Lecture 2

Common Sleep Disorders in Children

Pediatric Sleep: Children Are Not Mini Adults !

Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem

- The public health burden of chronic sleep loss and sleep disorders is immense
- Awareness among the general public and health care professionals is low
- The available workforce of health care providers is not sufficient to diagnose and treat individuals with sleep disorders
- There is a need to develop and reorganize public health and academic sleep programs to facilitate and improve the efficiency and effectiveness in public awareness, training, research, diagnosis, and treatment of sleep loss and sleep disorders
- The fragmentation of research and clinical care currently present in most academic institutions requires the creation of accredited interdisciplinary sleep programs in academic institutions
- An interdisciplinary approach requires the coordinated and integrated effort of not only the major medical fields involved in sleep clinical care (internal medicine and its relevant subspecialties, pediatrics neurology, psychiatry, psychology, and otolaryngology) but also other disciplines such as neuroscience, dentistry, nursing, and pharmacology.

Adapted from Colten[127]

Colten HR, Altevogt BM, editors. Institute of Medicine (US) Committee on Sleep Medicine and Research. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. *Washington, DC: National Academies Press*; 2006.

Sleep problems results from ?

- **Inadequate sleep duration for age (sleep restriction)**
  - Insomnia
- **Inadequate sleep quality (sleep fragmentation)**
  - Sleep apnea
  - Restless sleep
- **Inappropriate sleep timings (sleep habits)**
  - "night owl" very delayed bedtime
- **Excessive daytime sleepiness (hypersomnia)**
  - Narcolepsy
  - Sleep deprivation

Common sleep disorders

- Sleep disordered breathing
- Restless sleep
- Insomnia
- Hypersomnia
- Parasomnias
- Sleep bruxism
- Sleep epilepsy

Common sleep complaints in children

- Snoring, apneas or pauses in breathing (sleep apnea)
- Restless sleep (restless legs and PLMS)
- Difficulty fall asleep
- Difficulty getting up
- Frequent night time awakening
- Excessive daytime sleep (hypersomnia)
- Frequent nightmares, night terrors (parasomnia)

Other non-specific symptoms of sleep disorders

- Bruxism
- Chronic cough
- Bed wetting
- TMJ issues
- Dry mouth
- Neck pain
- Morning headaches
- Unusual sleep position
- Frequent awakening
- Difficult to control asthma
- Persistent allergies
- GERD
- ADHD poor response to Rx
- Insomnia
- Nightmares, night terrors

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Case presentation: Snoring Child

- 12 years old obese boy with allergic rhinitis and asthma, presents with loud snoring, witnessed apneas, gasping arousals, and mouth breathing for 1 year
  - On examination his BMI is 30, 3+ tonsils.
- Sleep study: severe OSA: AHI 30/hour, desaturation up to 82%
- Recommended adeno-tonsillectomy

Obstructive Sleep Apnea

- OSA is highly *heterogeneous* systemic inflammatory disorder of dysfunctional breathing during sleep
- Major public health burden
  - Estimates: 10-35% in adults in North America
- Susceptible host → genetic factors → environmental affect

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Definition: Pediatric OSA

- Recurrent episodes of partial/complete airway obstruction
- Essential feature: Increased upper airway resistance
- ICSD Criteria: Age < 18 years (at-least one present)
  - Snoring
  - Obstructive breathing/paradoxical/labored
  - Daytime sleepiness/hyperactivity/learning/behavioral issues
- PLUS at-least one of the following:
  - Sleep study: OAHI > 1/hour
  - Obstructive hypoventilation: Snoring/CO2 > 50 torr for > 25%

Habitual snoring: > 3 times/week without OSA
"Benign" → poor concentration, school performances
History alone cannot differentiate habitual snoring from OSA

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AASM ICSD 3rd Edn. 2014

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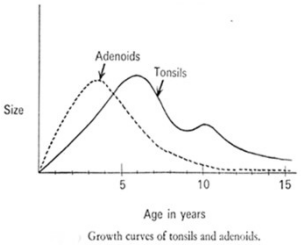
Sleep Apnea: How common is it ?

- How common is snoring in children ?
  - 8-12% in general population snore
  - 2-3% of children have sleep apnea
  - Obese children: 50% children snore, 1/3rd have sleep apnea
- What is the peak age ?
  - 1.5 – 5 years
  - Adolescence
- It is seen in both boys and girls
  - Before puberty M=F
  - After puberty M > F



Growth curves of tonsils and adenoids.

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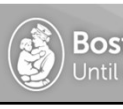
What are the symptoms of sleep apnea in children ?

