Sleep Deprivation and Shift Work

CASE PRESENTATION and DISCUSSION

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Current Concepts in Sleep Medicine
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Conflict of Interest

None
Case Presentation:

CC: Inability to focus at work, difficulty getting enough sleep at night

HPI: The patient is an active, healthy 46 year old local news reporter, who is struggling to stay focused at work due to trouble getting to sleep at night

- Daytime symptoms have been worsening over the last year or so, although sleep onset difficulties have been present throughout her entire career (12 years with the news station)
- Caffeine intake has increased to 5 cups of coffee during the day, 1-2 caffeinated sodas and an energy drink
- More anxious and irritable since the beginning of the year; started smoking again as she strangely finds this both calming and alerting
- No other changes to health.
- No medications or supplements.
  - She has tried melatonin (dose unknown) at bedtime but this did not help. Uses PRN ZzzQuil to help her sleep
- No snoring, witnessed apneas, AM headaches, restless legs, parasomnia activity, dream-enactment behaviors, cataplexy, hypnagogic hallucinations or sleep paralysis.
- STOP-BANG 0; ESS 8; FSS 40; PHQ-9 score 4; GAD-7 score 8
Case Presentation:

Sleep History:
- **Bedtime:** 8 PM but unable to sleep until 11 PM most nights, so works on laptop in bed
- Once asleep, able to sleep all night long
- **Wake time:** 3 AM to an alarm with several alarms set starting at 2:30 AM so she can awaken on time for work
- **Work schedule (M-F & some weekends):** 4 AM to ~2 PM depending on the events covered for the news that day
- Often “crashes” with a 30 minute - 1 hour nap upon returning home
- Then works on her computer from home most evenings
- **Average sleep in a 24 hour workday = 5 hours**
- On weekends she does not have to work, bedtime is 11 PM – 12 AM, but she sleeps until 9 AM to “recover” from the work week; this helps her feel “human” again
- Feels best on vacation when she can sleep from 12 AM to 8 AM
Case Presentation:

Physical Exam
- Vitals: BP 145/88, P 92, oxygen saturation 95%, height 5’1, weight 117 pounds, BMI 22.1
- Normal physical exam

Impression
- Shift work disorder (circadian rhythm abnormality) leading to sleep onset insomnia
- Poor sleep hygiene
- No strong clinical suspicion for any other sleep disorders

Plan and Recommendations:
- Review good sleep hygiene, including avoiding the post-work nap
- Overnight oximetry as a screen for sleep apnea
- Sleep logs x 2 weeks, then return to clinic to review this
- Melatonin 3 mg at 6 PM, bright light exposure for 30 minutes upon awakening
Why do we Sleep?

• All animals sleep.
• Sleep is vital to life. Animals and humans who are unable to sleep die.
• Sleep is vital to learning, memory and cognition.
• Sleep is critical to maintaining the health of our immune, nervous and other vital systems.
Sleep Deprivation

• The US Center of Disease Control and Prevention (CDC) estimates that 30% of Americans are sleep deprived
• Sleep deprivation occurs when someone sleeps 6 hours or less per day and can be acute or chronic*
• Vulnerability to sleep deprivation varies over time and between individuals
• Highest risk groups:
  • Those with underlying sleep disorders
  • Shift workers, especially healthcare workers, and those in transportation or manufacturing
How did things get this bad?

Technological leaps forward, unfortunately left sleep behind
1. The Industrial Revolution (circa 1760-1840)
2. The Light Bulb (1879)
3. The Digital Age (circa 1938)
How do we Sleep?

• 2 critical pathways affecting sleep and wakefulness:

  Process S: Sleep homeostasis: pressure to sleep, which is relieved by sleep and napping
  Process C: Circadian Rhythm
The Circadian Rhythm

Circadian Rhythm Generator = SCN (suprachiasmatic nucleus) of the hypothalamus

• Firing pattern of the SCN establishes the circadian rhythm
  • Synchronizing the release of multiple neurotransmitters and hormones
  • Coordinates the central nervous system with peripheral organs
    • Regulate hormone release, body temperature, sleep & wakefulness, appetite, activity/energy

• Regulates Sleep & Wakefulness
  • Slightly longer than 24 hours
  (actually 24 hours, 11 minutes +/- 16 minutes
The Circadian Rhythm

