Circadian Rhythm Sleep Disorders

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Circadian rhythms

- Latin
- *circa* about + *diēs* day
Circadian Rhythms

Biological rhythms which repeat approximately every 24 hours are called circadian rhythms.
Sleep regulation

- Homeostatic
- Circadian
- habits (human behavior – video games, tv, smoking, etc)
homeostatic

• Sleep drive

• The longer you are awake, the sleepier you are
Homoestatic drive

- Balance between alerting signals and sleep signals
- Not the only control
- Despite the fact that our sleep drive increases with every hour of wakefulness, we are typically no sleepier at 7:00 p.m. than we are at 11:00 am.
Circadian Rhythms

- At the beginning of the night your sleep drive is high
- alerting signal is declining rapidly.
- As the night goes on, sleep drive has decreased
- simple absence of an alerting signal is no longer sufficient to maintain sleep.
- the internal clock, plays a role in sleep promotion
General Properties of Circadian Rhythms

- Circadian rhythms are generated by an internal clock or pacemaker. Therefore, they persist in the absence of cues indicating the time or length of the day.

- The internal clock that regulates circadian rhythms is synchronized, or entrained to the light-dark cycle and other social and environmental cues.
Physiological and behavioral parameters known to exhibit circadian rhythmicity:

- **Hormones:** prolactin, growth hormone, insulin, cortisol, TSH, melatonin.
- **Cardiovascular:** blood pressure, heart rate, blood volume and flow, heart muscle function and responsiveness to hormones.
- **Bronchial smooth muscle reactivity:** with increased asthma symptoms at night and early morning.
- **Kidney function and urine formation:** urine volume, urine electrolytes.
- **Immune system and blood cell functions.**
- **Temperature.**
Clock in the Brain

- Overwhelming evidence indicates that the suprachiasmatic nucleus (SCN), a paired structure located in the anterior hypothalamus contains a circadian pacemaker.
Biological Mechanisms of the Circadian Rhythm

- Receptors in the retina stimulate the SCN
- Melatonin (from the pineal gland) inhibits the SCN
- SCN and pineal gland work together to regulate circadian rhythms
Manipulation of Circadian Rhythms

- Light
- Melatonin
- Medications (sleeping aids/stimulants)
- Activity
Light

- Light is alerting. Light in the morning will make you awaken earlier.
- Light at night makes you stay up later.
Melatonin

• Melatonin is a hormone produced by the pineal gland

• Administration of melatonin synchronizes circadian rhythms in humans. Evening melatonin will advance rhythms. Morning melatonin may delay rhythms
Circadian Rhythms

- Synchronization of the sleep wake schedule and the internal clock is essential to an individual's ability to maintain sleep and wakefulness when desired.

- Light is the most potent cue
Disorders of Circadian Rhythm

- Delayed sleep phase
- Advanced sleep phase
- Shift work
- Jet lag
Circadian Sleep Phase Delay (Night Owl) – Delayed Sleep Phase Syndrome

- equally distributed among women and men, is approximately 0.15%, or 3 in 2,000
- Higher prevalence in teens
- Genes being identified
- Runs in families
DSPD

- Usually sleepy between 1am to 10:30am as a bedtime
- (often 4am or later)
- Sleep is normal other than timing
- Report insomnia
DSPD

- Behavioral factors/habits play a role
- Computers/tv/texting at bedtime
- “Sleeping in” on weekends
- Caffeine/nicotine
- Tend to be “long sleepers”
DPSD

- Timed bright light therapy
- Gradually waking up earlier every one to 3 days - Chronotherapy
- Avoiding naps
- No scientific evidence that sleeping pills will help
Light Therapy

bright light (2,500-10,000 Lux) shifts human circadian rhythms

size and direction of the shift depends on time of exposure

Light boxes
lux

- Intensity of light over a given area
Light Therapy

- 30 minutes of 10,000 lux, or 500 lux blue light
- (2500 to 10000 lux effective in most studies)
- Read or eat or watch tv while looking at box.
Lux

- 100 lux Very dark overcast day

- \textbf{320–500 lux Office lighting}

- 400 lux Sunrise or sunset on a clear day.