- **Night-time symptoms**
  - Snoring
  - Rapid breathing
  - Night-time sweating
  - Bed wetting
  - Mouth breathing
  - Nightmares/night terrors
  - Sleep with hyper-extended neck
- **Day-time symptoms**
  - Morning headaches
  - Excessive daytime sleepiness
  - Hyperactivity
  - Poor academic performances
  - Depression / anxiety
  - Chronic fatigue, tiredness
  - Generalized body aches
  - Chronic pain



Symptoms of Sleep-Disordered Breathing in Children

- Snoring
  - Not all children who snore have significant SDB, and not all children with SDB snore
- Labored Breathing During Sleep
  - Children may exhibit noticeable effort in breathing, such as chest retractions, chest paradoxical movements and or visible use of accessory muscles (neck etc.)
- Pauses in Breathing (Apneas)
  - Pauses in breathing for brief periods during sleep, followed by gasping or snorting sounds.
- Restless Sleep
  - Frequent tossing and turning, movements or body position changes during sleep
- Mouth Breathing
  - Open mouth
  - Mouth breathing

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Pediatric SDB: *clinical phenotypes*

- Habitual snorers otherwise "asymptomatic"
  - mouth breathers
- ADHD type (Type 1 OSA)
  - UARS, mild-moderate OSA
  - Typically non-obese
  - Not much desaturations
- Excessively sleepy type (Type 2 OSA)
  - Obese, moderate to severe OSA

Non-Snoring Sleep-Disordered Breathing: An Overlooked Condition

- Variable Symptoms
  - Lack of history does not necessarily mean they are not snoring
  - Snoring – supine, REM, sick
  - Night to night variability
  - Focus on other symptoms
    - Asthma
    - Allergies
    - Learning issues
    - Attentional issues
    - Insomnia
- OSA exacerbation
  - Seasonal
  - Pollution
  - Sleep deprivation
  - Alcohol

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Non-snoring SDB

- Non-snoring SDB refers to the presence of abnormal breathing and respiratory events during sleep without snoring.
- These children present with subtle symptoms
  - restless sleep,
  - frequent awakenings
  - mouth breathing
  - behavioral issues like hyperactivity or inattention.
- Unlike snoring, which is a clear audible sign of airway obstruction, with good respiratory efforts
- These symptoms are often less obvious and can easily be attributed to other causes, such as behavioral disorders or poor sleep hygiene.

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Consequences of unrecognized SDB

- Failure to recognize and treat non-snoring SDB
  - significant long-term consequences
  - chronic sleep disruption,
  - cognitive and behavioral impairments.
- Risk for delayed diagnosis and treatment
- Additionally, untreated SDB can increase the risk of
  - developing cardiovascular issues,
  - growth retardation, and metabolic disturbances. I
- In children, being suspicious, early identification and diagnosis
- Crucial to prevent these adverse outcomes/ensure normal development.

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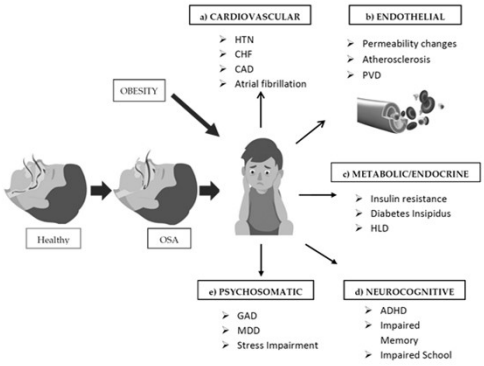
Why should we care about sleep apnea in children ?

Consequence of OSA in Children

OSA

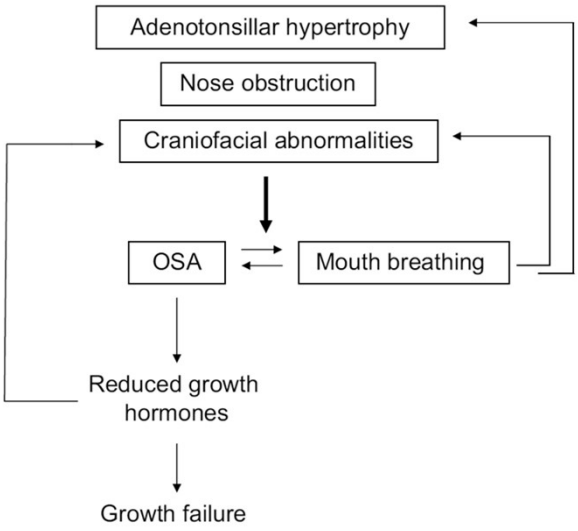
- Intermittent Hypoxemia
- Hypercarbia (CO_2)
- Sleep fragmentation
- ↑ Respiratory Effort

- Cardiovascular
  - BP dysregulation
  - Endothelial Dysfunction
- Metabolic
  - Dyslipidemia
- Endocrine
  - Insulin resistance
- Neuro-cognitive
  - EDS, ADD, poor memory
  - Poor concentration
- Nocturnal Enuresis



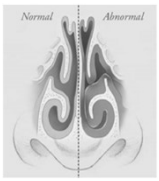
Individual *genetic and environmental susceptible factors* influences the ultimate expression of OSA sequelae….

