Sleep and circadian health: Relevance to EMS personnel

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<table>
<thead>
<tr>
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<th>Details of Potential Conflict</th>
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<tbody>
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 This talk presents material that is related to one or more of these potential conflicts, and references are provided throughout this lecture as support.
Sleep and circadian health: Relevance to EMS personnel

- The big picture
- Biological basis of circadian rhythms and sleep
- Circadian rhythms, sleep, and health
- Shift workers
- Interventions
Sleep is related to performance and public safety

Hon. Mark Rosekind, Ph.D.
- Member, NTSB 2011-2014
- Chair, NHTSA, 2014-
Sleep is related to individual health

Insufficient Sleep: maps showing distribution of sleep duration across the United States from 1991 to 2010, with colors indicating different sleep durations.

Diabetes: image of a person testing their blood sugar.

Coronary Heart Disease: image of a heart attack.

Obesity: maps showing prevalence of obesity in the United States from 1991 to 2010, with colors indicating different obesity rates.

Hypertension: image of a person checking their blood pressure.

Early Mortality: image of a cemetery.

Conditions related to insufficient sleep:
- Insufficient Sleep
- Early Mortality
- Hypertension
- Diabetes
- Obesity
- Coronary Heart Disease

Additional related conditions:
- 74-9.6
- 9.7-10.4
- 10.5-11.4
- 11.5-13.0
- 13.1-19.3

CDC

74-9.6
9.7-10.4
10.5-11.4
11.5-13.0
13.1-19.3
We live in two worlds...
The rhythms of life

<table>
<thead>
<tr>
<th>Time</th>
<th>Examples</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than a second</td>
<td>Brain (EEG) waves</td>
<td><strong>Ultradian</strong> = Rhythm that cycles in &lt;24 hrs</td>
</tr>
<tr>
<td>Seconds</td>
<td>Heart (EKG) waves</td>
<td></td>
</tr>
<tr>
<td>Minutes</td>
<td>Breathing</td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>Sleep stages</td>
<td></td>
</tr>
<tr>
<td>Day</td>
<td>Sleep-wake cycle</td>
<td></td>
</tr>
<tr>
<td>Month</td>
<td>Childbirth</td>
<td><strong>Circadian</strong> = Rhythm that cycles in ~24 hrs</td>
</tr>
<tr>
<td>Year</td>
<td>Heart attacks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blood pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alertness, performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Menstrual cycle</td>
<td><strong>Infraadian</strong> = Rhythms that cycles in &gt;24 hrs</td>
</tr>
<tr>
<td></td>
<td>Hibernation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Migration</td>
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</table>
The master circadian clock is in the Suprachiasmatic Nucleus (SCN) of the brain.

Videnovic, Nat Rev Neurol, 2014. 10:683–693
Clock genes and the expanded clock gene network

What is sleep?

- “A recurring, reversible neuro-behavioral state of relative perceptual disengagement from and unresponsiveness to the environment”

- Typically accompanied (in humans) by postural recumbence, behavioral quiescence, and closed eyes
What controls sleep? The hourglass, the clock, and the alarm

How long you’ve been awake

Time of day

Level of arousal

Sleep drive

Circadian sleep-wake rhythm

Moment-to-moment arousal
Sleep rhythms in older and younger adults on a “90-minute day”

Circadian

Homeostatic

Buysse, *SLEEP*, 2005; 28: 1365-1376
Why is shift work bad for sleep?

**A. Day Worker**
- **Sleep** during period of high/increasing circadian drive for wakefulness
- **Wake** during period of low/decreasing circadian drive for wakefulness

**B. Night-Shift Worker**
- **Sleep** during period of fragmented and shorter daytime sleep (circadian disruption)
- **Wake** during period of low/decreasing circadian drive for wakefulness

Sleep and health: Sleep medicine perspective

- Circadian Rhythm Sleep Wake Disorders
- Insomnia
- Hyper-somnias
- Sleep Apnea
- Sleep-Related Movement Disorders
- Parasomnias

↓ Health
Sleep Disordered Breathing (SDB) and mortality: 18-year follow-up (n = 1396)

**Baseline AHI category** | **All-cause mortality** | **Cardiovascular mortality**
---|---|---
None: 0 - < 5 | Reference | Reference
Mild: 5 - < 15 | 1.4 (0.7, 2.6) | 1.3 (0.4, 4.1)
Moderate: 15 - < 30 | 1.7 (0.7, 4.1) | 1.5 (0.3, 7.3)
Severe: ≥30 | 3.8 (1.6, 9.0) | 5.2 (1.4, 19.2)

P trend = 0.004 | P-trend = 0.03

*Hazard ratios adjusted for age, age², sex, body mass index, and body mass index²

AHI = Apnea Hypopnea Index  
(# apneas/sleep duration in hrs)

[SLEEP 2008 31:1071-78]
Sleep Health: Can We Define It? Does It Matter?

