Evaluating & Managing Sleep Disorders

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Future of Pediatrics, 2019
Topics

• Basics about sleep
• Effects of insufficient sleep
• Common sleep problems and disorders: signs symptoms and treatment
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
NonREM Stage 3 is dominant during the first half of night

Sleep stage REM is dominant during the second half of night
Process S
Sleep
Homeostatic

Process C
Circadian

Sleep Academic Award, Gerald Rosen
Process S
Sleep drive
Homeostatic

Process C
Circadian

Reduced Sleep drive

1st sleep

2nd sleep

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.
Sleep Time and Timing
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Age</th>
<th>Duration (24hr)</th>
<th>Timing</th>
<th>Nap</th>
</tr>
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<tbody>
<tr>
<td>Infant 1-12 Months</td>
<td>4-6m</td>
<td>16-14</td>
<td>6pm-6am</td>
<td>2-5</td>
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<tr>
<td></td>
<td>7-12m</td>
<td>16-12</td>
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<td>2-3</td>
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<tr>
<td>Toddler 1-2 Years</td>
<td>1-2</td>
<td>14-11</td>
<td>6pm-7am</td>
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<tr>
<td>Pre-School 3-5 Years</td>
<td>3-4</td>
<td>13-11</td>
<td>6:30p-7:30am</td>
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<td></td>
<td>5</td>
<td>11-12</td>
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<td></td>
</tr>
<tr>
<td>School-Age 6-12 Years</td>
<td>6-7</td>
<td>12-11</td>
<td>7:30pm-8:00am</td>
<td>0-1</td>
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<td>8-12</td>
<td>11-10</td>
<td>8:00pm-8:30am</td>
<td></td>
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<tr>
<td></td>
<td>12</td>
<td>10.5-9.5</td>
<td>8:30pm-8:30am</td>
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</tr>
<tr>
<td>Adolescent 13-18 Years</td>
<td>13-14</td>
<td>10-9.5</td>
<td>9:30pm-8:30am</td>
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<td>15-16</td>
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<td>10:00pm-9:00am</td>
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<td>17-18</td>
<td>9.5-8</td>
<td>10:30pm-9:00am</td>
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<td>19-25</td>
<td>8-7</td>
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<td>10:30pm-9:00am</td>
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<td>26-65</td>
<td>8-6.5</td>
<td>10:00pm-7:00am</td>
<td>8-6.5</td>
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<td>65+</td>
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<td>8-6.5</td>
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</table>
Sleep and Circadian Health Effects

- Metabolism regulation and energy expenditure
- Physical restoration
- Tissue repair
- Neuronal recalibration
- Memory consolidation
# The Sleep Habits Assessment

<table>
<thead>
<tr>
<th>Bedtime</th>
<th>EDS (Excessive Daytime Somnolence)</th>
<th>Awakenings</th>
<th>Regularity</th>
<th>Snoring</th>
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<tbody>
<tr>
<td>Routine</td>
<td>Hyperactivity</td>
<td>Call outs</td>
<td>Schedule</td>
<td>Volume</td>
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<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>

I. Evaluating & Managing obstructive sleep apnea (OSA)
   - Clinical assessment of OSA
   - Who, when, where and how to refer or order sleep study
   - Polysomnographic assessment
   - Therapeutic approaches

II. Evaluating & Managing Other Sleep Disorders:
   • Sleep - wake mechanisms
   • Diagnostic tools
   • Pediatric Sleep Disorders Assessment and Treatment
Evaluating & Managing Sleep
Obstructive Sleep Apnea (OSA)

Julia Aziz, MD
jaziz@childrensnational.org
Obstructive Sleep Apnea is a common and treatable condition

- OSA affects 3-5% of children
- Early diagnosis and management may prevent serious sequelae
  - Neurocognitive
  - Growth
  - Cardiovascular
- >60% of children with severe OSA had >12 months of symptoms prior to diagnosis

How serious is OSA in children? : Moderate
Severe OSA with desaturations to 50’s
Severe OSA with Sleep Fragmentation
Many barriers to picking up these kids...

