EAT SLEEP WORK

Napping on night shift: Powerful tool or hazard?

Banks S, Hilditch C, Centofanti S, Dorrian J[a]

VOLUME 1: 2016

ISSN (PRINT): 2205-0612
ISSN (ONLINE): 2206-5369

A journal for developing researchers who investigate the impact of lifestyle on brain, body and planet.

Napping on night shift: Powerful tool or hazard?

Banks S[a], Hilditch C[a], Centofanti S[a], Dorrian J[a]

a Centre for Sleep Research, School of Psychology, Social Work and Social Policy, University of South Australia

Students involved at the time of data collection:

Cassie Hilditch – PhD Candidate, University of South Australia

Stephanie Centofanti – PhD Candidate, University of South Australia

1 INTRODUCTION

About 1.4 million Australians are shift workers, of whom 15% work a regular night shift (1). Shift workers routinely have reduced sleep quantity and quality, and this chronic sleep deprivation can lead to adverse outcomes for productivity, health and safety (2-4). Naps can be a powerful tool for maintaining performance during conditions of sleep deprivation (5). Many workers take naps following shifts, and in some industries during shifts, to reduce the fatiguing effects of sleep loss (6). Naps are now an integral part of fatigue risk management guidelines and policies, and are recommended at the end of night shifts to promote alertness and safety during the drive home (7). However, napping can be hazardous. There is evidence that it can have deleterious effects, in particular, 'sleep inertia', the groggy feeling and performance impairment experienced after napping where workers are extremely vulnerable to errors (8). The impact can be particularly severe for night workers, who are on duty at times when their body rhythms naturally prime them to be asleep (9).

Given the major economic and personal ramifications of compromised productivity and safety in the workplace, and safety during the commute home, there is a critical need to determine which napping practices are likely to be beneficial and which are likely to be dangerous. In some workplaces, naps are recommended during the night shift (10). However, napping policies and guidelines provided to workers by industries and individual companies are frequently generalised from data collected at other times of day or based simply on opinion (11-15). Accurate advice about the correct nap duration, how to best use a nap during a night shift, and its impact on the commute home, is therefore imperative.

2 WORKER FATIGUE AFFECTS SAFETY AND PRODUCTIVITY AND INCREASES THE RISK FOR ACCIDENTS

Night shift workers have a 60% increased risk of experiencing unintentional sleep at work compared to day shift workers (16). As well as compromising safety, it is estimated that industrial productivity declines approximately 5% at night, as compared with day work (17). In addition to a decline in productivity, accidents and injuries are 30% more likely to occur on night shifts than day shifts (18). Not only is performance likely to be impaired during night shifts, workers also frequently report extreme sleepiness and fatigue while commuting home, not surprisingly contributing to fatal accidents and near misses (4, 10). Around 20% of fatal road accidents in Australia involve driver fatigue and these accidents cost well over $3 billion every year (19). One Intensive Care Unit (ICU) nurse recalled: "I drove home, went through a red light, and I didn't know...There are mornings—I have no recollection. I left the hospital, and I have no clue how I got home." pg e7 (10).

Sleepiness causes a deterioration in cognitive performance that leads to workplace errors (4, 20, 21) and increases accident risk during the commute home (4, 10). The evidence is dramatic. After 17 hours of wakefulness, the decline in cognitive performance is comparable to alcohol intoxication of 0.05% BAC (22), and significantly compromises safety. Shift work is a major source of fatigue because it limits the timing and duration of sleep opportunities; and there-fore night workers are often chronically sleep-deprived (2, 4). Individuals who work night shifts have six times greater risk of a sleep-related crash during the commute home (23). Nearly 95% of nurses working 12-hour night shifts report having had a car accident or near-miss while driving home from work in the morning (24). Taking a brief nap before driving home from the night shift may reduce the risk of having a drowsy driving crash, but there is no systematic data available to know if this practice is effective and safe.

