Pediatric Sleep/Circadian Disorders: Management Tools and Strategies.

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CNHN Future of Pediatrics
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Outline

- Brief update on basic mechanisms of sleep and circadian science and mechanisms
- Common Sleep Disorders
- The brief assessment
- Intervention Strategies
What is sleep?

“Sleep is a reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment. It is also true that sleep is a complex amalgam of physiological and behavioral processes.”

(Carskadon & Dement)
SLEEP DISORDERS

PSYCHOPHYSIOLOGICAL INSOMNIA
SLEEP STATE Misperception
IDIOPATHIC INSOMNIA
NARCOLEPSY
RECURRENT HYPERSOMNIA
IDIOPATHIC HYPERSOMNIA
POSTTRAUMATIC HYPERSOMNIA
OBSTRUCTIVE SLEEP APNEA SYNDROME
CENTRAL SLEEP APNEA SYNDROME
CENTRAL ALVEOLAR HYPOVENTILATION SYNDROME
PERIODIC LIMP MOVEMENT DISORDER
RESTLESS LEGS SYNDROME
INADEQUATE SLEEP HYGIENE
ENVIRONMENTAL SLEEP DISORDER
ALTITUDE INSOMNIA
ADJUSTMENT SLEEP DISORDER
INSUFFICIENT SLEEP SYNDROME
LIMIT-SETTING SLEEP DISORDER
SLEEP-ONSET ASSOCIATION DISORDER
FOOD ALLERGY INSOMNIA
NOCTURNAL EATING (DRINKING) SYNDROME
HYPNOTIC-DEPENDENT SLEEP DISORDER
STIMULANT-DEPENDENT SLEEP DISORDER
ALCOHOL-DEPENDENT SLEEP DISORDER
TOXIN-INDUCED SLEEP DISORDER
TIME ZONE CHANGE (JET LAG) SYNDROME
SHIFT WORK SLEEP DISORDER
IRREGULAR SLEEP-WAKE PATTERN
DELAYED SLEEP PHASE SYNDROME
NON-24 HOUR SLEEP-WAKE DISORDER
CONFUSIONAL AROUSALS
SLEEPWALKING
SLEEP TERRORS
RHYTHMIC MOVEMENT DISORDER
SLEEP STARTS
SLEEP TALKING
NOCTURNAL LEG CRAMPS
NIGHTMARES
SLEEP PARALYSIS
IMPAIRED SLEEP-RELATED PENILE ERECTIONS
REM SLEEP-RELATED SINUS ARREST
REM SLEEP BEHAVIOR DISORDER -
BRUXISM
ENURESIS
SLEEP-RELATED ABNORMAL SWALLOWING
SYNDROME
NOCTURNAL PAROXYSMAL DYSTONIA
SUDDEN UNEXPLAINED NOCTURNAL DEATH
SYNDROME
SUDDEN INFANT DEATH SYNDROME
PRIMARY SNORING
INFANT SLEEP APNEA
States of Being

AWAKE

REM Sleep

NREM Sleep
Neurobiology of Sleep and Wake

- Thalamus
  - Cortical Activation
  - Sleep Spindles
  - EEG Synchronization
- Brainstem
  - Ascending Cortical Activation
  - REM/SWS Switch
- Hypothalamus
  - Sleep/Wake Switch
- Suprachiasmatic Nucleus (SCN)
  - Circadian Clock

SWS = slow-wave sleep
Awake: low voltage – random, fast

Drowsy: 8 to 12 cps – alpha waves

Stage 1: 3 to 7 cps – theta waves

Stage 2: 12 to 14 cps – sleep spindles and K complexes

Delta sleep: (stages 3 and 4) 1/2 to 2 cps – delta waves >75 μV

REM sleep: low voltage – random, fast with sawtooth waves
Process S
Sleep
Homeostatic

Process C
Circadian

SLEEP LOAD
ALERTING SIGNAL

1st sleep
2nd sleep

9 AM 3 PM 9 PM 3 AM 9 AM
day - awake night - asleep

Sleep Academic Award, Gerald Rosen
Figure 3. The circadian clock has an impact on many aspects of our physiology. This clock helps to regulate sleep patterns, feeding behavior, hormone release, blood pressure and body temperature. A large proportion of our genes are regulated by the clock.
Molecular Clocks in Cells

- Clocks and the sleep state regulate energy/metabolism, immune function and other essential biological processes through oscillations of enzyme release across day and night.

Sleep Duration Dependent
Markers of inflammation

Haack M, Sanchez E, Mullington JM. Elevated inflammatory markers in response to prolonged sleep restriction are associated with increased pain experience in healthy volunteers. Sleep. 2007, September1; 30(9): 1145-1152.
Trees Sleep Too!