- Limited visit time, impossible to do everything recommended
- Your to-do list vs parents to-do list
- Patient’s with OSA often have many complaints/symptoms
- Vs parents may not even mention snoring
- Where to send the child?
  - ENT? Pulm? Sleep? (Don’t they just do sleep studies?)
- WAITING for the appointment or sleep study!
- Missed appointments/sleep studies
- Child won’t cooperate with the study (rare)
- Worth it if the parents don’t want surgery?
Clinical assessment of sleep breathing disorders
Sleep breathing disorders (SBD) 
Risk Factors

• Genetic (Trisomy 21, Achondroplasia, Prader Willi, others)
• Obesity
• Failure to thrive
• Obstructed/narrow airway (Pierre Robin, tonsils)
• Respiratory reserve ↓ (BPD, asthma, sickle cell)
• Systemic and Pulmonary HTN
• Brainstem (Arnold Chiari II)
• Dystrophy and other Neuromuscular diseases
Sleep breathing disorders (SBD) Daytime Symptoms

• Excessive daytime sleepiness (EDS)
• Napping
• Hyperactivity/ADHD-like
• Moodiness/Irritability
• Poor school performance
• Mouth breathing
• Dry mouth
• Nasal congestion
• Morning headaches
Sleep breathing disorders (SBD)
Nighttime Symptoms

- Snoring
- Gasping/coughing/choking arousals
- Witnessed apnea
- Paradoxic breathing
- Frequent night awakening/restless sleep
- Parasomnias
- Diaphoresis
- Enuresis
- Teeth grinding
- Infants: noisy breathing, stridor, poor feeding, growth
Sleep breathing disorders (SBD)  
Physical Exam

**Nose**
- Swollen nasal mucousa
- Deviated septum
- Nasal atrophy

**Face**
- Maxillary hypoplasia
- Mandibular hypoplasia
- Micrognathia/retrognathia
Sleep breathing disorders (SBD)
Physical Exam

- **Adenoid Facies**
  - Open mouth
  - Thin upper lip, larger lower lip
  - Elongated face
  - Pinched nostrils
  - High arched palate
  - Depressed nasolabial furrow

Sleep breathing disorders (SBD)  
Physical Exam

Mouth

- Tonsillar hypertrophy
- High-arched palate
- Cross-bite/Overbite
- Crowded oropharynx
- Macroglossia
- Glossoptosis
Sleep breathing disorders (SBD)
Physical Exam

Obesity
• BMI
• Neck circumference
• Waist circumference
  • Penn State Child Cohort
  • CHAT study

Take home pearls: What to do in your visit

Any of the risk factors (GO FOR SBD)
    OR
Complaining of any daytime symptoms
    OR
Complaining of any nighttime symptoms
    OR
Any of the exam findings
    =
SCREEN for OSA!
How to screen for OSA

• Minimum: Does your child snore?
  • Caveat: parents don’t always know/aren’t awake

• Ideal: Ask about all the other signs/symptoms

• Reality – In between?

• Positive screen: Snoring +1
What next?

A. Order PSG yourself and follow up results
B. Refer to sleep medicine for CLINIC appointment
C. Refer directly to ENT

• If primary concern is Insomnia/night waking, parasomnias, excessive sleepiness without snoring etc refer to sleep medicine (no sleep study)

**We review all sleep study orders and may request patient come to clinic first if this is most appropriate**
How to refer to clinic:

- Same as any clinic referral
- Should be to SLEEP MEDICINE (not just pulmonary)
- Can specify behavioral sleep medicine or medical sleep clinic
How to order a sleep study:

Form on our website:
https://childrensnational.org/departments/sleep-medicine
Things to know when ordering a sleep study

- PLEASE HIGHLIGHT ANY KNOWN SYNDROMES OR BEHAVIOR CONCERNS
  - Autism, Down syndrome etc
  - Mark here and/or include prominently in note.
- Important so they are scheduled for 1:1 tech
- Also 1:1 for children 3.5 years and under
Things to know when ordering a sleep study

• Almost always order PSG
  • If considering something else (MSLT, titration) should probably see us first
  • Seizure montage is extra leads but not a full EEG

• Follow up: Not automatic
Things to know when ordering a sleep study

• Include last history and physical exam note
  • Cardiopulmonary issues
  • Behavioral issues
  • Bedwetting
  • Tonsils size/airway
  • T&A date
• Previous sleep study or EEG
What do I do with the results?