- 1,000 lux Overcast day

- 10,000–25,000 lux Full daylight (not direct sun)

- 32,000–130,000 lux Direct sunlight
Light box

- Can be expensive
- $200 to $400
Light therapy

- No UV light

- Cautions: Photosensitivity, Mood disorders

- No eye damage documented

- Blue light seems to have the strongest effect (500 lux)
Melatonin

- No consensus on appropriate dose or timing
- Rule of thumb: 12hrs before bright light/awakening
Melatonin

- Need consistent timing, or phase shifts can worsen
- Most doses 0.5 to 5mg. 3mg most common
- Lack of longterm studies documenting potential side effects
DSPD

- Maintenance is the difficult part!
- Melatonin, 5-7 hrs before bedtime or 12hrs before light treatment. No consensus on timing of melatonin therapy.
Medical Consequences of Disruption of Circadian Rhythmicity

Aging

Many physiological and behavioral circadian rhythms are altered with advanced age:

- The most notable are changes in sleep, such as earlier onset of sleepiness, early morning awakening and increased daytime napping (33% of older people).

- The period of circadian rhythms appear to decrease or shorten with age.
Circadian Sleep Phase Advance (Early Bird)

- 1% of middle aged to older adults
- Also can run in families
ASPD

- Bright light at bedtime
- Melatonin in the MORNING
Jet Lag

• Temporary desynchronization between internal circadian rhythms and external time cues

• Symptoms

  Malaise
  Insomnia / hypersomnia
  Fatigue
  Poor performance
Jet Lag

- For most people, eastbound travel is more difficult (advancing your sleep phase)
- Adjustments are slower with eastbound than westbound travel
- Most circadian clocks are slightly more than 24hrs
- Light comes at “wrong time”
Jet Lag

- Eastbound:
  - use sunglasses before 11am
  - Second day, avoid light before 9am
  - Third day, before 7am

- OR, before travel – start waking up one hour earlier each day for 3 days

- 2-3 days to adjust once at destination

- If travel is short, just keep your home sleep timing
Jet Lag

- Westbound:
  - As much light as possible all day
Jet Lag

- Melatonin:
  eastbound – take melatonin 12hrs after light exposure (first day at 11pm, then 9pm, then 7pm)
  or, every night between 10pm and midnight
Jet Lag

- Westbound: light at night
- No studies of melatonin in westward travel
  (could be used in early morning hours)
Shift Work

- Chronic desynchronization of internal circadian and external time cues
- Symptoms
  - Insomnia / hypersomnia
  - Fatigue
  - Poor performance
  - Medical / psychiatric illness
  - Drug abuse
  - Social impact
Shift Work

- Light and melatonin also work
- Maintenance of routine sleep schedule on days off
- Bright light before shift, melatonin in the morning
Shift Work

• If sleep schedule varies frequently (for instance after 2-3 nights)

• May require sleep aids/stimulants, scheduled naps
Shift Work

- Nap before or during shift
- Light restriction in the morning (wear sunglasses home!)
- Dark environment at home
Mood Disorders that affect sleep timing

• Seasonal affective disorder (SAD) is characterized by depression which recurs in the autumn or winter.
• Each fall or winter, patients with SAD may tire easily, crave carbohydrates, gain weight, experience anxiety and depression.
• Bright light therapy has been shown to be useful in the treatment of SAD.
Neurological Disorders Affecting Sleep Timing

- Alzheimer’s Disease is associated with significant behavioral abnormalities, including nocturnal wanderings and restlessness.
- A decrease in the amplitude and organization of the circadian rhythms or temperature, rest/activity and hormones have been reported.
Neurological Disorders (cont.)

- Hepatic encephalopathy is associated with marked sleep disruption characterized by nocturnal wakefulness and daytime sleep. Circadian rhythms in hormonal variables have been reported to be disrupted in patients with hepatic encephalopathy.

- Tse-Tse fly encephalitis African sleep sickness