What Mediates Sleep Propensity and Wakefulness

- Evolution/Biology
- Lifestyle choices
- Light
- Drugs/alcohol
- Vigilance
- Social/workplace
Setting an Example!
Self reported poor vs. normal ‘sleepers’

- Sleep needs are not being met (43% vs. 23%);
- They sleep less than 6 hours on a typical workday or weekday (30% vs. 15%);
- They use a “sleep aid” (43% at least a few nights a week vs. 26%); and/or
- They have been told by a doctor they have/had a sleep disorder (25% vs. 10%).
Distribution of Sleep Periods

As a child develops, its sleep gradually becomes restricted to the night.

- Newborn infant
- 1 year old
- 4 years old
- 10 years old
- Adult

Rosen, Gerald, Sleep Academic Award
## Estimated Norms: Sleep Timing and Duration

<table>
<thead>
<tr>
<th>Age group</th>
<th>Duration and Timing</th>
<th>Population Study Switzerland {Iglowstein, 2003}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants 1-18 months</td>
<td>13-18 hours</td>
<td>13.9-14.2 hours</td>
</tr>
<tr>
<td></td>
<td>1-4 naps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6pm-6am</td>
<td></td>
</tr>
<tr>
<td>Toddlers and Preschool</td>
<td>11-12 hours</td>
<td>11.4-13.5 hours</td>
</tr>
<tr>
<td>1-5 years</td>
<td>1 nap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6:30pm-7:00am</td>
<td></td>
</tr>
<tr>
<td>School Age 6-10 years</td>
<td>10.5-11</td>
<td>9.9-11 hours</td>
</tr>
<tr>
<td></td>
<td>7:30Pm-8:00am</td>
<td></td>
</tr>
<tr>
<td>Early Teens 11-14 years</td>
<td>9.5-10.5 hours</td>
<td>8.1-9.6 hours</td>
</tr>
<tr>
<td></td>
<td>9:00pm-8:00am</td>
<td></td>
</tr>
<tr>
<td>Late Teens 15-19</td>
<td>8.5-9.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:00pm-8:00am</td>
<td></td>
</tr>
</tbody>
</table>
Sleep Logs
Actigraphy

<table>
<thead>
<tr>
<th>Day</th>
<th>TIB</th>
<th>TST</th>
<th>SOL (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri</td>
<td>22:12-11:01</td>
<td>724</td>
<td>45</td>
</tr>
<tr>
<td>Sat</td>
<td>22:52-10:09</td>
<td>505</td>
<td>210</td>
</tr>
<tr>
<td>Sun</td>
<td>22:12-6:05</td>
<td>387</td>
<td>101</td>
</tr>
<tr>
<td>Mon</td>
<td>22:27-5:58</td>
<td>432</td>
<td>20</td>
</tr>
<tr>
<td>Tue</td>
<td>22:00-6:19</td>
<td>406</td>
<td>90</td>
</tr>
<tr>
<td>Wed</td>
<td>22:03-5:53</td>
<td>457</td>
<td>25</td>
</tr>
<tr>
<td>Thu</td>
<td>22:34-6:01</td>
<td>380</td>
<td>126</td>
</tr>
<tr>
<td>Fri</td>
<td>22:00-6:19</td>
<td>470 (120)</td>
<td>88 (67)</td>
</tr>
</tbody>
</table>

Mean
Best Validated Test of Sleepiness
The Sleep Habits Assessment

<table>
<thead>
<tr>
<th>Bedtime</th>
<th>EDS</th>
<th>Awakenings</th>
<th>Regularity</th>
<th>Snoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Excessive Daytime Somnolence)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine</td>
<td>Hyperactivity</td>
<td>Call outs</td>
<td>Schedule</td>
<td>Volume</td>
</tr>
<tr>
<td>Resistance</td>
<td>Irritability</td>
<td>Partial Arousal</td>
<td>Age</td>
<td>Pauses</td>
</tr>
<tr>
<td>Fears</td>
<td>Difficulty waking</td>
<td>Restlessness</td>
<td>Periodicity</td>
<td>Periodicity</td>
</tr>
</tbody>
</table>

When to order a sleep study Polysomnography (PSG)

- Snoring +
  - Pauses and gasping
  - Attention and affect disregulation
  - Learning and behavior problems
  - Other sleep disorders (bed wetting parasomnia)

- Excessive daytime somnolence.
Top 5 Sleep Assessment Topics

• Difficulty falling asleep
• Difficulty staying asleep
• Daytime somnolence
• Defficient Sleep duration and timing
• Unplanned naps
• Snoring
## Pediatric Sleep Disorders