• You order PSG → You inform patient and act on results
  • Can always refer back to us (normal to severe)
  • If severe/urgent we will likely contact you, may arrange for patient to see us.

• We order PSG → We will follow up, refer to ENT, order CPAP etc.

• Checking follow up at CNMC Sleep Clinic does not get them a follow up. They still need a referral and parents to call for an appointment.
Polysomnographic assessment of sleep breathing disorders
Polysomnogram (PSG) leads

- EOG
- Frontal/Central/Occipital EEG leads
- Nasal End Tidal CO2 or (transcutaneous CO2)
- Nasal/Oral Thermistor/Nasal Pressure Transducer
- Microphone
- Chin EMG
- Oximetry
- Respiratory Inductance Plethysmography (Chest and Abdomen)
- EKG
- Leg EMG
PSG is essentially a Respiratory Test

• Simultaneous multi-channel assessment of respiratory function...
  – Upper airway flow
  – Breathing effort (Chest/abd)
  – Gas-exchange (O2/CO2)
• ...In the context of sleep stages
  – Wake
  – Non-REM (NREM)
  – REM
• Also EKG, limb movements, video, microphone
Polysomnography: Key Results

**Sleep Architecture and EEG**
- sleep latency/total sleep time, stages, seizure activity
- One night snapshot (First night effect: REM often delayed)

**Limb Movements**
- PLMI ≥ 5/hr + CLINICAL SYMPTOMS = PLMD

**Obstructive apnea/hypopnea index (OAHI) - Pediatric**
- 1.5/hr- 5/hr Mild OSA
- 5/hr-10/hr Mod OSA
- >10/hr Severe OSA
- Adult cut offs are different

**Respiratory status:**
- Pulse-oxymetry (% above 90%, nadir)
- Nocturnal hypoventilation ( CO2 >50mmHg >25%)
120 Sec Epoch Respiratory Events
PSG is not for:

- Insomnia
- Restless legs
- Normal parasomnias
- Nightmares
- Bedtime resistance
- Narcolepsy or idiopathic hypersomnia
- Telling if the patient has enough deep sleep or REM sleep

**All of these patients should come to sleep clinic instead!**
OSA therapeutic approaches
Snoring Child with OSA is AT necessary?

1 The Childhood Adenotonsillectomy Trial (CHAT)

• No difference in the attention and executive-function on Neuropsychological Assessment.

2 No significant change in fasting glucose, insulin, lipids, CRP, BP or HR

• Greater improvements in the early-AT group than in the watchful-waiting group based on:
  • Behavioral and quality-of-life scores
  • Polysomnographic findings
  • Symptoms

1. Marcus et al. NEJM 2013
2. Quante et al. SLEEP. 2015
Snoring Child with OSA is AT necessary?

1 Complications (7%)
   - 1.4% respiratory complications including pulmonary edema, hypoxemia and bronchospasm.
   - 5.9% had non-respiratory complications, including dehydration (4.5%), hemorrhage (2.3%) and fever (0.5%).

2 Spontaneous resolution (42%)
   - Lower AHI, better oxygen saturation, smaller waist circumference, higher-positioned soft palate, smaller neck circumference, and non-black race

3 After AT weight gain may trigger obesity in overweight children

2. Chervin et al. CHEST. 2015
Is PSG necessary prior to AT?

- Increased risk of AT postoperative respiratory compromise:
  - SaO2 nadir 80%, CO2 peak ≥60mmHg
  - OAHI ≥24/hour

- Children at highest risk of persistent OSAS after AT:
  - Obese
  - High preoperative AHI (especially those with an AHI ≥20/hour)
  - Children >7 years of age

Marcus et al. Pediatrics September 2012, VOLUME 130 / ISSUE 3
Clinical Practice Guideline: Tonsillectomy in Children (Update)