3 BENEFITS AND BARRIERS TO NAPPING ON NIGHT SHIFT

Sleep is the only real cure for sleepiness and fatigue and naps can be a useful way to improve alertness (25). However, many workers avoid this strategy because they presume naps need to be longer than 30 minutes to be beneficial and they worry the ensuing sleep inertia will make them feel worse. Additional perceived barriers to napping on night shift include safety, being too busy, understaffing, perception of laziness, concern relating to safety-critical tasks, discontinuity of care, the absence of a comfortable napping space, interruptions during the nap and perceived lack of management support for sleeping at work (10). With favourable risk–benefit data, brief naps could be the ideal solution to these barriers. For example, a 10-minute nap opportunity would take less time away from duties and require a less isolated nap area, since sleep does not need to be maintained over a long period and is far less likely to produce sleep inertia (26). Given these benefits, there is a surprising lack of research on the efficacy and safety of brief naps. Brief naps in the afternoon improve alertness and cognitive performance for several hours, but data regarding brief naps during night shifts are lacking and would likely impact cognitive performance and alertness quite differently, due to the increased drive for sleep at night (25).

4 SLEEP INERTIA: THE DOWNSIDE TO NAPS

Sleep inertia reflects a gradual transition from a sleep to a wake state and is associated with grogginess, performance degradation, and a lingering tendency to return to sleep (8). The magnitude and duration of the sleep inertia effect depends on three factors: the quantity of slow-wave sleep (SWS) or "deep sleep" during the nap; sleep pressure; and time of day, in particular, waking up when the circadian drive for sleep is at its greatest, typically 3–5am (25). Longer naps tend to have more SWS and tend to result in more sleep inertia on waking. Thus, while the quantity of slow waves in a longer nap is associated with the recuperative value of the nap, it is also often correlated with the intensity and duration of sleep inertia (8). The time course of sleep inertia from a 10-minute nap, waking during the vulnerable period around 4am, is unknown. A 10-minute nap in the afternoon does not cause sleep inertia, likely due to a lack of SWS during the nap given the time of day (26). However post-nap sleep inertia could be influenced by the increased sleep drive and the greater propensity for SWS at night, especially in the early hours of the morning.

5 ARE BRIEF NAPS THE SOLUTION?

Workplace guidelines and napping policies typically suggest that the ideal nap is between 10- and 30-minutes long, with little consideration of time of day (11-15). Ten-minute naps improve cognitive performance for up to three hours in the afternoon, but the effectiveness and length of any benefits following a 10-minute nap at night, waking up in the circadian nadir around 4am, is unknown (27). The potential benefits versus risks of a 10-minute nap on the night shift compared with 20- or 30-minute naps is also an open question, especially in relation to more complex cognitive tasks with higher ecological validity, such as driving. This information is crucial for industries with night work operations – not only to understand the possible impact of a nap for night shift performance, but also for the commute home. The commute commonly occurs around 7 or 8am for many workers who start their shifts in the early to late evening (28). A study of hospital doctors and nurses, investigating a 40-minute nap opportunity at 3am, found that while performance on some measures was improved at 7am, this did not extend to performance on a 40-minute simulated drive at 8am (29). Research is needed to not only investigate whether a 10-minute nap around the circadian nadir could benefit cognitive performance, but also to assess the time course of this benefit.

Findings from basic cognitive tasks may not be applicable when considering a more involved task such as driving. Not only does driving place significant demands on multiple aspects of cognition, but the nature of driving can often exacerbate sleepiness and associated performance impairment. Consequently, reports of extreme sleepiness, near accidents, and having "no clue how I got home" are common after driving home from night shift (10). In industries such as healthcare and emergency services, where people are required to perform complex cognitive operations (planning, risk assessment), an understanding of the impact of naps on higher executive functions is important.

6 NAPS ARE A CATALYST FOR OUR CHANGING THEORETICAL UNDERSTANDING OF SLEEP

Sleep is regulated by two main processes: a homeostatic Process S (sleep) and circadian Process C (circadian). The homeostatic Process S seeks to balance sleep and wake time; the need for sleep increases as wakefulness continues but dissipates across time asleep (30). The circadian Process C seeks to place wakefulness during the day and sleep at night, as driven by an endogenous circadian pacemaker. The interaction of these two processes, instantiated in the "two-process model", determines the timing and duration of sleep episodes as well as the time course of sleep propensity and fatigue during wakefulness. This "two-process model" underpins the current understanding of sleep, and influences everything from the way we describe the need for and benefits of sleep, through to the application of this knowledge, for example in biomathematical models of sleep and fatigue (31).