<table>
<thead>
<tr>
<th>Category</th>
<th>Disorder</th>
<th>Prevalence</th>
<th>Age range (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insomnia</strong></td>
<td>Psychophysiologic insomnia (307.42)</td>
<td>~20-50%</td>
<td>~6-18</td>
</tr>
<tr>
<td></td>
<td>Behavior Insomnia of Childhood (V69.5)</td>
<td>10-30%</td>
<td>0.5-~8</td>
</tr>
<tr>
<td></td>
<td>- Sleep-Onset Association type</td>
<td></td>
<td>0.5-~3</td>
</tr>
<tr>
<td></td>
<td>- Limmit Setting type</td>
<td></td>
<td>~1-~8</td>
</tr>
<tr>
<td><strong>Sleep Related Breathing</strong></td>
<td>Primary Sleep Apnea of Infancy (770.81)</td>
<td>0.5%(healthy)</td>
<td>0-0.2</td>
</tr>
<tr>
<td></td>
<td>Obstructive Sleep Apnea, Pediatric (327.23)</td>
<td>~3-5%</td>
<td>0.2-18</td>
</tr>
<tr>
<td></td>
<td>Congenital Central Alveolar Hypoventilation (327.25)</td>
<td>&lt;.01%</td>
<td>Birth</td>
</tr>
<tr>
<td><strong>Hypersomnia</strong></td>
<td>Narcolepsy (347)</td>
<td>&gt;.02%</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Kleine Levin Syndrome (327.13)</td>
<td>&gt;.01%</td>
<td>~14</td>
</tr>
<tr>
<td></td>
<td>Behav Induced Insufficient Sleep Syndrome (307.44)</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Category</td>
<td>Disorder</td>
<td>Prevalence</td>
<td>Age range (yrs)</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Circadian Rhythm Sleep Disorder</strong></td>
<td>Delayed Sleep Phase Syndrome</td>
<td>&gt;16%</td>
<td>&gt;12 .5-6</td>
</tr>
<tr>
<td></td>
<td>Advanced Sleep Phase Syndrome</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td><strong>Parasomnias</strong></td>
<td>Confusional Arousals (327.41)</td>
<td>17.5%</td>
<td>&lt;3-13</td>
</tr>
<tr>
<td></td>
<td>Sleep Walking (307.46)</td>
<td>17%</td>
<td>&lt;3-18</td>
</tr>
<tr>
<td></td>
<td>Sleep Terrors (307.46)</td>
<td>1-6.5%</td>
<td>&lt;3-18</td>
</tr>
<tr>
<td></td>
<td>Sleep Enuresis (788.36)</td>
<td>By age</td>
<td>&gt;4</td>
</tr>
<tr>
<td><strong>Sleep Related Movement Disorder</strong></td>
<td>Restless Legs Syndrome (333.99)</td>
<td>&lt;16%</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Periodic Limb Movement Disorder (327.51)</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Sleep Related Rhythm Movement Disorder (327.59)</td>
<td>3-6%</td>
<td>&gt;.5</td>
</tr>
</tbody>
</table>
Pediatric Sleep Disordered Breathing

- Spectrum of disorders ranging from snoring to severe central and obstructive sleep apnea syndrome
- Definition: Partial and complete obstruction/cessation of airflow
- Prevalence of Obstructive Sleep Apnea (OSA)
  - 1.1-2.9% of 4-5 year-olds (Ali, 1993)
  - 4.7% of 8-11 year olds (Spillsbury, 2003)
    - 5.1 OR for residents of low SES neighborhoods
    - 3.9 OR for African American Children (1.9 after SES adjustment)
  - 13-33% of overweight children (Beebe, 2006)
  - 18% of children with behavior & academic problems (Gozal 2001)
- Prevalence of Primary Snoring
  - up to 12% children
- Upper airway resistance syndrome?
African American Children
Median onset of symptoms for 24 months (IQR 12-43 months), which was the double of that in Caucasian/White. Moreover, severe hypoxemia due to OSA (SaO2 nadir <75%) was significantly more common in AA/black (n=39, 64%)
Pediatric OSAS: Signs and Causes

• Signs:
  snoring, snorting, gasping, airflow cessation

Causes:
  obstructed or narrow upper airway
OSA Treatment

• Adenotonsillectomy improves snoring and can be effective in up to 79%
• 42% remission after 7 months when OSA is mild.
• For persistent OSA CPAP is treatment of choice.

