Is Anyone Getting Any Sleep?

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Objectives
- Explain the causes and impact of insomnia in adolescents
- Explain the causes and management of obstructive sleep apnea in children
- Describe that “growing pains” may represent restless leg syndrome in children

Importance of sleep
- Rests the body
- Restores the brain
- Consolidates memory
- Time to dream
- Time for growth

Age-Related Changes in Sleep

2004 NSF Sleep in America Poll
- Overall, children get less sleep than recommended for age group.
- 69% of children experience ≥1 sleep problems at least a few nights a week.
- Nearly 1/3 of children <10 years wake up at least once a night needing attention.

2006 NSF Sleep in America Poll
- Only 20% of teens get the recommended 9.2 hrs of sleep/night.
- The typical high school senior sleeps 6.9 hours per night
- >50% of teens reported feeling sleepy during the day.
- Impact:
  - Tardy/absent from school
  - Sleep in school
  - Poor grades
  - Too tired to exercise
  - Drive while drowsy
Teenagers and Drowsy Driving

Risk factors
- Fatigue
- 75% of teens see peers driving fatigued vs. 50% recognized as making a difference in driving safely.
- One night of sleep deprivation = BMG of 0.11
- 4 hrs of sleep + 1 beer = same level of impairment as 8 hrs of sleep + 5 beers
- Inexperienced driver
- Talking on cell phones
- Strong emotions
- Multiple passengers
- Napping

Peak time of accidents is 7 and 8 a.m.
Fatality rate for drivers 16-19 years is 4x that of drivers 25-28 years.

The Sleepy Teenager

My 15-year old daughter prefers to stay up until midnight, but then has a difficult time getting up in the morning to catch the 6:30 AM bus for school.

What additional questions?
- Bedtime routine?
- Electronics?
- Caffeine use?
- Sleep environment?
- Naps?
- Weekends and vacations?

Adolescent Sleep Behavior
- Teens obtain less sleep than younger children despite on-going need for 9-10 hrs
- Sleep loss due to later bedtime
- 45% of teens went to bed after midnight
- Male and female high school students have similar patterns
- Sleep patterns consistent across broad range of socioeconomic backgrounds

Reasons to Stay up Late – “Social”
- Homework
- Job
- Babysitting
- Athletic events
- Clubs
- Art classes
- Piano
- Dance
- Theater
- Watch TV
- Talk on phone
- Text messages
- Use computer
- Read
Sleep and Jobs
- Teens who work ≥20 hrs/wk report more problems getting adequate sleep and being alert in school
  - Carskadon, Alcohol, Drugs and Driving 1990;5-6:317
- For every 10 hrs/wk of work, a student lost 14 min of sleep/night
  - Wolfson, Adoles Sleep Patterns, Cambridge University Press 2002

Too Wired to Sleep
- Summary of activities after 9 p.m.
  - 42% Watching television
  - 55% Being online
  - 42% Listening to MP3 player
  - 36% Watching DVD/videos
  - 34% Text messaging
  - 37% Completing homework
- Engaged in 4 tech activities/night
- Teens getting 8-10 hours of sleep tended to multitask less often
  - Calamari, Pediatrics, 2009; 123:e1005-1010

Sleep and Parental Input
- 50% of 10-11 year-olds report a parent is the reason for the time they went to bed
- <5% of 14-18 year-olds report a parent is the reason for the time they went to bed
  - Carskadon, Adoles Sleep Patterns, Cambridge University Press, 2002

Also Biological Factors….
- More mature self-reported pubertal ratings in 6th grade girls was associated with a delay in circadian sleep timing (greater “eveningness” scores)
  - Carskadon, Sleep 1993;16:258
- Advancing Tanner stages of puberty associated with delay in melatonin secretion by ~1 hour
  - Carskadon, J Bio Rhythms 1997;12:278
- Pubertal changes in sleep may antedate bodily changes associated with puberty.
  - Sadeh, Sleep 2009; 32:1602

Daytime Sleepiness Impairs Cognitive Functioning
- Difficult to sustain attention
- Difficult to stay on task
- Interferes with memory
- Decreases creativity
- Decreases ability to multitask
- Decreases ability to make effective choices
- Increases impulsivity
- Increases irritability
  - VanDongen, Sleep 2003;26:117
  - Randazzo, Sleep 1998;21:861
  - Fallone, Percept Mot Skills 2001:93:213

Effect of Daytime Sleepiness
- The emotional lability and social stresses that all teens experience are further aggravated as a result of sleep deprivation
  - O’Brien, Behav Sleep Med 2005;3:113
  - Feelings of depression
  - Feelings of anxiety
  - High-risk behaviors
  - Substance abuse greater among teens with sleep difficulties
  - Manni, J Sleep Res 1997;6:44
  - Patten, Pediatrics 2000;106
Benefit of Delayed School Start Time on Adolescent Behavior

Evidence suggests that students have a better opportunity to be rested and ready to learn by delaying school start times to 8:30 a.m. or later.

