



Adaptive and Therapeutic Strategies for Sleep Disturbances in Shift Workers

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Shift work disorder (SWD) results from circadian misalignment, where the internal circadian clock fails to synchronize with external changes induced by shift work. The prevalence of SWD ranges from 2.3% to 84.0%, depending on shift type, occupation, and measurement methods [1].

Currently, SWD treatments include medications or nonpharmacologic treatments to normalize the circadian cycle or alleviate symptoms like excessive sleepiness or insomnia. However, there are no treatments, whether pharmacologic or nonpharmacologic, that can completely restore altered circadian cycles to their baseline levels.

This opinion outlines diverse adaptive strategies and therapeutic approaches for sleep disturbances developed in our research laboratory.

Pharmacological Intervention

Limited evidence supports melatonin's efficacy in improving sleep duration after a night shift, with no impact on other sleep quality parameters [2]. Modafinil and armodafinil enhance alertness and reduce sleepiness in individuals with SWD; however, they are associated with adverse events. The combination of caffeine and naps decreases sleepiness during night shifts, though evidence quality is deemed low. Conversely, sedative-hypnotics show no improvements in sleep duration or quality after a night shift. The variability in shift schedules, melatonin dosage, and timing makes it challenging to draw definitive conclusions.

So far, there is no satisfying pharmacological intervention for SWD, emphasizing the need for more advanced experimental designs considering the environmental factors of shift workers.

Bright Light Therapy

Simulation studies and a few field studies suggest that daylight or bright light exposure in the early morning can inhibit adaptive circadian phase resetting. In addition, the use of dark goggles was also shown to successfully inhibit phase resetting [3].

However, relying solely on bright light therapy to normalize circadian rhythms disruption resulting from changing shift work is ineffective. Coordinating light therapy and melatonin with the shift work cycle is essential. Recommendations include adjusting shift work cycles, providing 4–5 days off between day and night shifts, incorporating light therapy, light restriction, and sleep timing adjustments to gradually shift the sleep phase. This complex approach, combining bright light therapy and chronotherapy, appears more effective. However, implementing such schedules requires more holidays, and increasing workforce,

which could be challenging without organizational support [4].

Recently, one meta-analysis of five studies indicated that exposure to light can decrease sleepiness levels, shift-work-related complaints, and insomnia while increasing psychomotor error, alertness, and daytime sleep duration following night shifts. However, statistical significance was lacking, possibly due to heterogeneity or an insufficient number of studies, emphasizing the need for larger, well-designed randomized control trials [5].

Sleep Hygiene Education

Tailored sleep hygiene guidelines for shift workers were recently developed, involving a collaborative effort by experts in sleep, shift work, and occupational health [6]. The draft guidelines went through three rounds of review, achieving consensus on all recommendations. The final set comprises 18 individual guidelines, referred to as “healthy sleep practices for shift workers” (Table 1). Future research is required to assess the acceptability and effectiveness of these guidelines among shift workers.

Shift Schedules Modification

Forward and faster rotation may reduce sleepiness during shifts, but its impact on sleep quality is uncertain. Limited evidence suggests that faster rotation decreases off-shift sleep duration, while shorter shift durations (16 hours) increase sleep duration and there is moderate evidence for reducing sleepiness [7]. Changes in shift duration and workweek compression show no clear effect on sleep or sleepiness, but the evidence is uncertain. No evidence is available for other shift schedule changes. More high-quality studies, preferably randomized controlled trials, are needed to conclusively determine the effects of shift schedule adaptations on sleep and sleepiness in shift workers.

Prescribed Sleep/Wake Scheduling

On-the-job sleepiness and associated safety incidents pose significant challenges for shift workers. However, there has been a lack of attention on the appropriate sleep duration to minimize on-the-job sleepiness among shift workers.

Our recent study focused on nurses in rotational 3-shift work. In a 2-week study using actigraphy and the Epworth Sleepiness

Table 1. Healthy sleep practices for shift workers

Guideline 1. Prioritize your sleep.
Guideline 2. Aim for 7–9 hours of sleep per 24 hours.
Guideline 3. Try to maintain a similar sleep schedule for each shift type.
Guideline 4. Find activities that help you wind-down and feel relaxed, and consistently engage in these activities before bed, ideally in a dimly lit and quiet environment.
Guideline 5. When transitioning to a block of days off, particularly after working late/night shifts, have a short sleep in the morning and go back to bed earlier than your usual bedtime.
Guideline 6. Use short napping (15–20 minutes) as a helpful tool.
Guideline 7. Avoid high-risk tasks (e.g., driving, operating machinery) during sleep inertia, typically lasts 15–30 minutes after waking.
Guideline 8. Create a comfortable sleep environment.
Guideline 9. Use your bed for sleep and intimacy.
Guideline 10. Avoid exposure to bright light before bed.
Guideline 11. Avoid caffeine too close to your bedtime.
Guideline 12. Avoid nicotine entirely, or limit nicotine intake in the 6 hours before bed.
Guideline 13. Avoid drinking alcohol close to bedtime, even in small amounts.
Guideline 14. Be mindful of medication. Melatonin, can be helpful. Sleep-inducing medications (i.e. sleeping tablets) should usually only be used for short-term or intermittent relief of sleep problems.
Guideline 15. Limit food intake during night shifts and choose a lighter meal before bed.
Guideline 16. Avoid too much fluid before bed.
Guideline 17. Engage in regular exercise.
Guideline 18. Develop strategies for sleep problems. If you're unable to sleep, get out of bed and do something relaxing in a quiet, dimly lit environment. Try to limit screen time and clock-watching and go back to bed once you're feeling sleepy. If sleep problems occur more than 3 times/week for several weeks in a row, seek advice from a healthcare professional.

Modified from Shriane et al. *Sleep* 2023;46:zsad182, under the terms of the Creative Commons License [6].

Scale, no significant correlation was found between average sleep duration and sleepiness levels. Analyzing shift workers' irregular sleep-wake patterns revealed varying sleep duration needs for day, afternoon, and night shifts, named the "circadian sleep sufficiency model." Shorter sleep durations were indicated after night shifts, while longer durations were needed after day or afternoon shifts when sleeping at night. These findings confirm that increasing sleep sufficiency reduces reported sleepiness among shift workers [8].

Based on these findings, we have created a personalized sleep algorithm for shift workers. This framework analyzes real-world sleep data from wearables, utilizing a mathematical model to predict alertness. We identified a novel sleep-wake pattern called adaptive circadian split sleep, optimizing alertness during work and nonwork periods. Our mobile app integrates this framework, suggesting personalized sleep schedules to maximize alertness during specific activities. This approach aims to improve the health and quality of life for shift workers. The algorithm is set to validate a larger group and to confirm its effectiveness in enhancing sleep quality and on-the-job alertness [9].

SWD among shift workers transcends individual concerns, manifesting as a profound societal issue. SWD not only encompasses the issue of insufficient sleep but also influences perceptions of health, emotional well-being, and stress coping mechanisms. Since SWD is a health concern demanding intervention, various studies have historically proposed single or multimodal strategies, yet a consistently effective approach is yet to be confirmed.

We are transitioning into an era of personalized medicine that aligns individual sleep habits and environmental factors with optimal sleep durations and timings tailored to the rapidly evolving landscape of shift work. This paradigm shift is reinforced by cutting-edge digital health devices. Therefore, the imminent availability of strategies attuned to minimizing SWD is now on the horizon.

Conflicts of Interest

The author has no potential conflicts of interest to disclose.

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