The Impact of Undiagnosed Sleep Disturbance in Children

Pediatric Sleep: A Growing Need

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Outline of Lectures

- Overview of sleep disorders in children
- Role of PSG in diagnosis, follow up
- Sleep disorders /Obesity/ ADHD Comorbidity
- Cost of lack of study / diagnosis
- Forcing the “Tipping Point”
Current conclusions

• Sleep is a necessary process to ensure normal physiologic, mental and emotional functions during waking hours.

• In the development of central nervous system, sleep provides a foundation for the development of normal alertness, attention, and productive wakefulness.

• Perturbations in development of sleep mechanisms in early childhood pose higher risk for problems with attention, alertness, and emotional well being later in life.

Golbin 2004

Current conclusions (cont.)

• Sleep is a necessary healing and recovery state.

• If sleep is abnormal, the consequences can be psychological or physical illness, or even death.

• Treatment of sleep disorders improves physical well being and can be instrumental in the treatment of medical and psychiatric disease.

Golbin 2004
Factors Impacting Children’s Sleep

- Developmental
- Circadian
- Sleep deprivation/fragmentation
- Neurologic
- Cardiopulmonary
- Gastrointestinal
- Endocrine
- Upper respiratory
- Allergy
- Drugs
- Psychiatric/psychological
- Infection
- Pain
- Dermatologic
- Environment

Sleep Disorders in Children

- Sleep-Onset Association Disorder
- Limit-Setting Sleep Disorder
- Sleep Related Breathing Disorders
- Parasomnias
- Restless Legs and Periodic Limb Movements
- Sleep Related Seizure Disorder
- Insomnia
- Circadian Rhythm Disorders
- Narcolepsy
- Sleep disorders related to other medical conditions
- Environmental issues
Results of National Sleep Foundation 2004 *Sleep in America* Poll

- Random sample 1473 telephone surveys
- Adults with child 10 yrs or younger
- Infants (n = 210)
- Toddlers (n=239)
- Preschoolers (n=387)
- School-aged (n=637)

Daytime Sleepiness

- One-quarter of infants, toddlers & preschoolers appear sleepy or overtired during the day
- 3 out of 10 school-aged children have difficulty waking in the morning
2006 NSF Sleep in America Poll

- Random sample: 1602 telephone surveys of adult caregivers of 11-17 year old adolescents
  - 6th grade (n = 228)
  - 7th grade (n = 238)
  - 8th grade (n = 244)
  - 9th grade (n = 233)
  - 10th grade (n = 239)
  - 11th grade (n = 221)
  - 12th grade (n = 199)

Sleepiness in Adolescents

- Only 1 out of 5 adolescents between 11 and 17 years old get an optimal amount of sleep (9 hours or more).
- While only 2 out of 10 adolescents in the 6th through 8th grade get insufficient sleep (less than 8 hours), 6 out of 10 adolescents in the 9th through 12th grade get insufficient sleep.
More Information

For more details on this and other studies, please visit the NSF website:

www.sleepfoundation.org

Online Resources (2008)

• New Abstracts and Papers in Sleep (NAPS) –
  www.websciences.org/bibliosleep/naps
• Peds-Sleep – email sadeh@ccsg.tau.ac.il
Sleep Disorders in Infants

- SIDS
- Failure to Thrive (rare)
- Sleep-Related Breathing Disorders

Note: Growth spurt post Tx for OSAS Children

SIDS epidemiology

- Incidence of SIDS is approximately 1:1000 live births
- SIDS yearly incidence fluctuates, but seems to be decreasing
- Peak incidence between 2-4 months
- More than 90% prior to 6 months
- Less than 1% before two weeks
Pediatric Sleep Disorders

- 25% of children between 1 and 5 years experience some type of sleep disturbance
- Childhood sleep disturbances tend to persist if left untreated
- Children with sleep-waking disorders during the 1st year of life often experience multiple sleep problems in later years

Evaluation Continuum

PSG

Focused Studies

Questionnaires
Indications for PSG in Children

- Diagnose SRBD (central and obstructive)
- Titration of positive airway pressure
- Evaluate SRBD treatment effectiveness
- Diagnose GERD
- Diagnose PLMD
- Diagnose narcolepsy/ CNS Hypersomnia
- Evaluate unresponsive insomnia
- Evaluate parasomnias and seizures