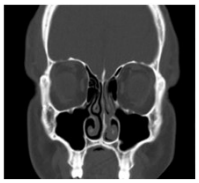
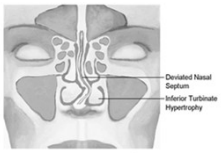
OSA and Growth

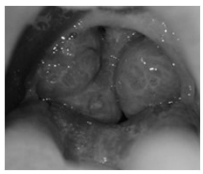
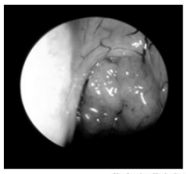
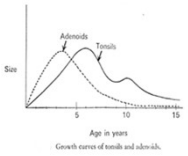


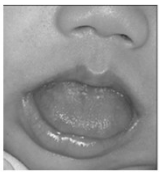
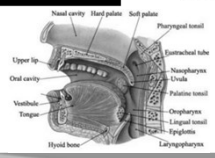
Pediatric OSA: Soft tissue factors

- Nasal obstruction
  - Nasal value collapse
  - Turbinates
  - Deviated septum
  - Polyps
- Soft tissue factors
  - Adeno-tonsillar hypertrophy
  - Lingual tonsils
  - Tongue size
  - Soft palate/uvula
  - Laryngomalacia
- Obesity

Deviated Nasal Septum




How do we diagnosis of OSA

- Evaluate symptoms and morbidity
  - History, questionnaires
- Assessment for severity of obstruction
  - Polysomnogram (Sleep Study)
- Assessment for site of obstruction:
  - Clinical examination
  - Radiological evaluation
    - Lateral neck films (adenoids)
    - Airway CT
  - Airway endoscopy

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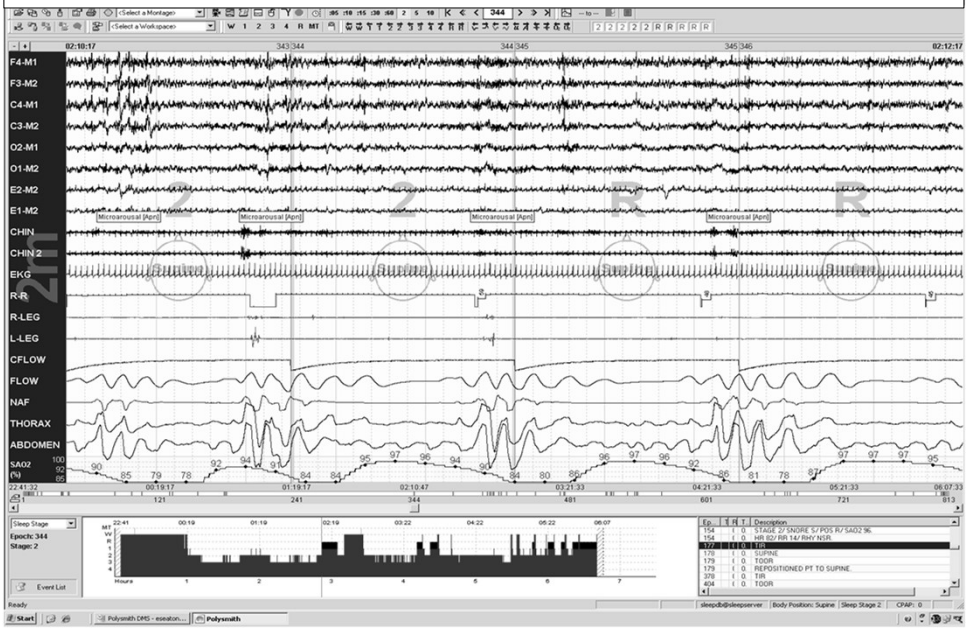
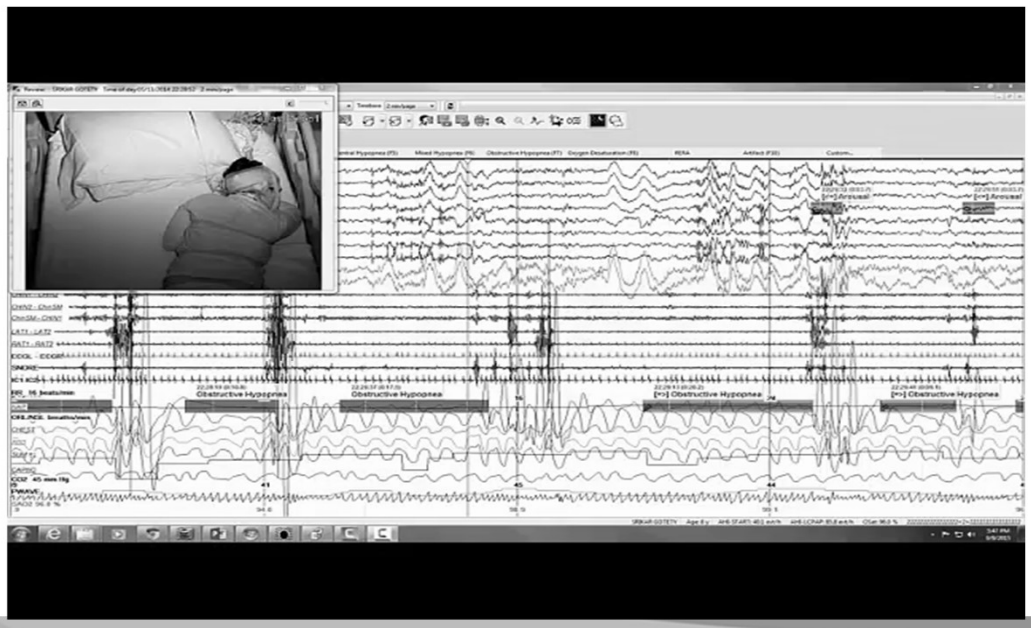