Timing of the Circadian Rhythm

• Light exposure: most powerful zeitgeber
  • Entrains SCN to a 24 hour day
  • Ganglion cells of the retina are most sensitive to and SCN is most active with blue wavelength light → this activates the SCN to suppress melatonin and promote wakefulness

• Exercise and activity
• Eating
• Social cues

Image: www.avstim.com
Circadian Rhythm and Sleep Homeostasis Work Together to Regular Sleep & Wakefulness
The Sleep of Modern Society

Pre-Industrial Revolution

Modern Workplace

Sleep Homeostasis

Circadian Rhythm Activity

Melatonin
The Individual Cost of Sleep Deprivation

Chronic Sleep Deprivation has significant health effects and can cause or exacerbate multiple different disease states

- Hypertension
- Type 2 Diabetes
- Obesity
- Dementia
- Depression
- Fibromyalgia
- Seizures
- Chronic pain
- Infections

- Trauma
- ADHD/hyperactivity in children
- Headaches
- Dry eyes
- Nystagmus
- Anxiety
- Mania
- Heart attacks
- Poor wound healing
Sleep Deprivation & Cognition/Alertness

• Sleep deprivation results in:
  • ↓ Reaction time, alertness, & vigilance
  • ↓ Motor & language skills
  • ↓ Reasoning, information processing and decision making ability
  • ↓ Working & long-term memory
  • Intrusive drowsiness (adults) & microsleeps

• People awake for 17-19 hours performed the same or worse than those with a blood alcohol level of 0.05%; those deprived of sleep longer than this performed worse than those with a blood alcohol level of 0.1%; 21 hours of not sleeping = a BAL of 0.08% (Occup Environ Med 2000;57(10):649-655; Nature 1997;388(6639):235)

• Sleep deprivation also results in:
  • Hyperactivity and poor school performance in children
    • As many as 25% of children diagnosed as ADHD may have underlying obstructive sleep apnea
  • ↓ Pain tolerance
  • ↑ Irritability, mood lability, poorer coping, depression
Sleep Deprivation & Metabolism

• Sleep deprivation results in:
  • ↓ Leptin levels: hormone that makes you feel full
  • ↑ Ghrelin levels: hormone that makes you crave salty, sweet, starchy, and fatty foods (Ann Intern Med 2004;141:846)
  • ↑ Energy intake with no change in expenditure
  • Increased hunger, appetite, and food intake, without and increase in burning calories, can lead to obesity
  • Population studies show that less sleep time is associated with obesity (Sleep 2005;28(10):1217-1220)

• Sleep deprivation results in:
  • ↑ Insulin resistance
  • Is strongly correlated with DM2
Sleep Deprivation & The Immune System/Illness

• Sleep deprivation leads to:
  • ↑ Increased WBC of innate immune system (neutrophils, lymphocytes and monocytes) within 7 days of working a night shift (Chronobiol Int 2017; 34 (6): 721-731)
  • ↑ Increased inflammatory markers: IL-1, IL-6, TNF-α, and CRP
  • ↓ Resistance to infection
  • ↓ Febrile response to bacterial infection with endotoxin

• Sleep deprivation leads to:
  • Diminished antibody response to vaccination (JAMA 2002;288(12):1471-2)
Sleep Deprivation & the Cardiovascular System

• Sleep Deprivation leads to:
  • ↑ Sympathetic activation
  • ↑ Inflammatory cytokines that can cause endothelial damage
  • 60% higher risk of coronary artery disease and cardiovascular disease in patient sleeping less than 6 hours per night (SLEEP 2011;34(11):1487-92)
  • ↑ Risk of dying from coronary artery disease
  • ↑ Risk of dying from stroke (Eur Heart J 2011;32:1484-92)
The Consequences of Sleep Deprivation

