Review Article

The Nighttime Nap Strategies for Improving Night Shift Work in Workplace

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Abstract: Nighttime napping is an effective measure to prevent adverse effects due to night shift work. A characteristic of nighttime nap is that it can result in considerably deeper sleep. Several studies have shown that taking nighttime naps suppressed increasing sleepiness, decreasing alertness during the period following awaking from a nap, and prevented disturbance of circadian rhythm (“anchor sleep”). The length of daytime sleep after night shift, when combined with a nighttime nap, is shorter than that without nap. This finding might be interpreted as a beneficial effect rather than a negative feature because workers can then spend time engaged in other activities rather than sleeping. Nevertheless, the introduction of nighttime sleep break in the workplace has not been widely accepted. To promote nighttime napping strategy in the workplace, consensus building while acting on conflicting interest is essential. Recently, participatory method for improvement of working condition has expanded worldwide. A characteristic of the activity is using action checklist and group work, and heightening motivation to improvement working condition between worker and manager. Through the activities, nighttime napping strategy would be spread more in the workplaces and play a role as one of the effective tools for improving working conditions, work performance and safety in the future.

Key words: Nighttime nap, Napping strategy, Shift work, Safety, Health, Participatory activity

Introduction

Recently, the demand for 24-h operations in various types of industries has expanded worldwide. In multi-shift work schedules, workers need to operate well when on duty, despite sleeping irregular hours. Daytime sleep is often of a shorter length and provides lower restorative values than a full night’s sleep1. During a night shift, alertness and performance often diminish as time progresses. Night-shift work can cause not only occupational accidents due to severe sleepiness and a resulting reduction in alertness but also can introduce several health problems among these non-daytime shift workers2-4. Previously, various countermeasures to prevent adverse effects due to night-shift work have been examined. Exposure to stimulant environment condition such as “light”, “sound”, and “temperature”, intake of caffeine or pharmacological substances, and taking a nap has been investigated to enhance and sustain worker’s alertness during night shift5. Taking a nap particularly has known one of effective countermeasure to prevent increasing sleepiness and decreasing alertness. Previous nap research related to nightshifts has examined two kinds of nap strategies to help avoid reduced the work performance among night workers6-7. One is a nap taken in advance to avoid sleep deprivation (“prophylactic nap”)8-9, and the other is a nap taken during the night shift (nighttime nap)10-13. Some studies have indicated that a prophylactic
nap sustains alertness and performance during the nightshift19, 20). However, if night-shift workers try to sleep before their night shift, generally they have to fall asleep at the nadir of sleepiness (“forbidden zone” for sleep)14). On the other hand, nighttime nap is not only deep sleep but also preventing the disturbance of circadian rhythm due to night shift. However, the introduction of nighttime naps in the workplace has not yet become widespread15). It seems there are various practical problems when implementing napping into the nighttime workplace.

In this paper, we reviewed past studies regarding nighttime napping, and discussed the roles of nighttime naps and various considerations when a napping strategy is implemented in a night-shift work environment.

**Expanding Nighttime Napping in the Workplace**

How many workplaces have introduced nap systems, and how long and how often workers nap are important matters. Previous surveys, most of them conducted in Japan, have indicated an increase in nighttime napping programs in the workplace. In an earlier study, Matsumoto found that 38.6% of the night-shift workers engaged in the pulp-paper and other industries (458 firms) took nighttime naps16). Sakai et al. conducted a questionnaire survey among 828 iron and steel firms (continuous process plants) and found that taking nighttime naps accounted for 37–43% of the male shift workers and 37% of the female on night shifts17). Nishiyama et al. conducted a questionnaire survey in the Japanese chemical and allied industries (1,844 shift workers), and reported that 49.5% of these shift workers take a nap during their night duty18). Sakai and Kogi examined how long workers could take a nap in continuous process plants in the Tokyo area19). Most three-shift workers (8 h shift) take 2–3 h (70.4%), while other workers take 0.5–1 h (15.7%) or 4–5 h (7.4%). In the case of two-shift (16 h shift), 50.6% of workers take 2–3 h and 46.1% of workers take 4–5 h. These findings indicate that nap length partially depends on shift length. Sasaki et al.20) reported that naps were rarely taken if the night break was less than 30 min. When a break was allowed for 30–59 min, about one-third of the workers took a nap. In the cases of 60–89 min and 90 min or more, about 80% of the workers took a nap. These results indicate that the longer the break that is allowed, the more workers take naps. Taking a nap during the night shift has been introduced in Japanese industries with a high percentage of approval among workers21). However, little attention has been given to the value of napping during night duty in most other countries. Therefore, it can be expected that these values are higher in Japan than those in other countries.

