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EXPOSURE TO BRIGHT LIGHT AND DARKNESS TO TREAT PHYSIOLOGIC MALADAPTATION TO NIGHT WORK

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Abstract Working at night results in a misalignment between the sleep-wake cycle and the output of the hypothalamic pacemaker that regulates the circadian rhythms of certain physiologic and behavioral variables. We evaluated whether such physiologic maladaptation to nighttime work could be prevented effectively by a treatment regimen of exposure to bright light during the night and darkness during the day. We assessed the functioning of the circadian pacemaker in five control and five treatment studies in order to assess the extent of adaptation in eight normal young men to a week of night work.

In the control studies, on the sixth consecutive night of sedentary work in ordinary light (approximately 150 lux), the mean (=SEM) nadir of the endogenous temperature cycle continued to occur during the night (at 03:31 ±0:56 hours), indicating a lack of circadian adaptation to the nighttime work schedule. In contrast, the subjects in the treatment studies were exposed to bright light 12,000 lux) at night and to nearly complete darkness during the day, and the temperature nadir shifted after four days of treatment to a significantly later, midafternoon hour (14:53±0:32; P<0.0001), indicating a successful circadian adaptation to daytime sleep and nighttime work. There were concomitant shifts in the 24-hour patterns of plasma cortisol concentration, urinary excretion rate, subjective assessment of alertness, and cognitive performance in the treatment studies. These shifts resulted in a significant improvement in both alertness and cognitive performance in the treatment group during the night-shift hours.

We conclude that mal aidaptation of the human circadian system to night work, with its associated decline in alertness, performance, and quality of daytime sleep, can be treated effectively with scheduled exposure to bright light at night and darkness during the day. (N Engl J Med 1990; 322:1253-9.)

APROXIMATELY 7.3 million Americans work at night, either on permanent shifts or on schedules, requiring a rotation of day, evening, and night work.' These workers forgo nocturnal sleep and then attempt :o sleep during daylight hours. Yet, as Benedict first noted at the turn of the century, a complete physiologic adaptation of endogenous circadian rhythms to such inversion of the daily routine does not occur=; even after years of permanent nighttime work.' -6 Physiologic maladaptation to an inverted schedule results in diminished alertness and performance during nighttime work, with attendant increases in the number of fatigue-related accidents during nighttime hours.'-9 Then, despite the nocturnal depri

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vation of sleep, these workers typically experience daytime insomnia. 10-14 Long-term exposure to variable work schedules that include work at night is also associated with an increased risk of cardiovascular disease, gastrointestinal illness, reproductive dysfunction in women, and sleep disorder.' 5-18 Improvements in performance and well-being have been achieved as a result of modifications in work-schedule design, 14 but true physiologic adaptation to night work under field conditions has not previously been demonstrated.

During the past 20 years, considerable progress has been made in understanding the underlying neurophysio!ogic processes that regulate adaptation to the periodic aspects of the external environment. Studies involving ablation, transplantation, and other procedures have demonstrated that the suprachiasmatic nuclei of the hypothalamus serve as the principal pacemaker of the circadian timing system in mammals. l9-21 A specialized retinohypothalamic tract links the retina to these nuclei, forming a nonvisual photoreceptive system that mediates the synchronization, or entrainment, of the circadian pacemaker with the light-dark cycle.22 Even though corresponding structures subserving rhythmicity and photic entrain