an uninterrupted night’s sleep (i.e., without a call) sleep inertia is still present upon waking and presents a challenge to immediate performance and alertness²⁸). Further, the build-up of sleep debt after multiple days of shortened sleep could exacerbate the effects of sleep inertia on subsequent days^{29, 30}); a problem for those who work consecutive nights of on-call.

Countermeasures for reducing short-term performance impacts after receiving a call

While performance after waking is an issue due to poor sleep, addressing performance after waking may actually exacerbate sleep loss issues for on-call workers. We will review a) the efficacy of existing sleep inertia countermeasures, and b) the impact of sleep inertia countermeasures on subsequent sleep.

a) The efficacy of existing countermeasures

Several countermeasures have shown promise in reducing the impairment associated with sleep inertia. These countermeasures can be proactive and planned ahead of time, or reactive and implemented upon waking¹¹).

Proactive sleep inertia countermeasures include, but are not limited to: a) waking naturally rather than waking to an

alarm³¹); b) the use of dawn simulators³²); and c) the use of caffeine before a short nap^{33, 34}). While these proactive countermeasures can effectively improve performance upon waking (i.e., reduce sleep inertia), they are only suitable when workers have a planned sleep opportunity and wake time is known. Therefore, these proactive countermeasures are not applicable for on-call workers who can be woken at any time during the sleep period.

Reactive countermeasures to sleep inertia may be more effective for on-call workers as they are performed after waking and do not require any pre-sleep planning¹¹). Research into reactive sleep inertia countermeasures (particularly for on-call workers) has grown in recent years. While potential countermeasures have been evaluated as options, more research is needed. These reactive countermeasures include but are not limited to: a) bright light³⁵); b) caffeinated gum³⁶); c) sound³⁷); and d) exercise^{38, 39}).

For example, in a proof-of-concept study by Kovac, Vincent⁴⁰), exercise completed immediately upon waking during the night increased noradrenaline levels and reduced sleepiness levels after 5 minutes⁴⁰). Increasing noradrenaline through exercise may reduce the cognitive impacts of sleep inertia and accelerate the transition from sleep to wake⁴⁰), thereby making exercise a suitable reactive countermeasure for on-call workers. Preliminary evidence has also shown some support for bright light, sound, and caffeine as reactive countermeasures (for review see¹¹). One study found that exposure to 1-min of bright light (2,000 lux) after waking reduced subjective sleepiness after 15 min and improved memory and reaction time³⁵). However, while exposure to bright light after waking may improve cognitive performance, this improvement lasted 45 mins. Another common reactive sleep inertia countermeasure is caffeine, a cost effective and easily available stimulant¹¹). One study that explored the use of caffeine as a reactive countermeasure gave participants chewing gum containing 100 mg of caffeine or a non-caffeinated placebo gum when woken at 01:00 or 06:00³⁶). Improved reaction time lasted between 12–18 min after chewing the caffeinated gum compared to the placebo gum, suggesting that caffeine could be a more effective countermeasure compared to bright light, given the faster cognitive performance improvements. Sound has also been investigated as a reactive countermeasure for sleep inertia^{11, 37}) and has shown the potential to improve performance under certain conditions. In a study by Hayashi *et al.*⁴¹), music was played at 60 dB for 20 min after waking from a nap, with reduced subjective sleepiness observed. Cognitive performance was also improved when the music played was music that was pre-

ferred by the participant. However, it is important to note that there was not a control group in this study.

However, these other countermeasures have shown some improvements to alertness and performance upon waking, as discussed above, protecting subsequent sleep (i.e., post-call out) is an important consideration for on-call workers. Further, the feasibility of these countermeasures, particularly for on-call workers who are likely returning to bed, has not been explored. This includes both practicality of a countermeasure, and motivation of the workers. For example, an exercise countermeasure may not be practical unless workers have access to exercise equipment, such as an exercise bike or treadmill. Further, although there are positive implications for sleep inertia, there may be some workers who do not want to exercise and then go back to sleep.