The surveys indicate some complaints such as “too short”, “disturbed by noise”, “uncomfortable temperature”, and “filthy bedclothes” from workers who take naps because some industries are not equipped with a comfortable room separated from the work site even though they may have introduced a nap system17, 18). These findings indicate the necessity of considering not only shifts designed to allow naps but also the facilities suitable for napping.

**Effects of Nighttime Napping**

**Advantage and disadvantage of nighttime napping**

A characteristic of nighttime naps is that it can result in considerably deeper sleep as indicated by lower body temperature, much as Slow Wave Sleep (SWS)22). The physiological feature of the nighttime nap during the initial period of nighttime napping from the electroencephalographic aspect is comparable to that of normal night sleep23). Several studies have indicated that a nighttime nap prevented reduction in alertness and performance, and reduced sleepiness during the period following awaking from a nighttime nap, although there are differences of methodology6, 10–13).

Another advantage point of the nighttime nap, “anchor sleep”, has become known, and was introduced by Miner and Waterhouse24). They divided an 8-h sleep into two 4-h sleep periods. One of the 4-h sleep periods was taken consistently at the same time (0:00–4:00), and the other 4-h sleep period was taken at irregular times over a time span ranging between 7 and 12 d. Their study demonstrated that if one of the 4-h sleep periods was taken at the same time each day, the circadian rhythms became stabilized, even when the other 4-h sleep period was irregular. However, there has been little study examining the effect of “anchor sleep,” after the Miner and Waterhouse study. Further study is necessary to confirm whether a nighttime nap sustains circadian rhythms under various nap conditions such as nap duration and the time when a nap is taken.

Nighttime naps affect subsequent daytime sleep. In short, daytime sleep, when combined with a nighttime nap, is shorter in length and has less SWS than daytime sleep alone25). In a sense this finding seems to indicate a disadvantage. However, Matsumoto and Harada observed that total hours of sleep were nearly equal between daytime sleep without a nap and total sleep (2-h nighttime nap plus subsequent daytime sleep)26). Sallinen et al. reported a reduction of SWS in daytime sleep when a 50-min nighttime nap was taken at around 1:00 and 4:00, but this reduction was not significant26). The effect of a nighttime nap on subsequent
daytime sleep might be affected by its length and timing. However, this finding might be interpreted as a beneficial effect rather than a negative feature because workers can then spend time engaged in other activities rather than sleeping.

Despite these beneficial effects, the existence of the transient impairment of performance and mood just after awaking from nap has been established. This effect of napping is called “sleep inertia”27). The duration of reduced performance capability reportedly has varied6, 28, 29). The severity and duration of sleep inertia depends on the length and quality of sleep, sleep timing, and the length of the prior time awake15, 30). In the work site, impairment of performance due to sleep inertia presents a potential problem.

Effective length and timing of the nighttime nap

Previous nap studies have examined naps of various lengths. Generally, in a case of naps taken during the night shift, a long nap is not realistic. It is expected that an effective nap be taken as briefly as possible in the workplace. Regarding the length of the nap, it is thought that approximately 90–120 min of a single sleep cycle (falling asleep to REM sleep) is the most effective. Saito and Sasaki11) compared 2-h and 1-h naps at 3:00 a.m. and a no-nap condition. Their results showed that early morning subjective sleepiness was lower for both nap lengths than no-nap condition. Roger et al.25) also showed that a 1-h nap at 2:00 a.m. had a beneficial effect on performance. A recent field study examining much shorter naps (20 min) by Purnell10) indicated the vigilance tasks are shorter at the end of a night shift from those brief naps than no napping at all. However, it is difficult to conclude the adequate nap length necessary to maintain alertness and performance, because there are methodological differences among these studies.