Ron B. Mitchell, MD¹, Sanford M. Archer, MD², Stacey L. Ishman, MD, MPH³, Richard M. Rosenfeld, MD, MPH, MBA⁴, Sarah Coles, MD⁵, Sandra A. Finestone, PsyD⁶, Norman R. Friedman, MD⁷, Terri Giordano, DNP⁸, Douglas M. Hildrew, MD⁹, Tae W. Kim, MD, MEHP¹⁰, Robin M. Lloyd, MD¹¹, Sanjay R. Parikh, MD¹², Stanford T. Shulman, MD¹³, David L. Walner, MD¹⁴, Sandra A. Walsh⁶, and Lorraine C. Nnacheta, MPH¹⁵
2019 Tonsillectomy Guidelines

• Ask about comorbid conditions that may improve after AT
  • Growth retardation, poor school performance, enuresis, asthma, behavioral problems

• Refer for PSG first if children are < 2 years old or have obesity, trisomy 21, craniofacial abnormalities, neuromuscular disorders, sickle cell disease or mucopolysaccharidoses

• Advocate for PSG prior to AT for children without above in whom need for AT is uncertain or there is discordance between PE and reported severity of OSA
2019 Tonsillectomy Guidelines

• Recommend tonsillectomy for children with OSA documented on PSG
• Explain that OSA may persist or recur after AT and may require further management
• Arrange for overnight inpatient monitoring for children < 3 years old or with severe OSA (OAHI > 10, nadir < 80% or both)
OSA Therapy Beyond Adenotonsillectomy

• Severe or symptomatic OSA
  • CPAP
  • Tracheostomy

• Non-surgical options
  • Nasal steroids (6 wks)
  • Leukotriene receptor antagonists (12 wks)
  • Rapid Maxillary Expansion and Oral Appliances
    • Effective in selective patients
Pearls for CPAP Therapy

- **Needs an office visit**
  - Do not just order “the machine”
- **Review and explain results**
- **Review treatment options, CPAP**
  - Need family buy-in
- **Assess readiness for CPAP**
  - Start CPAP now vs. titration
  - Mask fitting
  - Desensitization
- **Close follow up:**
  - Correct/adequate use
  - Titrate pressures

Patient is ready for CPAP titration
Snoring Child with OSA Therapy beyond AT

Rapid Maxillary Expansion
Severe OSA in Infants

Laryngomalacia and supraglottoplasty
Severe OSA in Infants

Pierre Robin (Retrognatia-Glossoptosis)
References


Katz ES et al. Growth After Adenotonsillectomy for Obstructive Sleep Apnea: An RCT. Pediatrics 2014;134;282


Restless Legs Syndrome (RLS) Periodic Limb Movement Disorder (PLMD)

• 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 ferritin below 50 was present 83%. Kotagal S., et al. Annals of Neurology. 56(6):803-7, 2004 Dec
RLS/PLMD Treatment

• When Ferritin <50mcg/ml, Iron supplementation (3-6 mg/kg of elemental iron), ferrous sulfate or ferrous gluconate may be efficacious for the treatment or RLS/PLMD.

Behavioral Sleep Problems

- Sleep disorders that respond to interventions that are based on behavioral and psychological principles

- Sleep problems associated with lifestyle or mental health issues that require assessment and treatment
Behavioral Insomnias of Childhood (BIC)

- **Sleep Onset Association Disorder**
  - Sleep onset at bedtime or the middle of the night will not occur w/out cue

- **Limit Setting Sleep Disorder**
  - Delayed bedtime
  - Parents reinforce undesirable behavior at bedtime
  - Inconsistent Limit setting
  - Otherwise normal nocturnal sleep

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## Two-Week Sleep Record

**Date of Sleep Record:** From _____ To _____

**Instructions:**
1. Leave wake periods blank
2. Mark bedtimes with down arrows
3. Fill in Sleep Periods
4. Mark wake-up times with up arrows

| Day of Week | 12a | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12p | 1p | 2p | 3p | 4p | 5p | 6p | 7p | 8p | 9p | 10p | 11p |
|-------------|-----|----|----|----|----|----|----|----|----|----|-----|-----|-----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| Sun         |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Mon         |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Tues        |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Wed         |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Thurs       |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Fri         |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |
| Sat         |     |    |    |    |    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |     |     |     |     |     |     |

