Interventions mitigating health risks among shift workers: Current knowledge and workplace practices

Controlled exposure to light and darkness

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Circadian adaptation to shift work


- Circadian physiology substantially affects an individual tolerance to working shifts
  - Phase angle of entrainment (Benhaberou-Brun et al 1999; Gibbs et al 2007)
Aims

- Review a series of interventions based on controlled exposure to light and darkness for shift workers
- Discuss the pros and cons of circadian adjustment to night shift work
Phototherapy trial in nurses

- Control nurses: 3 men, 6 women, 42.0 ± 7.2 y.o
- Treatment nurses: 4 men, 6 women, 41.7 ± 8.8 y.o
- ≥ 8 night shifts/15 days

Circadian adaptation to permanent night shifts

**Light/Darkness Intervention**
- Regular sleep/darkness schedule, darkened bedrooms
- Bright light exposure at night (3,243 ± 928 lux)
- Sunglasses (15% visual light transmission) during commute

**Phase shifts**

**Control group:**
- CBT: $-4.09 \pm 1.94$ h
- S. melatonin: $-5.08 \pm 2.32$ h
- S. cortisol: $-3.05 \pm 2.12$ h

**Intervention group:**
- CBT: $-9.32 \pm 1.06$ h
- S. melatonin: $-11.31 \pm 1.13$ h
- S. cortisol: $-11.07 \pm 1.27$ h

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*Boivin et al. J Biol Rhythms (2002)*
*Boivin et al. Chronobiol International (2012)*
TST (±SEM): 7:06 ± 0:08 vs 6:36 ± 0:11 h, treatment and control, respectively.

Day sleep
Night sleep
CONTROL

TREATMENT

Hours of peak melatonin during sleep/darkness

**Experimental Protocol**

- 15 police officers on patrol
  - control n=9; intervention n=8
  - 2 police officers participated in both conditions (1 year interval)
- Age: 30.1 ± 5.2 years old

![Chart showing experimental protocol with dates and days of the week, along with visual elements such as sunglasses and police officers.]

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**Intervention**

- 15 police officers on patrol
  - control n=9; intervention n=8
  - 2 police officers participated in both conditions (1 year interval)

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**Boivin et al. Chronobiol International (2012)**
Experimental Measures

**Laboratory**
- Urinary aMT6s
  - Wake period: 1x / 3h
- Salivary melatonin
  - Wake period: 1x / 30 minutes
  - 1\textsuperscript{st} sleep period: 1x / 2 hours

**Ambulatory**
- Urinary aMT6s
  - 10 minutes before and after main sleep period
- Psychomotor Vigilance Task (PVT)
  - Before and after work shift

*Boivin et al. Chronobiol International (2012)*
Results: Phase Shift of Circadian Markers

- Significant phase delays in both groups (p=0.009)
- Greater, but not significant, phase delays in the intervention group compared to controls.

Results: Urinary aMT6s Excretion Rate

- Significant increase of Urinary aMT6s excretion during daytime sleep across consecutive night shifts in both groups ($p \leq 0.0001$)
- Significant greater rate of increase in the intervention group ($p=0.032$)

Results: Ambulatory Performance

- Significant decrease of reaction speed across consecutive night shifts in the control group ($p \leq 0.04$) but not in intervention group ($p \geq 0.35$).

Peripheral clocks and simulated night shift work

James et al., Sleep (2007)
Summary of findings

- Circadian misalignment in shift workers
  - Major determinant of sleep duration, quality
  - Impact the temporal relationship between circadian rhythms and the shifted sleep schedule
  - Individual differences in tolerance to living at abnormal circadian phases
  - “Molecular” circadian desynchronisation (peripheral and non-SCN brain oscillators)
  - Sensitive to light-induced phase shift of the central circadian pacemaker
  - Possible greater role in increased medical risks associated with shift work than reduced melatonin

- Control of light-darkness in shift workers
  - Can improve the phase angle between circadian rhythms and the atypical sleep schedule
  - Possible direct stimulating effect of bright light exposure
  - Pros and cons
**Promoting circadian resetting?**

**PROs**: intermittent timed bright light exposure is an effective countermeasure:

1. **Robust phase shifts** (Baehr et al 1999; Rimmer et al 2000; Boivin et al 2002; James et al 2004; Gronfier et al 2004; Lee et al 2006; Revell et al 2006)

2. **Circadian adaptation in 78-100% of participants** (appropriate phase angle between ECP and the sleep-wake cycle)

3. **Improves daytime sleep duration, efficiency, quality** (Yoon et al 2002; Burch et al 2005; Bjortvatn et al 2006; Garde et al 2009; Sasseville et al 2009)

Interventions targeting circadian resetting

**CONs:**

1. Partial adaptation in 52-56% of controls (Midwinter and Arendt 1991; Baehr et al 1999; Boivin et al 2002) might be sufficient to stabilize psychomotor performances (Crowley et al 2004)

2. Maintenance of stable daytime sleep might be sufficient for appropriate phase angle and increased TST (Santhi et al 2008; Dumont et al 2009)

3. Melatonin reduction at night (Hansen et al 2006; Stevens et al 2006; Davis et al 2006; Schernhammer et al 2010)

4. Bright light levels could be aversive

5. The repetitive shifting back can be a health hazard

6. Blocking low wavelength light at night (Kayumov et al 2005)
Sources


Boivin DB and James FO. *Prevention of Physiologic Maladaptation to night shift work by phototherapy.* Peer-reviewed research report from the Institut de Recherche en Santé et en Sécurité du Travail 2002; R-303;108 pages


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