In addition to the nap length, the time when a nap is taken may have an important effect. Matsumoto researched the effect of 2-h nap taken at 5 different times at night and suggested that the nap taken at the nadir of circadian rhythm is most favorable based on his evaluation of changes of circadian rhythm after the naps22). Gillberg examined the effect of 1-h naps at either 21:00 or 4:30, with compared to the no-nap condition31). Their study revealed that both naps improved performance at the end of night shift (7:00) compared with no nap, especially the nap taken at 4:30. Sallinen et al. investigated the effects of naps taken during the first half of a night shift (around 1:00) for 30 and 50 min, and naps taken during the second half of a night shift (around 4:00) for 30 and 50 min26). Their results indicated that 30 or 50 min naps had beneficial effects at both times while the 50 min naps produced sleep inertia for 10–15 min. Matsumoto31) reviewed this based on previous studies with reference to the length and timing of a nighttime nap. He suggested that a nap of more than 120 min taken in the first half of a night shift and a nap of approximately 60 min taken in the second half of a night shift might help maintain alertness during the post-nap period.

Recently, we also examined the effects of 5 different nap conditions during night duty regarding nap length and timing under laboratory conditions32). In short, the effects of naps taken at 0:00 for 60 and 120 min, naps taken at 4:00 for 60 and 120 min, and no-nap conditions on alertness and performances were investigated. Both 60 and 120 min naps in the latter half of the night shift were superior to earlier naps in terms of sleep quality. However, performance declined after a 1-h nap taken later during the night shift due to sleep inertia. Our finding suggested that the appropriate timing of a short nap must be carefully considered, such as a 60-min nap during the latter half of a night shift.

Workplace nighttime nap studies

Studies conducted on the implementation of nighttime naps at work sites have been few. Bonnefond et al. carried out a precise longitudinal study on the workplace15). They introduced an organization a new program allowing a 1-h nap between 23:30 and 3:30, and examined for 1 yr whether napping during night work would be acceptable to shift workers, and would not be disruptive to work performance and the general quality of life of the workers. It was found that the workers’ vigilance level was higher after the nap, and the efficacy of napping progressively increased for most workers.

Purnell et al. also carried out a valuable study to identify the benefits from taking a single nap on the night shift on subsequent performance and alertness among aircraft maintenance engineers6). In this study, the worker was given the opportunity to take a 20-min nap at the workplace between 1:00 and 3:00. It was found that taking a single 20-min nap during the first night shift significantly improved the speed of response on a vigilance task at the end of the shift compared with taking no nap. The 20-min nap in Purnell’s study is quite short. Therefore, it might be easier than longer naps when introducing napping into a worksite.

Our study conducted at a fire station indicated that the workload among the ambulance paramedics was higher than that among the firefighters called to a large number of emergency services at night33). Therefore, we carried out an intervention study, which modified the work system for
ambulance services during night work so that ambulance paramedics could be allowed to take a nap, and examined the effects of this new system on the fatigue and physiological functions among the ambulance paramedics (data not published). In short, the traditional system was that the ambulance paramedics had to deal with all emergency calls throughout their 24-h shift. In the modified system, two ambulance paramedics could always take a nap at either 21:00–3:00 or 3:00–8:30 by substituting for another firefighter. The total length of naps and the longest continuous nap taken in the new night shift plan were significantly longer than those in the traditional shift, the number of emergency dispatches was fewer, and naps was longer in new shift plan than that in the traditional shift. The beneficial effects of this new shift plan on performance and subjective data were also observed. The modified systems in the present study ensured workers of taking long and continuous naps, and reduced the adverse effects of night duty. Shoji et al. suggested that psychological stress due to the likelihood of a forced and expected awakening could reduce the sleep quality of emergency physicians. Ambulance paramedics must be prepared to dispatch at anytime, when there is an emergency call. Therefore, knowing they could take uninterrupted naps affected the quality of their sleep positively.