Obstructive apnea



Severity of OSA

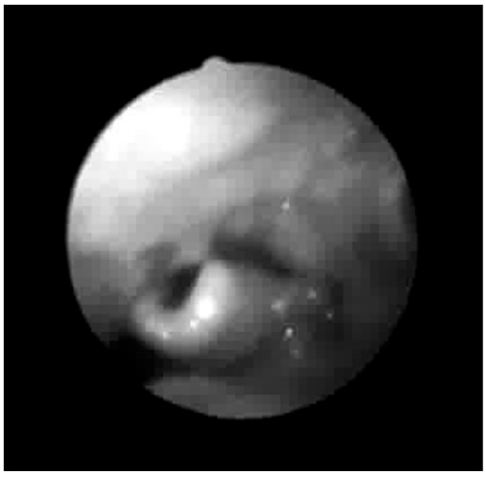
Children

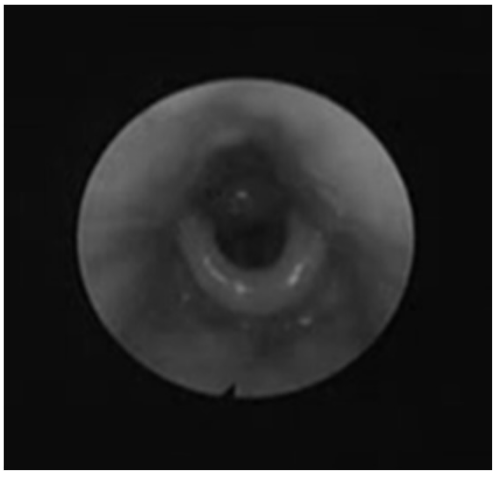
- Mild OSA
  - AHI 1 – 5/hour
- Moderate OSA
  - 5-10/hour
- Severe OSA
  - > 10/hour

Adults

- AHI > 5/hour with symptoms
- AHI > 15/hour (without sx)
  - Mild: 5-15/hour
  - Moderate: 15-30/hour
  - Severe: > 30/hour

Airway endoscopy during sleep





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Treatment of OSA

- **Life style changes**
  - Weight loss
  - Positional
- **Pharmacological treatment**
  - Inhaled steroids
  - Leukotriene antagonist
  - oxygen
- **Surgical treatment**
  - **Adenotonsillectomy**
  - Turbinectomy
  - supraglottoplasty
  - Tracheostomy
- **Positive airway pressure treatment**
  - CPAP
  - BiPAP
- **Dental devices**
  - Rapid maxillary expanders
  - Mandibular advancement devices
- **Myofunctional therapy**
- **Oro-maxillary surgery**
  - Tongue lip adhesion
  - Mandibular distraction surgery
  - UPPP

Sleep disorders other than OSA

- Circadian sleep disorders
- Insomnia
- Restless sleep
- Periodic limb movement of sleep
- Narcolepsy

Insomnia

- **Definition**: Difficulty falling asleep, staying asleep, or waking too early.
- **Causes**:
  - Anxiety, stress, irregular sleep habits.
  - Poor sleep hygiene or environmental factors (e.g., screen time).
- **Symptoms**:
  - Difficulty falling asleep.
  - Frequent nighttime awakenings.
  - Daytime irritability or tiredness.
- **Management**:
  - Behavioral therapy, consistent sleep routines, relaxation techniques.