Cognitive performance such as vigilant attention, processing speed and working memory (all important for safe and effective functioning) are affected by these processes and, as such, critically depend on sleep/wake history and circadian time (32). For example at times when Process S is elevated due to an extended period of wakefulness and when Process C is low, such as around 4am, fatigue is high and cogni-tive performance is dramatically impaired (33). A nap can significantly reduce Process S and thereby mitigate fatigue. The "two-process model" predicts that the benefits of a nap increase in proportion to the amount of SWS they contain. Ten-minute naps are less likely than longer naps to contain SWS. With the traditional focus on greater time in SWS producing more recovery, sleep recommendations have tended to centre on achieving as much sleep as possible. Recent work suggests that the total amount of sleep achieved in a given timeframe, more than SWS time, is predictive of cognitive performance, regardless of whether sleep is consolidated or in several sleep periods (34). Indeed, some studies, including ours (21, 35), suggest that total sleep time is the primary driver of recovery. The suggestion that longer is better does not necessarily hold true for napping, given an important cost of longer naps is greater sleep inertia. If total sleep time, rather than SWS, is the primary driver of the benefit of napping, then two 10-minute naps may produce equivalent benefits to a single 20-minute nap, without the negative impact of sleep inertia. It may therefore be preferable to split the nap-sleep into several brief sleep opportunities. This is a significant departure from traditional thinking and raises important questions regarding napping advice. For example, are two 10-minute naps of similar value in terms of maintaining cognitive performance to a single 20-minute nap?; Can 10-minute naps be used to supplement and/or extend the beneficial effects of previous naps?; and could a 10-minute nap before the home commute maintain sufficient levels of cognitive performance during this safety-critical time?

7 REFERENCES

1. Australian Bureau of Statistics. Working Time Arrangements, Australia 2009: Summary of results. ABS cat.no. 6342.0 Canberra: ABS. 2010.
2. Dorrian J, Baulk SD, Dawson D. Work hours, workload, sleep and fatigue in Australian Rail Industry employees. Applied ergonomics, 2011. 42(2): 202-9.
3. Dorrian, J, Paterson J, Dawson D, Pincombe J, Grech C, Rogers AE. Sleep, stress and compensatory behaviors in Australian nurses and midwives. Revista de Saude Publica, 2011. 45(5): 922-30.
4. Dorrian J, Tolley C, Lamond N, van den Heuvel C, Pincombe J, Rogers AE, et al. Sleep and errors in a group of Australian hospital nurses at work and during the commute. Applied Ergonomics, 2008. 39(5): 605-13.
5. Tremaine R, Dorrian J, Lack L, Lovato N, Ferguson S, Zhou X, et al. The relationship between subjective and objective sleepiness and performance during a simulated night-shift with a nap counter-measure. Applied Ergonomics, 2010. 42(1): 52-