- Chervin RD, et al.
Insomnia: Essential Features

“Frequent and persistent difficulty initiating or maintaining sleep that results in general sleep dissatisfaction...despite adequate sleep opportunity”

Behavioral Insomnia of Childhood 6 months -6 Years

- Identify and eliminate reinforcers or cues that delay an independent wake-sleep transition
- Positive Routines
- Sleep hygiene training
- Establish appropriate bed times
- Establish appropriate bedtime routines
Cognitive Behavior Therapy for 
*Insomnia* 
*(CBTI)*

- **Sleep Hygiene**
  - Sleep related habits
  - Prioritization of sleep
- **Sleep Education**
  - Sleep schedule, duration and continuity
- **Stimulus Control**
  - Dissociate stimulus (e.g., bed) associated with frustration/activation
- **Cognition**
  - Address sleep-related misconceptions, predictions
  - Tools to decrease cognitive arousal
- **Sleep Restriction**
  - Limit TST to weekly average
  - Setting a fixed sleep window
- **Relaxation Therapy**
  - Tools to decrease physiological and cognitive activation
Circadian Rhythm Disorder
Delayed Sleep Phase Syndrome

• **Definition:**
  A shift of the sleep phase to a later period that conflicts with academic and work schedules & social norms

• **Prevalence:**
  affects 7% of adolescents
# TWO-WEEK SLEEP RECORD

**PATIENT'S NAME**

**PARENT'S NAME**

**PATIENT'S DATE OF BIRTH**

**ADDRESS**

**DATE OF SLEEP RECORD: FROM**

**TO**

**TELEPHONE NUMBER**

## INSTRUCTIONS:

- Leave blank the periods your child is awake.
- Mark your child's bedtime with downward-pointing arrows.
- Fill in the times your child is asleep with shaded boxes.
- Mark the time your child gets up in the morning and after naps with arrows pointing upwards.

## SPECIAL OBSERVATIONS AND NOTES:

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![Sleep Tracking Table]

---

**2:00**  |  **4:00**  |  **6:00**  |  **8:00**  |  **10:00**  |  **Noon**  |  **2:00**  |  **4:00**  |  **6:00**  |  **8:00**  |  **10:00**  
---

Mon  |  Wed  |  Fri  |  Sun  |  Mon  |  Wed  |  Fri  |  Sun  |  Mon  |  Wed  |  Fri  |  Sun  
---

Sleep Through 12 Period  |  Missed Bus  |  Slept 7 Hrs  |  Slept 9 Hrs  |  Slept 6 Hrs  |  Slept 8 Hrs  |  Slept 5 Hrs  |  Slept 7 Hrs  |  Slept 4 Hrs  |  Slept 6 Hrs  |  Slept 8 Hrs  
---
Circadian Rhythm Disorder Treatment

• Advance sleep phase by focusing on wake times that differ no more than 1.5 hours (social jet lag)
• Eliminate naps longer than 15 minutes
• Eliminate Caffeine after noon
• Dim lights – PM / Bright light AM
• No Electronics within 30 minutes of target bedtime.
Non-REM Parasomnias

- Disorders of Arousal – Sudden arousals from deep sleep (confusional arousals, night terrors, sleep walking)
- Prevalence decreases w/ age
- Treatment – Safety-Safety-Safety-Safety-Safety
  - Parent education
  - Sleep schedule modification to Increase TST
  - Afternoon naps
  - Scheduled awakenings
Restless Legs Syndrome (RLS)

- RLS is a clinical diagnosis involving uncomfortable sensations in the limbs that are relieved by movement.
  - In a referred sleep disorder sample of 538, 28% were diagnosed with RLS. Inattention was present in 25% and low serum ferretin below 50 was present 83%. Kotagal S., et al. Annals of Neurology. 56(6):803-7, 2004 Dec

- RLS and PLMD Co-occur about 80% of the time

- When Ferritin is <50ng/ml supplement with ferrous gluconate of ferrous sulfate (3-6mg/kg of elemental iron)
Top Sleep Tips

• Regular sleep timing and duration
• No electronic media in the bedroom and within an hour of bedtime
• Regular bedtime routines
• Quiet and together time before bedtime
• Comfortable sleep environment
• Cut out Caffeine
• NEVER DRIVE SLEEP DEPRIVED!
Percentage of Physicians Prescribing Specific Medications for Sleep Problems

Owens, Rosen, Mindell 2002

- Antihistamine
- Alpha Agonist
- Benzodiazepines
- Chloral Hydrate
- Antidepressant
THANK YOU

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Sleep Resources

• National Institutes of Health - StarSleep.nhlbi.nih.gov
• National Sleep Foundation - Sleepfoundation.org
• American Academy of Sleep Medicine - AASM.org
• A Clinical Guide to Pediatric Sleep: Diagnosis and Management of Sleep Problems (Jodi Mindell & Judith Owens)
• Sleeping Through the Night – Jodi Mindell
• Solve Your Child’s Sleep Problems - Richard Ferber
Pediatric Sleep Resources & Suggested Bibliography

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Selected References


• Research Support, Non-U.S. Gov't]. *Sleep, 34*(12), 1671-1680. doi: 10.5665/sleep.1432