Case: Sleepy Teenager

- 16 years old boy, overweight (BMI 28)
- **History:**
  - Depressive mood, increasing truancy, declining academic performance
  - Presents: falling asleep in class, irritability, nearly daily headaches
  - Excessive daytime sleepiness, but difficulty falling asleep
  - Cannot be awakened in the morning despite vigorous stimulation
  - On one occasion, EMS was called and he was taken to a local emergency department for "altered mental status."
- Primary care: tried melatonin which have not help
- Referred to psychiatry and neurology
  - A routine EEG was normal
  - Mood disorder/anxiety disorder was ruled out, started on low dose Ambien
- Referred to sleep clinic as these symptoms > 1 year

Case continued……

- He reports playing video games until 11pm at least nightly
- Eats 3-4 bowls of cereal afterward and then lies in bed unable to fall asleep
- After 45 minutes, he texts, surfs the web, tweets, and sometimes watches television

- Sleep timings:

	In bed	Asleep	Wake-time	Duration
Weekday	~11:30 pm	2 am	6:30 am	4 - 5 hrs
Weekend	2 am	3-4 am	2-3 pm	11 - 12 hrs

So what is the problem here ?

- Poor sleep hygiene
- Significant sleep deprivation on school days
- Variable sleep duration (5 hrs – 12 hrs)
- Excessive sleeping on weekend (sleep in)
- Social jet lag
- Normal teenagers needs 9 hours sleep consistently

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Adolescents sleep changes

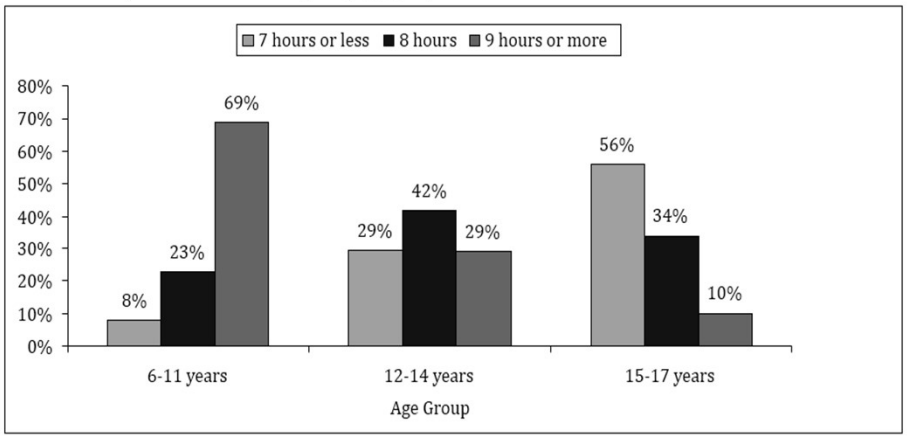
- Circadian rhythm (body clock) changes with puberty (rather than chronological age)
  - Shift (delay) to later sleep-wake times
  - May be exacerbated by evening light exposure
- Accumulation of sleep drive changes
  - Easier for adolescents to delay sleep onset; more difficult to initiate sleep
- Environmental factors
  - Competing priorities for sleep: sports, peer time, homework, activities, after-school employment,
  - Screen time or social time”
- Earlier wake times
  - School starts early: (high school starts 7 AM)
  - Tendency to go to bed late and fall asleep later, then forced wake up due to early school start time → sleep deprivation (< 6 hours)

National Sleep Foundation's Sleep Duration Recommendations:

Age	Recommended	May be appropriate	Not recommended
Newborns *0-3 months*	14 to 17 hours	11 to 13 hours 18 to 19 hours	Less than 11 hours More than 19 hours
Infants *4-11 months*	12 to 15 hours	10 to 11 hours 16 to 18 hours	Less than 10 hours More than 18 hours
Toddlers *1-2 years*	11 to 14 hours	9 to 10 hours 15 to 16 hours	Less than 9 hours More than 16 hours
Preschoolers *3-5 years*	10 to 13 hours	8 to 9 hours 14 hours	Less than 8 hours More than 14 hours
School-aged Children *6-13 years*	9 to 11 hours	7 to 8 hours 12 hours	Less than 7 hours More than 12 hours
Teenagers *14-17 years*	8 to 10 hours	7 hours 11 hours	Less than 7 hours More than 11 hours

NATIONAL SLEEP FOUNDATION

Exhibit 2. Sleep duration on school nights by age group.