61.
6. Ficca G, Axelsson J, Mollicone DJ, Muto V, Vitiello MV. Naps, cognition and performance. Sleep Medicine Reviews, 2010. 14(4): 249-58.
7. Di Milia L, Rogers NL, Akerstedt T. Sleepiness, long distance commuting and night work as predictors of driving performance. PLoS ONE, 2012. 7(9): e45856.
8. Tassi P, Muzet A. Sleep inertia. Sleep Medi-cine Reviews, 2000. 4(4): 341-353.
9. Dorrian J, Lamond N, Holmes AL, Burgess HJ, Roach GD, Fletcher A, et al. The ability to self-monitor performance during a week of simulated night shifts. Sleep, 2003. 26(7): 871-7.
10. Fallis WM, McMillan DE, Edwards MP. Napping during night shift: practices, preferences, and perceptions of critical care and emergency department nurses. Critical Care Nurse, 2011. 31(2): e1-11.
11. VicRoads: National Transport Commission. Guidelines for Managing Heavy Vehicle Driver Fatigue 2006.
12. Vicroads: National Transport Commission. Guidelines for Using Napping to Prevent Commercial Vehicle Driver Fatigue. 2007.
13. Fatigue: Prevention in the workplace. WorkCover Victoria. 2008.
14. Information Bulletin: Managing Fatigue in Your Workplace. Bus and coach sector. National Transport Commission Australia. 2008.
15. Information Bulletin: Napping Tips - To help prevent driver fatigue. Heavy vehicle driver fatigue reform. National Transport Commission Australia. 2008
16. Åkerstedt, T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Work organi-sation and unintentional sleep: results from the WOLF study. Occupational and Environmental Med-icine, 2002. 59: 595-600.
17. Vidacek, S, Kaliterna L, Radosevic-Vidacek B, Folkard S. Productivity on a weekly rotating shift system: circadian adjustment and sleep deprivation effects? Ergonomics, 1986. 29(12): 1583-90.
18. Folkard S. Tucker P. Shift work, safety and productivity. Occupational Medicine, 2003. 53(2): 95-101.
19. Beyond the Midnight Oil, Managing Fatigue in Transport. House of Representatives Standing Committee on Communications, Transport and the Arts. Canberra: p. October 2000.
20. Williamson A, Lombardi DA, Folkard S, Stutts J, Courtney TK, Connor JL. The link between fatigue and safety. Accident; Analysis and Prevention, 2011. 43(2): 498-515.
21. Banks S, Van Dongen HP, Maislin G, Dinges DF. Neurobehavioral dynamics following chronic sleep restriction: dose-response effects of one night for recovery. Sleep, 2010. 33(8): 1013-26.
22. Dawson D, Reid K. Fatigue, alcohol and performance impairment [letter]. Nature, 1997. 388(6639): 235.
23. Rosekind MR, Gander PH, Gregory KB, Smith RM, Miller DL, Oyung R, et al. Managing fatigue in operational settings 1: Physiological considerations and countermeasures. Hospital Topics, 1997. 75(3): 23-30.
24. Novak RD, Auvil-Novak SE. Focus group evaluation of night nurse shiftwork difficulties and coping strategies. Chronobiology International, 1996. 13(6): 457-463.
25. Lovato N. Lack L. The effects of napping on cognitive functioning. Progress in Brain Research, 2010. 185: 155-66.
26. Brooks A, Lack L. A brief afternoon nap following nocturnal sleep restriction: which nap duration is most recuperative? Sleep, 2006. 29(6): 831-40.
27. Akerstedt T, Wright KP Jr. Sleep Loss and Fatigue in Shift Work and Shift Work Disorder. Sleep Medicine Clinics, 2009. 4(2): 257-271.
28. Dorrian J, Paterson J, Pincombe J, Grech C, Rogers AE, Dawson D. Sleep, Stress and Compensatory Behaviours in Australian Nurses and Midwives. Revista de Saude Publica, 2011.
29. Smith-Coggins R, Howard SK, Mac DT, Wang C, Kwan S, Rosekind MR, et al. Improving alertness and performance in emergency department physicians and nurses: The use of planned naps. Annals of Emergency Medicine, 2006. 48(5): 596-604.
30. Borbély AA, Achermann P. Concepts and models of sleep regulation: an overview. Journal of Sleep Research, 1992. 1: 63-79.
31. Dinges DF. Critical research issues in development of biomathematical models of fatigue and performance. Aviation, Space and Environmental Medicine, 2004. 75(3): A181-A191.
32. McCauley P, Kalachev LV, Mollicone DJ, Banks S, Dinges DF, and Van Dongen HP. Dynamic circadian modulation in a biomathematical model for the effects of sleep and sleep loss on waking neurobehavioral performance. Sleep, 2013. 36(12): 1987-97.
33. Banks S. Dinges DF. Behavioral and physiological consequences of sleep restriction. Journal of Clinical Sleep Medicine, 2007. 3(5): 519-528.
34. Mollicone, D, Van Dongen H, Dinges DF. PVT performance as a function of total sleep time in a

dose response sleep restriction experiment with and without naps. Sleep, 2008. 31: A133-A133.
35. Mollicone DJ, Van Dongen HP, Rogers NL, Banks S, Dinges DF. Time of day effects on neurobehavioral performance during chronic sleep restriction. Aviation, Space, and Environmental Medicine, 2010. 81(8): 735-44.