### Special Observations and Notes:

__________________________

__________________________
Treatment
Behavioral Insomnias of Childhood

- Identify and eliminate cues that delay an independent wake-sleep transition
- Positive Routines
- Sleep hygiene training
- Establish appropriate bed times
- Establish appropriate bedtime routines
Insomnia: Essential Features

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

Cognitive Behavior Therapy for Insomnia (CBTI)

- **Sleep Hygiene**
  - Sleep related habits
- **Sleep Education**
  - Awakenings are normal
  - Optimal bedtimes and sleep duration
- **Stimulus Control**
  - Decrease wake time in bed
  - Get rid of clocks
- **Cognition**
  - Negative labels and predictions about sleep
- **Sleep Restriction**
  - Sleep time and timing - Set to specific hours.
- **Relaxation Therapy**
  - Tools to decrease physiological and cognitive activation
Sleep Hygiene

- Establish Sleep as a priority (time limited)
- Regular bed & wake times
- Regulate napping
- Eliminate or regulate caffeine habit
- Eliminate stimulating behavior before bedtime
- No electronic media use within a half hour of bedtime
  - Negotiation point
- Quiet time & close time
- Establish an early evening worry time
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
# Morning Vs. Evening Chronotype

## Morbidity

<table>
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<tr>
<th>Disorder</th>
<th>Evening Chronotype</th>
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<tbody>
<tr>
<td>Psychological Disorders</td>
<td>OR=1.9,</td>
</tr>
<tr>
<td>Diabetes</td>
<td>OR=1.3,</td>
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<tr>
<td>Neurological Disorders</td>
<td>OR=1.3</td>
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<tr>
<td>GI/Abdominal</td>
<td>OR=1.2</td>
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<tr>
<td>Respiratory</td>
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## Mortality

<table>
<thead>
<tr>
<th>Cause</th>
<th>Evening Chronotype</th>
</tr>
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<tbody>
<tr>
<td>All cause</td>
<td>OR=1.1</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>OR=1.04</td>
</tr>
</tbody>
</table>

Case Study: Brandon

• 16-year-old boy
• Presenting complaint
  – Missed 30+ days of school, scheduled truancy hearing
  – Does not get up for school
  – Cannot fall asleep at night

• Medical History
  – Unremarkable

• Psychiatric History
  – Long history of academic problems
  – Possible history of depression
### 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 bedtimes with downward-pointing arrows.
- Fill in the times your child is asleep with shaded boxes.
- Mark the times your child gets up in the morning and other naps with arrows pointing upwards.

<table>
<thead>
<tr>
<th>Day</th>
<th>AM</th>
<th>PM</th>
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<tbody>
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<td></td>
</tr>
<tr>
<td>Sun</td>
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</tr>
</tbody>
</table>

**Notes:**
- Missed bus
- Sleep through 1st period
- Bus to school
- Missed bus
- First thing is read
- Missed bus
- Missed bus
- Missed bus
- Missed bus

**Special Observations and Notes:**

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Signature: ____________________
Delayed Sleep Phase Treatment

- Motivation???
- Gradual wake time advance
- Melatonin (4-5 hours before bedtime)
- Light
- Temperature
Percentage of Physicians Prescribing Specific Medications for Sleep Problems

Owens, Rosen, Mindell 2002

- Antihistamine
- Alpha Agonist
- Benzodiazepines
- Chloral Hydrate
- Antidepressant
Indications For Use of Sedative Hypnotics in Pediatric Populations

- Pain
- Acute trauma
- Major life stressor
- Severe developmental disability
- Recurrent high risk parasomnias
- ?Short term use in treatment resistant insomnia?
THANK YOU

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dlewin@cnmc.org
Pediatric Sleep Resources & Suggested Bibliography

• American Academy of Sleep Medicine - AASM.org
• National Institutes of Health - StarSleep.nhlbi.nih.gov
• National Sleep Foundation - Sleepfoundation.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