School Start Time Study in Minneapolis-St Paul Minnesota

- N = >18,000 students
- School year 1996-1997
- Outcomes collected 2 years prior until 3 years after high schools changed school start time
- School start time changed from 7:15 a.m. to 8:40 a.m.
- Documented impact on:
  - Students' educational experience
  - Changes to community

Wahlstrom, NASSP Bulletin 2002;86:633
Wahlstrom, Adoles Sleep Patterns, Cambridge University Press, 2002
http://www.ci.minneapolis.mn.us/

School Start Time Study in Minneapolis-St Paul Minnesota

- Multiple benefits to the student
  - Increased total sleep time
  - Increased daily attendance
  - Decreased daily tardiness
  - Increased rates of continuous attendance at one school
  - Increased rates of graduation
  - Overall improvement in academic performance not statistically significant

Pollack, Pediatrics 2003;111:42-46

Caffeine Consumption Associated with Disrupted Sleep

- N = 191 middle school students
- Average: 52.7 mg caffeine/day
- 19% consumed >100 mg/day
- Boys consumed more caffeine
- Disrupted sleep associated with increased caffeine consumption
  - Later bedtime
  - Increased arousals/awakenings
  - More daytime sleepiness

Polack, Pediatrics 2003;111:42-46

Physicians reporting at least 1 nonprescription medication recommendation for teens’ sleep in the past 6 months

<table>
<thead>
<tr>
<th>Product</th>
<th>Serving size</th>
<th>Caffeine content (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca-cola</td>
<td>12 oz</td>
<td>35</td>
</tr>
<tr>
<td>Pepsi</td>
<td>12 oz</td>
<td>38</td>
</tr>
<tr>
<td>Mountain Dew</td>
<td>12 oz</td>
<td>54</td>
</tr>
<tr>
<td>Coffee</td>
<td>8 oz</td>
<td>133</td>
</tr>
<tr>
<td>Starbucks coffee, grande</td>
<td>16 oz</td>
<td>138</td>
</tr>
<tr>
<td>Einstein Brothers Coffee</td>
<td>16 oz</td>
<td>200</td>
</tr>
<tr>
<td>Dunkin Donuts coffee</td>
<td>16 oz</td>
<td>206</td>
</tr>
<tr>
<td>Tea, brewed</td>
<td>8 oz</td>
<td>33</td>
</tr>
<tr>
<td>Iced tea, Snapple</td>
<td>16 oz</td>
<td>42</td>
</tr>
<tr>
<td>Chocoloate milk</td>
<td>8 oz</td>
<td>13</td>
</tr>
<tr>
<td>Hot chocolate</td>
<td>1/2 cup</td>
<td>30</td>
</tr>
<tr>
<td>Hershey’s Kisses</td>
<td>9 pieces</td>
<td>9</td>
</tr>
<tr>
<td>Dextroine</td>
<td>1 tablet</td>
<td>200</td>
</tr>
<tr>
<td>Red Bull</td>
<td>8.3 oz</td>
<td>50</td>
</tr>
<tr>
<td>Monster Energy</td>
<td>16 oz</td>
<td>368</td>
</tr>
<tr>
<td>Spike Shooter</td>
<td>8.4 oz</td>
<td>368</td>
</tr>
</tbody>
</table>

Antihistamine 34.1%
Pain reliever 20.4%
Melatonin 18.9%
Herbal preparations 15.6%

Owens, Pediatrics 2003; 111:e628-e635
Physicians reporting at least 1 prescription medication recommendation for teens’ sleep in the past 6 months

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha agonist (e.g., clonidine)</td>
<td>18.9%</td>
</tr>
<tr>
<td>Antihistamine</td>
<td>15.2%</td>
</tr>
<tr>
<td>Antidepressant</td>
<td>15.1%</td>
</tr>
<tr>
<td>Benzodiazepine (e.g., clonazepam)</td>
<td>8.6%</td>
</tr>
<tr>
<td>Chloral hydrate</td>
<td>2.3%</td>
</tr>
<tr>
<td>Hypnotic (e.g., zolpidem, zaleplon)</td>
<td>7.9%</td>
</tr>
<tr>
<td>Antipsychotic (e.g., risperidone)</td>
<td>4.9%</td>
</tr>
<tr>
<td>Anticonvulsant</td>
<td>0.9%</td>
</tr>
<tr>
<td>Barbiturate (e.g., phenobarbital)</td>
<td>0.45%</td>
</tr>
</tbody>
</table>