Sleep deprivation leads to…..

- Poor attention span
- Reduced memory and learning
- Decreased school performance
- Decreased co-ordination, risk for injuries
- Increased reaction time, risk for accidents
- Frustration and aggressive behavior
- Risk for anxiety, depression, ADHD, weight gain, and other chronic medical conditions

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Diagnosis: Delayed Sleep Phase Syndrome (Night Owl)

- When does “night-owl” become a sleep disorder?
- Most common sleep disorder in teenagers
- Very common in teenagers
- 20-40% have family history of night owls
- Usually misdiagnosed as:
  - Lazy, lack of motivation, anger management issues
  - ?? Drug abuse
  - Depressed, anxiety, ADHD

Treatment of delayed sleep phase

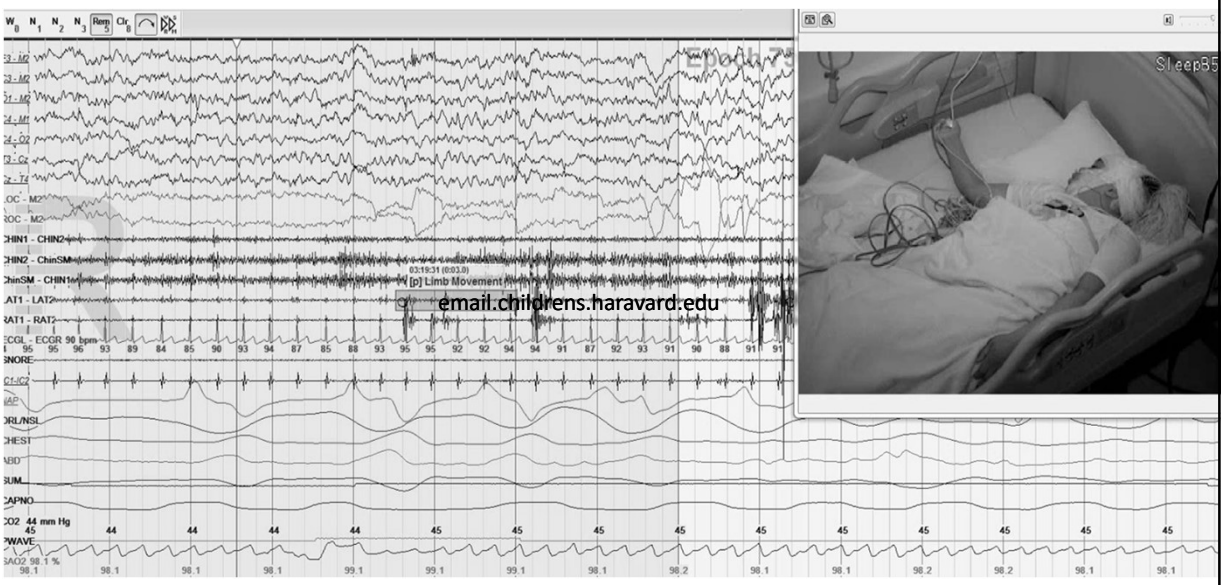
- Melatonin
- Sleep hygiene
- Light therapy
- Sleep monitoring
- Consistency of sleep pattern all days of week

Behavioral Insomnia of Childhood

- **Types**:
  - **Sleep-Onset Association Type**: Child relies on certain conditions (e.g., being rocked or fed) to fall asleep.
  - **Limit-Setting Type**: Difficulty falling asleep due to bedtime resistance or lack of boundaries.
- **Symptoms**:
  - Difficulty falling asleep without specific conditions.
  - Bedtime resistance, refusal to go to bed.
- **Management**:
  - Establishing consistent bedtime routines, setting limits, reducing sleep associations.

Parasomnias

- **Definition**: Unusual behaviors or experiences during sleep.
- **Types**:
  - **Night Terrors**: Episodes of intense fear, screaming, and thrashing during non-REM sleep.
  - **Sleepwalking**: Walking or performing activities while still asleep.
  - **Nightmares**: Frightening dreams during REM sleep.
- **Causes**:
  - Immaturity of the sleep-wake cycle, stress, overtiredness.
- **Management**:
  - Safety precautions (locking windows), consistent sleep schedules, reassurance



Derry CP et al. SLEEP 2009

Derry CP et al. SLEEP 2009

General Sleep Hygiene Tips for Children

- **Key Recommendations**:
  - Consistent bedtime routines.
  - Limiting screen time before bed.
  - Creating a sleep-conducive environment (quiet, dark, cool).
  - Avoiding caffeine or large meals before bedtime.
  - Ensuring age-appropriate sleep duration.