Infant, Child, Adult PSG

- Technology *similar* to adult studies
- Few technical differences
  - importance of CO2 monitoring, size of electrodes, monitors etc.
- **Critical** differences:
  - “kid friendly” environment a must
  - appropriate staffing (both numbers and good match regarding skill and interest sets)
  - plan for educating parents, other medical / social significant others for the child
  - need to have pediatric crash cart
Routine polysomnogram

C3/A2    Anterior tibialis EMG
O2/A1    Airflow; Nasal, Oral
ROC/A1   Respiratory; Thoracic, Abdominal
LOC/A2   Tidal Volume
Chin EMG O2 Saturation
ECG      CO2

Polysomnography - Special Studies

- Increased number of EEG channels
- Endoesophageal pH
- Endoesophageal pressure
Standards & Indications for Cardiopulmonary Sleep Studies in Children

- Emphasizes the role of end tidal CO₂
- Minimizes the role of $P_{ES}$
- Minimizes the role of Sleep Staging

American Thoracic Society
Standards and Indications for Cardiopulmonary Sleep Studies in Children.

Normal Polysomnographic Respiratory Values in Children and Adolescents

- N= 70 normals, children & adolescents, age 1-15 yrs
- Overnight PSG (EEG, EMG, EOG, ECG, pulse oximetry, SpO₂, chest wall & ab motion, oral & nasal airflow, PETCO₂.)

**Conclusions / recommended limits for normal values:**

- OA index, 1
- CA index, 0.9
- O₂ desaturation, 89%
- baseline saturation, 92%
- PETCO₂ > 45 mm Hg for < 10% of TST (range of 46-47 mm Hg)

*Chest 2004;125;872-878 Uliel, Tauman, Greenfeld, Sivan.*
Comparison of Results

(Chest 2004;125;872-878 Uliel, Tauman, Greenfeld, Sivan)

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CURRENT STUDY</th>
<th>MARCUS ET AL.†</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA index</td>
<td>0.4</td>
<td>NR*</td>
</tr>
<tr>
<td>Mean</td>
<td>0.33</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>Median†</td>
<td>0.9</td>
<td>NR*</td>
</tr>
<tr>
<td>OA duration, s</td>
<td>11.8 ± 3.0</td>
<td>0.56 ± 0.9 †</td>
</tr>
<tr>
<td>Range</td>
<td>6–20</td>
<td>10–18</td>
</tr>
<tr>
<td>OA index</td>
<td>0.37</td>
<td>≤ 10</td>
</tr>
<tr>
<td>Median†</td>
<td>0.18</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>97.5 percentile</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>6.5 ± 1.2</td>
<td>6.0 ± 1.6</td>
</tr>
<tr>
<td>PETCO₂ levels &gt; 45 mm Hg, % of TST ± SD</td>
<td>6.9 ± 19.1 †</td>
<td>96 ± 2 †</td>
</tr>
<tr>
<td>TST, h</td>
<td>6.0 ± 1.6</td>
<td>6.0 ± 1.6</td>
</tr>
<tr>
<td>Sleep efficiency, %</td>
<td>90.8 ± 6.5</td>
<td>94.6 ± 2.2</td>
</tr>
</tbody>
</table>

* For parameters with nonnormal Gaussian distribution.
† No information is available regarding the distribution pattern of values.

Recommendations for Normal Polysomnographic Respiratory Values

(Chest 2004;125;872-878 Uliel, Tauman, Greenfeld, Sivan)

<table>
<thead>
<tr>
<th>CA</th>
<th>Current Study</th>
<th>Marcus et al**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lasting &gt; 20 s</td>
<td>NR*</td>
</tr>
<tr>
<td>CA index</td>
<td>Any length when associated with SpO₂ &lt; 89% or SpO₂ drop &gt; 4% †</td>
<td>Any length when associated with SpO₂ &lt; 90%</td>
</tr>
<tr>
<td>OA index</td>
<td>≤ 1.0</td>
<td>NR*</td>
</tr>
<tr>
<td>SpO₂ nadir, %</td>
<td>&gt; 92</td>
<td>&gt; 92</td>
</tr>
<tr>
<td>PETCO₂ levels &gt; 45 mm Hg, % of TST</td>
<td>&lt; 10</td>
<td>&lt; 60</td>
</tr>
</tbody>
</table>

* No recommendations (NR) were given. Nevertheless, extrapolation from their data shows very similar results for CA (lasting > 18 s and any apnea associated with SpO₂ < 90%, and CA index < 1.0).
† SpO₂ drop > 14% is recommended by other sources and does not result from the present study (see text).
Pediatric SDB Features

- Unrefreshing sleep
- Behavioral awake problems
- Difficulty gaining weight
- Bed wetting / secondary nocturnal enuresis
- Night sweats
- Snoring / Mouth breathing

What is UARS?