Individual differences

As reviewed in the studies to date, a nap is an effective tool to reduce the possible adverse effects from night work. However, we should recognize the existence of individual differences regarding the capability of falling asleep. “Sleepy” and “alert” types have been used as terms indicated individual differences of sleep propensity. In short, the “sleepy” type has the ability to fall asleep more readily. The “alert” type, however, cannot easily fall asleep and normally resists sleep. “Morningness” and “eveningness” are well known as individual differences of chronotype. “Morning” type (M-type) has a rigid sleep-wake cycle while the “evening” type (E-type) has more flexiblity in their time of sleep. We examined the psycho-physiological effects of the 2-h nighttime nap (2:00–4:00) on M-type and E-type. In the M-type, task performance decreased and subjective feelings of fatigue and anxiety scores decreased after a nap compared with the no-nap condition. These recovery powers were not shown in the E-type. Recently, Daurat and Foret investigated individual differences of sleep-wake pattern between the nurses who slept during night shift (night-nappers) and the nurses who did not (nonnight-nappers). The night-nappers had short daytime sleep with polyphasic patterns during daytime after night shift, and nonnight-nappers had long daytime sleep and took preventive naps to anticipated sleepiness during night shift. These different patterns seem to be related by circadian rhythm.

Another important individual aspect of napping is aging. Härmä suggested that sleep flexibility reduces with aging. Sakai and Kogi reported that older workers prefer to go to bed for a nap before or at midnight, while younger workers prefer the latter half of the night shift. Moreover, we need to be concerned about gender with more and more women now engaged in night work. These individual differences are also related to worker lifestyle and are very complex. Careful design should be the rule when a nap strategy is introduced at a work site.

Nighttime Napping Strategy in the Future

From the findings of the previous studies, it is difficult to assert the most effective nighttime nap conditions because there are methodological differences among the studies and individual differences. However, there is no doubt that nighttime napping is an effective tool to improve nightshift work at a work site.

When a nap strategy is implemented in the work place, several factors should be considered. First, understanding the negative effects of nighttime napping as well as the beneficial effects should be communicated to the workers. Sleep inertia might be a crucial factor that might cause occupational accidents in some circumstances. Second, nighttime napping means that some workers must leave their job in turns to take a nap when on duty. There are also limitations in the duration and timing of naps. Therefore, it is also important to assure a comfortable environment to guarantee high-efficiency sleep during the allowed rest periods to managers. As described below, Kogi suggested five rules of thumb for on-duty napping by nightshift workers.

- Facilitate the habit of napping at the workplace by encouraging it.
- Select 60–90 min as the napping period where possible
- Select prudent timing in the arrangement of naps so that the workers can nap in turn during the midnight and early morning hours.
- Provide a good sleeping environment in a quiet, dark, and air-conditioned area.
- Collectively plan the nap periods as part of multifaceted measures for improving shift-work conditions.

Despite the beneficial effects of nighttime napping, however, there are some obstacles when a napping strategy is implemented in the workplace. As described above,
nighttime napping has been introduced in Japanese industries conventionally. On the other hand, there is the fact that managers and workers seemed to suffer from the notion that napping is an indicator of a lack of professional ethics in other countries\textsuperscript{43}. Providing information to workers and managers about the risks of lowered alertness reduction and performance, and the beneficial effectiveness of nighttime napping for safety, health, and quality of life might be one of the solutions to ethical attitudes.

When nighttime napping strategy is introduced in the worksite, we should consider that naps are not the only effective countermeasure for work performance problems during the night shift. Moreover, we should consider how to create an effective strategy for improving work performance and promoting safety and health is different for each worksite. Rosekind et al. pointed out the requirement for attention to multifactors when a nap strategy is implemented in the workplace\textsuperscript{41}. Recent international regulations by the International Labour Organization (ILO) have emphasized multifaceted protection and flexibility in working time arrangements\textsuperscript{42}. Flexibility is an important subject in many practical approaches toward better shift schedules and improving health and tolerance of shiftworkers\textsuperscript{43}. The ILO showed three essential steps could be identified as follows: 1) group study of operational requirements and workers’ needs; 2) establishing feasible options; and 3) consensus building while acting on conflicting interests\textsuperscript{44}. Participatory methods for the improvement of working conditions have expanded in Asia\textsuperscript{45}. The characteristics of these methods are approaches to improve working conditions focusing on low-cost and using action checklists and group discussions. These action and participatory oriented activity heighten motivation among workers and managers, and help improve further aspects of the working conditions combined with these initial improvements. This activity is important to promote multiple countermeasures linked with reducing excessive workload among shift workers. Through these activities, nighttime napping strategy would be spread more in the workplaces and play a role as one of the effective tools for improving working conditions, work performance and safety in the future.

References

with English abstract).