Owens, Pediatrics 2003; 111:e628-e635

Newest Prescription Sleep Aids

- NOTE: None are FDA-approved for children <18 years

- Zolpidem (Ambien®)
  - Nonbenzodiazepine hypnotic
  - Interacts with GABA receptors
  - Short half-life

- Escapliclone (Lunesta®)
  - Nonbenzodiazepine hypnotic
  - Interacts with GABA receptors
  - Longer half-life

- Ramelteon (Rozeram®)
  - Melatonin-receptor agonist

Disorders of Circadian Rhythms: Delayed Sleep Phase Syndrome

- Delayed Sleep Phase Syndrome: Epidemiology
  - 5% to 10% of adults presenting to sleep disorders clinics with complaints of chronic insomnia
  - Prevalence in adults: <1%
  - Prevalence in adolescents: 7-16%
  - Onset typically in adolescence

- Most adolescents with delayed sleep phase disorder respond best to combination therapy including chronotherapy, bright light therapy, and melatonin.
  - A. Yes
  - B. No

Delayed Sleep Phase Syndrome: Treatment

- Chronotherapy
  - Phase advance vs. phase delay
- Bright light in morning
- Pharmacologic treatment in evening
  - Melatonin
  - Hypnotics

- Cognitive-behavioral therapy
  - Behavioral contract
  - Rewards and consequences
  - Resetting habits and associations

Wyatt, Sleep 2004; 27:1195-1203
Mundey, Sleep 2005; 28:1271-1278
The Snoring Child: OSA vs. ADHD?

My 6-year old daughter has loud snoring, labored breathing, and obstructed pauses in her breathing during sleep. She has difficulty concentrating and was recently diagnosed with Attention Deficit Disorder.

Epidemiology of Pediatric OSA

- **Incidence:**
  - Habitual snoring
  - OSA: 6-9% of all children
  - Peak age: 1-3% of all children
  - 2-6 years
  - Gender: Boys = Girls
  - Race: African-American

OSA is associated with behavioral and school problems

- 18% of 279 poorly-performing first-graders had OSA. Half underwent adenotonsillectomy. Mean grades improved in these children.
  - Gredel, Pediatrics 1998; 102:616-620
- Among 866 children, inattention and hyperactivity were associated with snoring. Among frequent "snorers," 22% had high ADHD scores.
- Children in the original study who snored regularly were 4x more likely to have developed new hyperactivity. Snoring early in life predicted new or worsened behavior problems four years later.
  - Chervin et al, Sleep 2005; 28:889-890
- An unusually high prevalence of snoring was identified in children with mild ADHD. OSA was not more likely to occur in children with significant ADHD.
  - O’Byrne, Pediatrics 2003;111(3):504-03

Who’s at Risk to Develop OSA?

- Adenotonsillar hypertrophy
- Craniofacial anomalies
- Allergic rhinitis
- Obesity
- Neuromuscular weakness

Tonsils and adenoid are larger in children with SDB

N = 18 children with OSA and 18 control children
All children underwent MRI studies

Ann Am J Respir Crit Care Med 2001;164:638
Upper Airway Structure in Obese Children

N = 22 obese children with OSA had enlarged lymphoid tissue, but also had larger pharyngeal fat pads compared to non-obese children, but no difference in head or neck subcutaneous fat.

Arens, Am J Respir Crit Care Med, 2011; 183:782

Dynamic changes in cross-sectional area at midtonsillar level (level 2)

- Controls have little change in AP or lateral dimension throughout respiratory cycle.
- Children with OSA have significant narrowing in lateral dimension, especially during inspiration.
- Suggests OSA airway is more collapsible.

Arens, Am J Respir Crit Care Med, 2005; 171: 1298

Management of OSA in children

- Adenotonsillectomy
- CPAP
- Other
  - Weight reduction
  - Management of allergic rhinitis
  - Management of upper airway inflammation

Inflammation as a factor in sleep-disordered breathing

Increased leukotriene-receptor activity in children with sleep apnea (adenoids>tonsils)

Increased leukotriene levels in children with sleep apnea


Montelukast improves mild SDB

- N = 24 children with AHI >1 but <5.
- Age = 5.4 years (range = 2 to 10 years)
- Treatment = Montelukast for 16 weeks
- Results
  - Adenoid/nasopharyngeal ratio decreased
  - Respiratory arousal index decreased (7/hr to 3/hr)