Upper Airway Resistance Syndrome:

A CAUSE OF EXCESSIVE DAYTIME SLEEPINESS

Increased Breathing Effort in Sleep

Pes Event
Pediatric Obesity and OSA

– EDS, proinflammatory cytokine increase, increased leptin, decreased adiponectin
  • points to inflammatory/insulin resistance state
  • Suggests SDB in obese children shares similarities with SDB adults
  • SDB in obese children may also be manifestation of metabolic syndrome
Sleep Volume 32, Abstract Supplement, 2009

- 0185, 0195, 0215, 0217, 0218, 0226, 0228, 0229, 0230, 0237, 0249, 0265, 0297, 0341, 0342
- (Additional 10 abstracts re: kids but not in pediatric section)

- Sleep and Obesity.
  - Daniels SR.
- Obesity and Excessive Daytime Sleepiness in Prepubertal Children with Obstructive Sleep Apnea.
  - Gozal D, Kheirandish-Gozal L.
    - Pediatrics 2009; 123(1):13-8
- Meta-analysis of Short Sleep Duration and Obesity in Children and Adults.
  - Cappuccio FP, Taggart FM, Kandala NB, Currie A, Peile E, Stranges S, Miller MA.
• Does Excessive Daytime Sleepiness Contribute to Explaining the Association between Obesity and ADHD Symptoms.
  – Cortese S, Konofal E, Dalla Bernardina B, Mouren MC, Lecendreux M.
• Mr. Pickwick and his child went on a field trip and returned almost empty handed…What we do not know and imperatively need to learn about obesity and breathing during sleep in children!
  – Spruyt K, Gozal D.
• Obesity and Obstructive Sleep Apnoea Hypopnoea Syndrome in Singapore Children.
  – Tang JP.

• Marked Obesity in Infancy and Relationship to Sudden Infant Death.
  – Byard RW.
• Sleep in Children and Adolescents: A Worrying Scenario: Can We Understand the Sleep Deprivation-Obesity Epidemic.
  – Currie A, Cappuccio FP.
    • Nutr Metab Cardiovasc Dis 2007;17(3):239-2
• Behavior and Obstructive Sleep Apnea in Children: Is Obesity a Factor?
  – Rudnick EF, Mitchell RB.
    • Laryngoscope 2007; 117(8):1463-6.
• Obesity Increases the Risk for Persisting Obstructive Sleep Apnea after Treatment in Children.
  – O’Brien LM, Sitha S, Baur LA, Waters KA.
  • Int J Pediatr Otorhinolaryngol 2006 Jul 1;[epub ahead of print].

• Obstructive Sleep Apnea-Hypopnea syndrome in Children is not Associated with Obesity.
  – Sardon O, Gonzalez Perez-Yarza E, Aldasoro A, Bordoy A, Mintegui J, Emparanza JI.
  • Arch Bronconeumol 2006;42(11):583-587.

• Obesity and Obstructive Sleep Apnea in Children.
  – Tauman R, Gozal D.

• Obstructive Sleep Apnea, Morbid Obesity and Adenotonsillar Surgery: A Review of the Literature.
  – Shine NP, Coates HL, Lannigan FJ.
  • Int J Pediatr Otorhinolaryngol 2005 Sep 16;[epub ahead of print].

• Obesity is an Important Risk Factor for Sleep Disordered Breathing in Children with Down Syndrome.
  – Ng DK, Chan CH.
  • Sleep 2004;27(5):1023-4; author reply 1025.

• Obstructive Sleep Apnoea Syndrome and Obesity in Children.
  – Ng DK, Lam YY, Kwok KL, Chow PY.
  • Hong Kong Med J 2004; 10(1):44-48
• Hypopnea in Pediatric Patients with Obesity Hypertension.
  – Reade EP, Whaley C, Lin JJ, McKenney DW, Lee D, Perkin R.
    • J Pediatr Nephrol 2004 June 4;[epub ahead of print]

• Associations of Obesity, Sleep Disordered Breathing, and Wheezing in Children.
  – Sulit LG, Storfer-Isser A, Rosen CL, Kirchner HL, Redline S.
    • Am J Respir Crit Care Med 2004 Dec 10;[epub ahead of print].