b) Understanding the impact of countermeasures on subsequent sleep

In order to reduce the likelihood of chronic sleep disruption, sleep inertia countermeasures should be examined for their potential impact on subsequent sleep. To date, only caffeine has been investigated in the context of subsequent sleep. While caffeine intake during the day is known to influence subsequent sleep at night, typically prolonging sleep latency and reducing sleep time and efficiency⁴²), caffeine consumed during the night has different effects^{36, 43, 44}). In a cross-over study by Newman *et al.*³⁶), fifteen participants slept in a laboratory and, after being woken at 01:00 and 06:00, were immediately given a gum pellet either containing 100 mg of caffeine or a placebo. Not only did the caffeine result in better cognitive performance upon waking compared to the placebo, the participants in the caffeine group displayed a relatively short sleep onset latency when returning to sleep after being woken, similar to that found for the placebo group. This is promising for on-call workers who must perform immediately upon waking and then return to sleep. However, it is important to note that there was no difference in sleep onset latency between the caffeine and placebo group at approximately 01:30. This is a time of day during which sleep pressure is maximal, which may explain the absence of an effect of caffeine on sleep onset latency, that is, participants did not find it difficult to fall asleep. However, sleep quality after caffeine administration was not measured during this study. This will be important to measure in future studies as caffeine may influence sleep quality during subsequent sleep. Further, sleep inertia testing was conducted for approximately 25 minutes after participants were woken. While this may be the length of time that some workers are awake and performing after a call, there are numerous on-call scenarios which are not covered

by this simulation. These include less time awake after being awoken (e.g., a medical practitioner providing medical advice), or more time awake (e.g., a fire fighter on a call-out). These different scenarios may require different levels of caffeine and have different effects of subsequent sleep. Future research should be mindful to explore these various on-call arrangements. Additionally, while some studies reported minimal effects on sleep after caffeine taken during the day (e.g.,^{43, 44}), they were not conducted in on-call contexts, where the workers consume caffeine upon waking during the night and return to sleep post-call. There remains a critical need for research on the effects of countermeasures for sleep inertia on subsequent sleep.

Where to from here? Future research directions

First, further research is needed, specifically in the context of on-call work, on reactive countermeasures that have preliminary support (e.g., sound, temperature, and exercise) in reducing sleep inertia and other future novel countermeasures. Second, those countermeasures that have shown promise at reducing the impacts of sleep inertia (e.g., light and caffeine) should be investigated for their impacts on sleep. We propose the systematic experimental implementation of these countermeasures within a laboratory environment, where post-call sleep latency and sleep quality are also examined. Third, as suggested by multiple authors^{34, 38}, qualitative measures, such as interviews and focus groups, should be implemented in future methodologies to assess implementation and feasibility of sleep inertia countermeasures in real world contexts. Qualitative measures are important for understanding the experience of on-call workers who are required to be alert after being woken by a call and also the barriers to sleep inertia countermeasure implementation²⁰. Previous work by our group has shown that males and females employ different coping styles when managing on-call work⁴⁵, therefore it is possible there may also be differences in how sleep inertia countermeasures are implemented by different genders.

Finally, until the impacts of sleep inertia countermeasures on sleep have been determined, on-call workers should be mindful that strategies to reduce sleep inertia after a call have the potential to impact subsequent sleep. Upon completion of their work commitments, workers should engage in sleep-promoting measures to improve subsequent sleep. This may include employing healthy sleep practices (i.e., sleep hygiene), such as reducing bright light, or engaging in mindfulness strategies. Furthermore, it

is critical that workers are strategic in their use of sleep inertia countermeasures in situations where they know they will need to sleep after a call. For example, small amounts of caffeine could be used strategically (i.e., at times when it is expected that responding to a call will take a significant amount of time, rather than when a call may simply result in a short phone-based response) as opposed to a standard response to a call. However, future research is necessary to determine which strategies may be effective in reducing sleep inertia (for call response), but which do not disrupt subsequent sleep.

Conclusion

The sleep of on-call workers is a concern for both the health and safety of the workforce. Given the factors that exacerbate sleep inertia, on-call workers are likely to experience sleep inertia when woken by overnight calls. While several countermeasures have preliminary support for minimising the negative impact of sleep inertia on cognitive performance (e.g., bright light, exercise, sound), the impact of these countermeasures in on-call contexts where there is a high likelihood of returning to sleep is unknown. Therefore, any sleep inertia countermeasures need to be assessed not only considering their effectiveness in promoting alertness and performance, but also in relation to their impact on subsequent sleep. Such research should include laboratory and field studies to assist on-call workers to “switch on” to promote alertness, and then “switch off” to allow for subsequent sleep, thus improving health, performance, and safety in often safety critical work environments.

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