Practice Parameters: Respiratory Indications for PSG - Standards

- PSG is indicated when clinical assessment suggests OSA
- Children with mild OSA pre-operatively should have clinical assessment after T&A. PSG should be performed if there are residual symptoms
- PSG is indicated post-operatively if child had moderate to severe OSA, or other risk factors (e.g., obesity, craniofacial anomalies, neuromuscular weakness)
- PSG is indicated for PAP titration

Executive Summary: Sleep 2011; 34:389
Practice Parameters: Sleep 2011; 34:379
Clinical Practice Guidelines—
Recommendations

- All children should be screened for snoring.
  - Affirmative answer requires more focused evaluation.
  - AAP, Pediatrics 2012;130:576-584

Clinical Practice Guidelines (2)

- Polysomnography should be performed in children with snoring and OSA symptoms.
  - History and physical exam are poor at discriminating between primary snoring and OSA
  - Polysomnography is the “gold standard”
  - Other diagnostic studies (audio/videstaping, overnight oximetry studies, daytime nap studies) have limitations

Clinical Practice Guidelines (3)

- Adenotonsillectomy is first line of treatment for most children.
  - CPAP is an option for those who are not candidates for surgery or do not respond to surgery
  - Treatment for select cases includes weight loss, management of allergies, craniofacial surgery, tracheotomy

- High-risk patients should be monitored inpatient post-operatively.
  - Associated complex medical condition
  - Children <3 years old
  - Children with “severe” OSA by polysomnography
  - Patients should be reevaluated postoperatively to determine whether additional treatment is required.

“Growing Pains”

- My 8-year-old daughter has difficulty falling asleep at night. She is tired and is in bed by 8:30 PM but is unable to fall asleep. She reports that “worms are crawling in her legs” and rubbing her legs relieves the sensation.

Restless Leg Syndrome

- Sensorimotor disorder characterized by
  - Uncomfortable sensations in the lower extremities
  - Almost irresistible urge to move the legs
  - Worsens during inactivity
  - Improves with walking
  - Typically occurs during evening hours

Restless Leg Syndrome: Epidemiology

- Adult population:
  - Incidence of 5% to 15%

- Pediatric population:
  - Incidence unknown
  - 17% of more than 800 children reported “restless legs at night.”
  - Chervin Sleep 2002; 25:213-8
  - Higher rate of RLS in children with ADHD
**Restless Leg Syndrome: Etiology**

- **Primary RLS**
  - Idiopathic
  - Genetic link
  - BTBD9

- **Secondary RLS**
  - Iron deficiency anemia
  - Neurologic disorders
  - Polyneuropathies
  - Medical disorders
    - Diabetes mellitus
    - End-stage renal disease
    - Peripheral vascular disease
    - Rheumatoid arthritis
    - Arteriopathy
    - Williams syndrome
  - Medications
    - Caffeine
    - Tetracyclic antidepressants
    - Sedative withdrawal

**Restless Leg Syndrome: Treatment**

- **Nonpharmacologic**
  - Sleep hygiene
  - Moderate exercise
  - Massage/stretching
  - Biofeedback/relaxation
  - Hot or cold packs
  - Substances to avoid
    - Caffeine
    - Alcohol

- **Pharmacologic**
  - Iron supplementation*
  - Anticonvulsants
    - Gabapentin*
    - Oxcarbazepine
  - Dopamine precursors
    - Levodopa
  - Dopamine agonists
    - Mirapex®
    - Requip®

- *Most common treatments in children

**RLS and Ferritin Levels**

- **N = 97 children**
- **61% of children were 5-11 years**
- **Ferritin levels**
  - Median baseline level = 22.7 ng/ml
  - 70% of children had level <30 ng/ml
  - 65% of children received iron as monotherapy or combination

**Positive Outcomes**

- **80% of children who received iron and had follow up had improvement/resolution of symptoms**
- **Median time to improvement/resolution of symptoms was 3.8 months**

**Recognition of Sleep Disorders Key**

- >50% of parents reported that child’s doctor did not ask about the child’s sleep.
- The older the child, the less likely the discussion.

**SUMMARY**

- Children’s sleep patterns have unique characteristics related to age and maturity, as well as social factors.
- Sleep disorders are quite common among children.
- Evaluation and management must take into account children’s special sleep needs.
Good Night, Sleep Tight!

When to refer to a pediatric sleep center
- Family-centered care
- Understand the age-specific sleep patterns
- Understand the age-specific respiratory patterns
- Be comfortable prescribing the appropriate medications and therapies

Alertness versus Sleep Drive

Courtesy of Dr. Richard Ferber