• Societal cost:
  • Major public health catastrophes often occur at night due in part or in full to sleep deprivation:
    • Chernobyl (1:23 AM)
    • 3 Mile Island (4:37 AM)
    • Bhopal, India chemical gas leak (11 PM – 12:40 AM)
    • Exxon Valdez (12:04 AM)
  • Motor vehicle and workplace injuries
    • Crashes of AA flight 1420 & Colgan Air flight 3704
    • National Highway Traffic Safety Administration (NHTSA) found sleepiness to be the causative factor in 100,000 police reported crashes and 4% of fatal accidents
    • Medical residents sleeping ≤ 5 hours per night are nearly twice as likely to:
      (SLEEP 2004;27(2):217-223)
      • Cause a significant medical error and be named in malpractice suit
      • Be injured accidently (ie. Needle stick) or self-medicate with alcohol
      • Have a serious conflict with other staff
  • Loss of productivity, personal health & wellness & lives
If Sleep Deprivation is So Bad for Us – Why Do We Do It?

The Boiling Frog Anecdote

• If a frog is put suddenly into boiling water, it will jump out, but if the frog is put in cold water which is then brought to a boil slowly, it will not perceive the danger and will be cooked to death.
If Sleep Deprivation is So Bad for Us – Why Do We Do It?

Psychomotor Vigilance Testing (PVT)

- No Sleep x 3 days
- 4 hours sleep x 2 weeks
- 6 hours sleep x 2 weeks
- Normal: 8 hours sleep

Perception of Sleepiness & PVT Deficit

- No Sleep x 3 days
- 4 & 6 hours sleep x 2 weeks
- Normal: 8 hours sleep

SLEEP 2003:26(2); 117-126
Insufficient Sleep Treatment

Good sleep hygiene
1. Maintain a regular sleep schedule
2. Ensure adequate light exposure upon arising and while awake
3. Avoid bright light exposure (esp. from electronics) close to sleep
4. Avoid napping after work and prior to sleep time
5. Make sure sleep environment is conducive for sleep
6. Avoid stimulants (ie. caffeine, nicotine) close to bedtime
7. Eat regular meals, exercise regularly
8. Have a wind down routine
9. Correct any other underlying sleep disorders (OSA, RLS, etc.)
Shift Work

• Shift work is any work schedule outside the conventional day shift of 8 AM – 5 PM, including:
  • Occasional overnight on-call duty
  • Rotating schedules (clockwise and counter-clockwise)
  • Steady, permanent 2\textsuperscript{nd} or 3\textsuperscript{rd} shifts

• Common: 20% of the US workforce
  • ♀ > ♂

• 32.1% of night workers and 26.1% of rotating workers have difficulty with their sleep or alertness
Circadian Rhythm Disorder

ICSD-3 Definition: All 3 Criteria must be met

1. A chronic or recurrent pattern of sleep-wake disruption due to a misalignment between the endogenous circadian rhythm and the desired sleep-wake schedule

2. This disruption results in clinical symptoms of:
   • Insomnia
   • Excessive sleepiness
   • Both

3. The sleep-wake disturbance causes significant impairment in mental, physical, social, occupational, or educational functioning
Risk Factors

• Age: there is less circadian adaptation with increasing age and is a significant reason for retirement
• “Morning types” are more sleepy during night shifts than “Delayed types”
• Daytime obligations
• Type of shift schedule
  • Evening shifts from 2 PM – 12 AM tend to be better tolerated than night shifts from 9 PM – 8 AM
  • Stable schedules are better tolerated than rotating schedules
    • A circadian rhythm will only shift 1-2 hours per day; so adaptation to a new schedule takes time (Physiol Behav 1993;53:119-26)
  • Rapidly changing (every 1-2 days) versus slower change (every 2 weeks or more)
  • Clockwise rotating schedules are better tolerated than counterclockwise rotating schedules as it is easier to phase delay than phase advance (Science 1982;217:460-3)
    • Delaying sleep tends to be better tolerated (phase delay average is 97 minutes/day)
    • Advancing sleep is not as well tolerated (phase advance average is 57 minutes/day)
Shift Work Disorder Treatment

• Scheduling Sleep Time
  • Designate 8 hours for sleep
  • Long-term shift workers maintain the same schedule of wake/sleep on work and non-work days. ([Chronobiology Intern 1993;10:143-155])
  • If a patient wants to switch sleep schedules between work & non-work day, try to only half the difference between schedules
  • Planned napping lasting ≤1 hour prior to the work shift +/- caffeine intake improves alertness ([SLEEP 2006;29:39-50])
  • Consider low dose melatonin (3 mg) prior to sleep & wake time with bright light ([J Clin Endocrinol Metab 2006;91:54-9])