Restless Sleep

- Restless legs syndrome
- Restless sleep disorder
- Periodic limb movement of sleep

Restless Legs Syndrome (RLS): Definition (children>12 yrs)

1. An urge to move the legs usually accompanied by, or caused by, uncomfortable or unpleasant sensations in the legs.
2. The urge to move or the unpleasant sensation begins or worsens during periods of rest or inactivity, such as lying or sitting.
3. The urge to move or the unpleasant sensations are partially or totally relieved by movement, such as walking or stretching, at least as long as the activity continues.
4. The urge to move or unpleasant sensations are worse in the evening or night than during the day or only occur in the evening or night.

(Allen *et al*, 2003)

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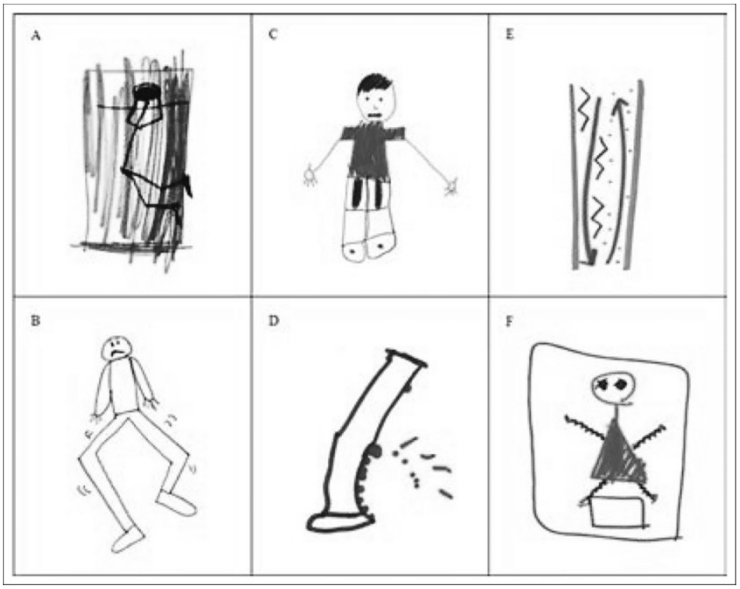

7 years old boy – “they (my legs) like feel weird, and they want to kick”

June 2011 Journal of Child Neurology 26(11):1365-76

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Restless Legs: Definition Children (2-12 years)

- The child meets all four essential adult criteria for RLS (the urge to move the legs, is worse during rest, relieved by movement and worse during the evening and at night)

And

- The child relates a description in his or her own words that is consistent with leg discomfort (the child may use terms such as oowies, tickle, spiders, boo-boos, want to run and a lot of energy in my legs to describe the symptoms. Age-appropriate descriptors are encouraged)

Or

- The child meets all four essential adult criteria for RLS and
- Two of the three following supportive criteria are present.

  (a) Sleep disturbance for age

  (b) A biologic parent or sibling has definite RLS

  (c) The child has a polysomnographically documented periodic limb movement index of 5 or more per hour of sleep.

Restless sleep disorder

- Restless sleep disorder (RSD) is a recently identified pediatric sleep disorder characterized by frequent movements during sleep associated with daytime symptoms (age 6-18 years, ~ 7%)
- Increased prevalence in parasomnias and attention deficit hyperactivity disorder
- Polysomnography is necessary for the diagnosis of RSD
  - 5 large movements per hour
- Current evidence →
  - increased sympathetic predominance,
  - increased NREM sleep instability
  - iron deficiency

Symptoms of Restless Sleep Disorder

- **Signs of Restlessness During Sleep**:
  - Frequent tossing and turning.
  - Kicking, jerking, or moving around the bed during sleep.
  - Sleep positions constantly changing.
- **Daytime Symptoms**:
  - Irritability, mood swings.
  - Daytime fatigue or lethargy.
  - Difficulty concentrating, learning, or increased hyperactivity.