Sleep health is a multidimensional pattern of sleep-wakefulness, adapted to individual, social, and environmental demands, that promotes physical and mental well-being.

- Good sleep health is characterized by
  - Regularity
  - Subjective satisfaction, high quality
  - Sustained alertness during waking hours
  - Appropriate timing
  - High efficiency
  - Adequate duration

- Measured by
  - Self-report
  - Behavior (actigraphy)
  - Physiology (polysomnography)

Buysse, SLEEP 2014; 37(1):9-17
Sleep and health: Dimensional perspective

- Regularity
- Satisfaction
- Alertness
- Timing
- Efficiency
- Duration

↑ Health
# Sleep health matters!

<table>
<thead>
<tr>
<th></th>
<th>Mortality</th>
<th>Metabolic Syndrome/Obesity</th>
<th>Diabetes/impaired glucose metabolism</th>
<th>Hypertension</th>
<th>Coronary Heart Disease</th>
<th>Depression</th>
<th>Impaired neuro-behavioral performance</th>
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<tbody>
<tr>
<td>Quality/satisfaction</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Alertness/sleepiness</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Efficiency</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Regularity</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
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<td>+</td>
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Sleep disorders in shift workers

- N = 817 hospital staff
  - Day n = 422
  - Rotating n = 323
  - Night/shift n = 52

- Sleep diagnoses by computer-guided algorithm

- Rotating workers have highest % with
  - Difficulty falling asleep
  - Irregular sleep times
  - Work-related accidents

* p < .01 vs. fixed daytime schedule

Ohayon, J Psychosom Res, 2002; 53: 577-583.
Sleep in shift workers

- N = 2570, age 18-65, 45% F
- Representative community sample
- Night, rotating workers have increased odds of
  - Ulcers
  - Heart disease

# Sleep health and EMS personnel

<table>
<thead>
<tr>
<th>Sleep health dimension</th>
<th>EMS personnel</th>
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<tbody>
<tr>
<td><strong>Regularity</strong></td>
<td>Irregular work and sleep-wake schedules common</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td>Higher rates of insomnia</td>
</tr>
<tr>
<td><strong>Alertness</strong></td>
<td>Compromised due to work schedules, sleep duration, sleep disorders</td>
</tr>
<tr>
<td><strong>Timing</strong></td>
<td>Sleep, wake at unfavorable circadian times</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>Reduced due to sleep timing, on call schedules</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Short sleep related to scheduling, life demands</td>
</tr>
</tbody>
</table>
## Treatment recommendations for Shift Work Sleep Disorder

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned sleep schedule</td>
<td>Regularity enhances sleep</td>
</tr>
<tr>
<td>Napping</td>
<td>Pre-emptive (prior to shift) and operational (during shift)</td>
</tr>
<tr>
<td>Timed light-dark exposure</td>
<td>Appropriately timed light-dark helps shift circadian rhythms to an appropriate phase</td>
</tr>
<tr>
<td>Timed melatonin</td>
<td>Appropriately timed melatonin helps shift circadian rhythms to an appropriate phase</td>
</tr>
<tr>
<td>Hypnotics</td>
<td>May help with sleep initiation, maintenance at unfavorable circadian phase</td>
</tr>
<tr>
<td>Stimulants</td>
<td>Help to maintain alertness at unfavorable circadian phase (modafinil, armodafinil, caffeine, others)</td>
</tr>
<tr>
<td>“Compromise” phase position</td>
<td>Partially shifting circadian phase helps to optimize sleep on night shift and off days</td>
</tr>
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Effects of a text message intervention to reduce fatigue and sleepiness in EMS personnel

Circadian and sleep health: Broader perspective

Can we use this...  To change these...  Acting through these...  To optimize these?

Interventions

Circadian Timing System

Sleep

Nutrition, Obesity

Physical Activity

Changes in Physiology
- Epigenetics
- Inflammation
- Immunity
- Hormones

Health Outcomes
- Physical Health
- Mental Health
- Cognitive Health

Genes, Environment, Social Interactions
What would sleep/circadian health interventions look like?

- Educational component
- Behaviorally-based “modules” for each dimension
  - Focus on simple techniques and recommendations
  - Individualized
- Derived from principles of
  - Cognitive-behavioral therapy for insomnia
  - Circadian interventions (light, melatonin)
  - Exercise interventions
  - Dietary interventions
- Individual, group, internet options
Sleep and circadian health: Conclusions

- Circadian rhythms and sleep are fundamental biological processes related to health and safety
- Two perspectives on sleep and health outcomes
  - Sleep disorders (categorical; medical disorders)
  - Dimensions of sleep health (dimensional; continuous characteristics)
- Shift work in EMS personnel interferes with circadian rhythms and sleep
  - Sleep disorders
  - Sleep health
- Treatment in EMS personnel can be directed at
  - Sleep disorders (mostly medical interventions)
  - Sleep health (mostly behavioral interventions)