• Make bedroom environment conducive to sleep
  • Darken windows in sleep environment ([J Bio Rhy 2001;16:502-11])
  • Use ear plugs, white noise machines, fans, etc. to block out daily noise.
Shift Work Disorder Treatment

• Light Exposure (or Avoidance)
  • Wearing dark glasses on the commute home (SLEEP 2004;27:1077-8)
  • Avoid bright light (especially blue wavelength light) exposure for the 2 hours prior to your sleep time
  • Turn off electronic devices (phones, iPADs, laptops, etc.) as you prepare for sleep & during sleep
    • For those working in low-light environments, even less intensity light (12-600 lux) can cause phase shifts; so exposure to ordinary artificial light can strongly effect circadian rhythms in those that spend most of their time indoors (J Physiol 200;526: 695-702)
  • Darken windows in your sleep environment (J Bio Rhy 2001;16:502-11)
  • Get bright light exposure upon awakening from sleep
  • Increase light exposure in work environment - 6000-12,000 LUX for 50% of shift improves alertness (Am J Ind Med1995;27:771-8)
Shift Work Disorder - Treatment

• **Insomnia:** Hypnotic medications promote daytime sleep duration and quality, but not alertness
  - Dependence potential with possible withdrawal effects (delirium, hallucinations, seizures); can increase potential for sleep walking and amnesia

• **Excessive sleepiness:** Stimulants promote wakefulness
  - Ensure patient is getting adequate sleep
  - Modafinil 200mg improves alertness (by MWT & MSLT) and performance ([SLEEP 2004;27:434-439](#))
  - Caffeine 4mg/kg 30 minutes before a night shift improves alertness ([SLEEP 2006;29:39-50](#))

• Discuss situation with employer
How do we improve our sleep?

1. We must prioritize it. On the personal, administrative & societal levels.
   - ACGME regulates medical trainee work hours
   - DOT regulates commercial driving hours
2. Be knowledgeable about sleep & how it affects you
3. Practice good sleep hygiene
4. Be good role models for others and be okay with asking for help
5. Evaluate and treat underlying sleep disorders
Case Presentation

Return to Clinic: 1 month follow-up

- Normal overnight oximetry
- Sleep logs/diary reviewed and discussed
  - Had several “rough days” when avoiding naps, but has started to feel sleepier earlier by 9:30 PM (even on weekends). Still only getting 5½ hours of sleep
  - Caffeine use and nicotine stopped by noon
  - Feels a little more alert since paying attention to getting more light in her workplace.
  - Worried though that she has a big assignment and deadline coming up at work, so high potential to work long hours at home on laptop

Impression

- Mild improvement: Sleep now consolidated at night, but total sleep time only increased by ½ hour, and still is < 6 hours routinely
- Maintaining good sleep hygiene strongly encouraged
- Melatonin 3 mg dose moved to 5 PM nightly with zolpidem (Ambien) 5 mg at 7 PM PRN
Case Presentation

Return to Clinic: 1 year follow-up (also was seen 1 & 6 months following the previous visit)

- Initially had to use Ambien nightly x 1-2 month; this was effective at inducing sleep onset
- Once she got in the habit of sleeping every night by 8-ish PM, she was able to decrease Ambien use to PRN only; first on weekdays, now only the week before major work deadlines – now wants to do a story on shift work disorder for the news
- No side effects from the medication
- Continued melatonin for 3 months, but once was in a regular sleep routine, stopped this on her own; but she had to restart after a vacation to Hawaii because her sleep routine changed & she had some trouble getting back into her prior routine
- Goes to bed at 8 PM even on weekends, but sleeps later until 5 AM on Sat/Sun, then exercises
- Caffeine use down to 2 cups coffee in AM and 1 caffeinated soda in the afternoon
- Able to maintain focus at work, still has some days where she is more fatigued than others; no daytime sleepiness
- Just got a prescription for varenicline (Chantix) from PCP to try to quit smoking again

Impression

- Improved sleep time and daytime symptoms
  - Continue good sleep hygiene, melatonin 3 mg at 5 PM, Ambien 5 mg PRN