• Effects of Obesity on Morbidity in Children and Adolescents.
  – Must A, Anderson SE.
    • Nutr Clin Care 2003;6(1):4-12.

• Is Obesity Associated with Poor Sleep Quality in Adolescents.
  – Gupta NK, Mueller WH, Chan W, Meininger JC.

• Risk Factors for Sleep-Disordered Breathing in Children. Associations with Obesity, Race, and Respiratory Problems.
  – Redline S, Tishler PV, Schluchter M, Aylor J, Clark K, Graham G.

  – Barlow SE, Dietz WH.
Figure 2. Typical Sleep Pattern of a Young Human Adult

Stage 1 and REM

Stage 2

Delta

Hours 1 2 3 4 5 6 7 8

Stage 1 sleep and REM sleep (black) are graphed on the same level because their EEG patterns are very similar.
Children’s Sleep is the Gold Standard

- Short sleep latency
- 95+% sleep efficiency
- Some (few) spontaneous arousals
- Arise in the morning with smile and song
- No daytime sleepiness except for nap times
Sleep Disorders & ADHD

Owens JA. The ADHD and sleep conundrum: a review.


Attention-Deficit / Hyperactivity Disorder

“...The essential feature of ADD/HD is a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development.”

“...There are no specific physical features...although minor physical anomalies (...high arched palate...) may occur at a higher rate...”

DSM IV
Papers: 2003-2005

- At least 50 studies reported
- Range of N = 6 to 1144
- Positive correlation between sleep disturbance and ADHD in all but two
- Study failing to show correlation (N = 30) with sleep disorders but positive for decreased sleep efficiency
- Study (N=48) where sleep architecture was not significantly different between ADHD controls and normals; no sleep abnormalities in the ADHD children that could be responsible for, or contributing to, the disorder. (Cooper J et al. *Clin Pediatr* 2004;43(7):609-14. No evidence of sleep apnea in children with attention deficit hyperactivity disorder.)

Some Additional Recent Papers


Some Additional Recent Papers(2)


- Taheri S. The link between short sleep duration and obesity: we should recommend more sleep to prevent obesity. *Arch Dis Child.* 2006 Nov;91(11):881-4.


Some Additional Recent Papers(3)

- Beebe DW. Neurobehavioral morbidity associated with disordered breathing during sleep in children: a comprehensive review. *Sleep.* 2006 Sep 1;29(9):1115-34.


Some Additional Recent Papers(4)


Some Additional Recent Papers(5)


• Chervin RD. How many children with ADHD have sleep apnea or periodic leg movements on polysomnography? *Sleep*. 2005 Sep 1;28(9):1041-2.
Sleep-disordered breathing & school performance in children

- Identified 1st graders performing at the bottom 10% percent of grade level
- Found over 20% had OSA
- All were offered surgery (T&A), but only half accepted
- All children who had surgery improved their grades, the others stayed the same


Hidden Cost

- Increased use in health care services

2008 Meeting & Papers (1)


2008 Meeting & Papers (2)

2008 Meeting & Papers (3)


2008 Meeting & Papers (4)

2008 Meeting & Papers (5)


2008 Meeting & Papers (6)

2008 Meeting & Papers (7)


Do you know?

- By 1997 about 5% of 3-17 yr olds were diagnosed with ADD or ADHD
- National estimates are 3-4 million and rising
- In 2000 an estimated 20 million Rx written for stimulants, the majority to tx ADHD
- No long term studies on effects, kids often medicated form kindergarten through HS
Ritalin
(methylphenidate hydrochloride)

- Antidepressant stimulant
- Others in class: cocaine, novocaine
- Street names: R Ball, Vitamin K
- Schedule II drug same as opium, cocaine, morphine
- Dispensing regulated by federal law

What parents read on the Internet

“Stimulant medication is so effective that a parent with a child diagnosed with ADHD should receive an explanation if the clinical judgment is NOT to prescribe the medication.”

Weiner J. Is Ritalin Overprescribed?
Health Priorities 1996; 8 (3): 97-8
Biopsychosocial Model

- Sleepiness is physiological
- Decreased self esteem, depression, decreased performance
- Need for paradigm shift, society needs to push medical awareness of possible influence in both medical and psychiatric settings


Next Step?

- Physical evaluation, vaccinations prior to school
- Why not sleep questions?
  1. *How much, quality?*
  2. *In what environment?*
The Tipping Point

• Mavens
• Connectors
• Context
• Stickiness