Periodic Limb Movements of Sleep (PLMS)

- Diagnosed by sleep study
- Leg movements at a typical pattern
- PLM index (PLMI)
  - Children: Abnormal if PLMI >5/hr
  - Adult: Abnormal > 15/hr
- Exacerbated by concurrent sleep-disordered breathing
- More common in patients with other sleep disorders:
  - RLS: 80-90%
  - Narcolepsy - 45-90%
  - REM sleep behavior disorder (very rare in children): 70%

Restless Legs Syndrome (RLS)
Periodic Limb Movements of Sleep (PLMS)

- Prevalence - unknown
- Estimate: children 8-17% (US and UK)
  - Picchietti *et al*., 2007
- ? Girls > boys
- 40% of adults with RLS had onset < age 20
- Risk factors:
  - Iron deficiency, pregnancy, renal failure (with uremia), osteoarthritis, rheumatoid arthritis
- Differentials:
  - "Growing pain"
  - Trauma (hidden fractures
  - Neuropathy
- PLMD: It becomes a disorder if associated with features of sleep disturbances and daytime sleepiness
  - Often co-morbid however, one can occur without the other
- Serum ferritin <50 ng/mL (Kotagal, 2004)
- Iron Hypothesis: Patients with RLS have marginal CNS iron stores

PLMS/RLS: ADHD connection

- 26 - 64% of children with ADHD have PLMS index >5/hr of sleep (Picchietti 1998, 1999)
- 44% of children with PLMS have ADHD.
- Children with both ADHD and a PLMS index >5/hr of sleep have increase incidence of both personal and familial history of RLS
- Symptoms of ADHD measured 2x as likely to occur with symptoms of RLS than would be expected by chance alone (Chervin *et al*., 2002)
- RLS-ADHD may persist into adulthood (Wagner et al, 2001)

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RLS/PLMS: Treatment

- Optimize sleep hygiene, scheduling, avoid meals or exercise prior to bed
- Treatment of underlying sleep-disordered breathing
- **Iron supplementation** – 2-6 mg/kg elemental iron divided BID-TID; preferably with vitamin C to increase absorption
- Dopamine agonists (not FDA approved for children)
  - Pramipexole
  - Ropinorole
- Other meds: Clonazepam, Clonidine and Gabapentin
- Gentle massage at bed time

Narcolepsy

- **Definition**: Narcolepsy is a chronic neurological disorder that affects the brain's ability to regulate the sleep-wake cycle, leading to excessive daytime sleepiness and sudden sleep attacks.

- **Prevalence**: Rare in children, but typically presents between the ages of 7 and 25 years.

Causes of Narcolepsy

- **Autoimmune Hypothesis**:
  - The body attacks the brain cells that produce hypocretin (orexin), a neurotransmitter involved in regulating wakefulness.
- **Genetic Factors**:
  - Family history may increase the risk.
- **Possible Triggers**:
  - Infections (e.g., strep throat, flu) or stress may trigger the onset.

Narcolepsy

- Type 1: With cataplexy
- Type 2: without cataplexy

Symptoms of Narcolepsy

- **Excessive Daytime Sleepiness**:
  - Persistent sleepiness, even after a full night's rest.
  - Sudden sleep attacks during daily activities (e.g., at school).
- **Cataplexy** (in some cases):
  - Sudden loss of muscle tone triggered by emotions like laughter or excitement.
  - Weakness, slurred speech, or inability to move temporarily.
- **Sleep Paralysis and Hallucinations**:
  - Inability to move upon waking or falling asleep, often accompanied by vivid, dream-like hallucinations.
- **Disrupted Nighttime Sleep**:
  - Frequent awakenings during the night, leading to fragmented sleep.

Diagnosis of narcolepsy

- **Medical History and Symptom Assessment**:
  - A detailed evaluation of sleep patterns, excessive daytime sleepiness, and cataplexy.
- **Sleep Studies**:
  - **Polysomnography (PSG)**: Overnight monitoring to assess sleep stages and rule out other sleep disorders.
  - **Multiple Sleep Latency Test (MSLT)**: Measures how quickly a child falls asleep during the day and checks for REM sleep occurring too soon after sleep onset.
- **Hypocretin Levels**:
  - Cerebrospinal fluid (CSF) testing to check for low hypocretin levels in suspected cases.

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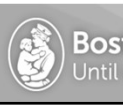
Evolution of sleep symptoms….

- Slow and insidious
- Intermittent worsening
- Persistent
- Effect on behavior, alertness
- Then effect on cognition and memory
- Changes stabilize during late childhood
- Remerges during adults

Mimicking sleep symptoms.. how to differentiate

- **Daytime sleepiness**
  - Inadequate sleep
  - Narcolepsy
  - OSA
  - Medication
  - Sleep fragmentation
- **ADHD**
  - OSA
  - Snoring
  - Sleep fragmentation
  - Inadequate sleep
- **Nightmares/night terrors**
  - Sleep fragmentation
  - Developmental
- **Restless sleep**
  - Sleep apnea
  - RLS
  - Medication
- **Bruxism**
  - Sleep disordered breathing
  - Iron deficiency
  - Increased autonomic activity
  - GERD

Thank You



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