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Children's Hospital Colorado

Pediatric Sleep & Sleep Apnea

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Disclosures

- No relevant financial relationships with any commercial interests

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Objectives

The learner will -

- Recognize the spectrum of sleep disordered breathing
- Become familiar with pediatric sleep studies
- Implement initial treatment strategies for pediatric OSA

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Why Sleep?

'If sleep does not serve an absolutely vital function, then it is the biggest mistake the evolutionary process ever made'.

Alan Rechtschaffen

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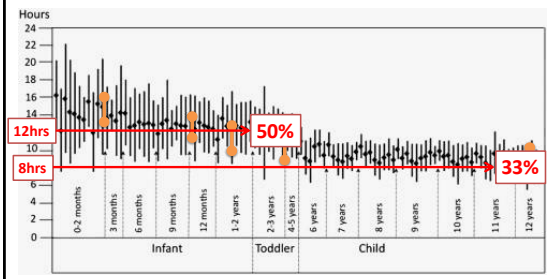
How Much Time We Spend Sleeping



Meta-analysis with tens of thousands of kids' and "normal" sleep duration National Sleep Foundation recommendations

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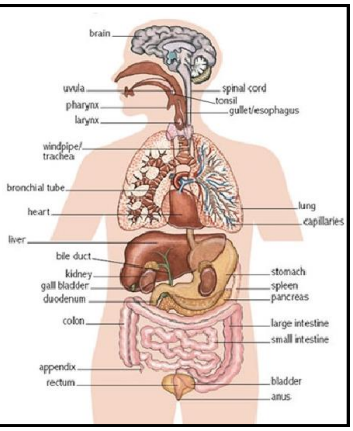
Not enough good sleep?



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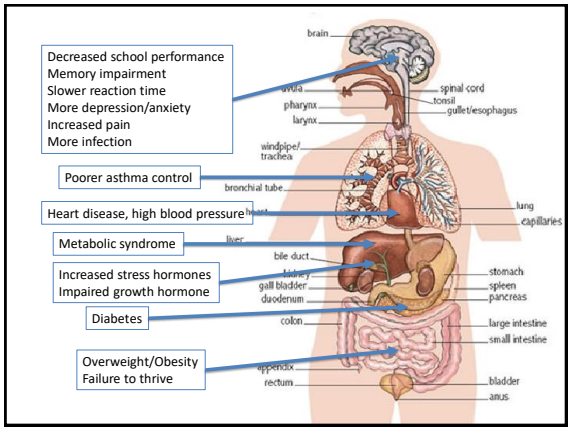

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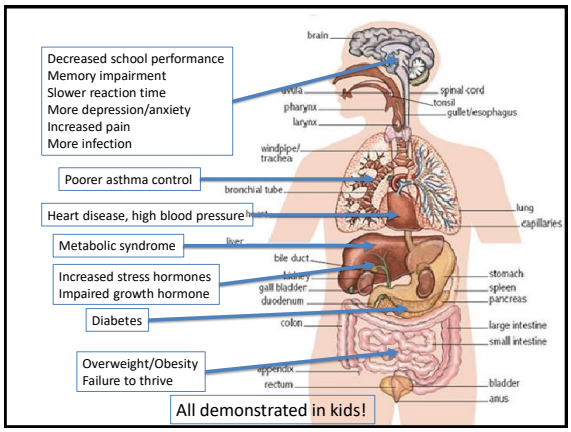

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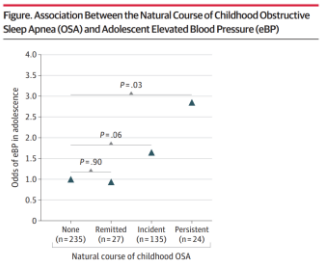
Hypertension in adolescence



Modified from: Fernandez-Mendoza, JAMA Cardiology 2021

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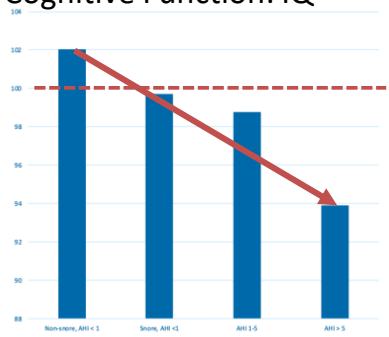
Cognitive Function: IQ



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Hunter & Gozal, Am J Respir Crit Care Med 2016

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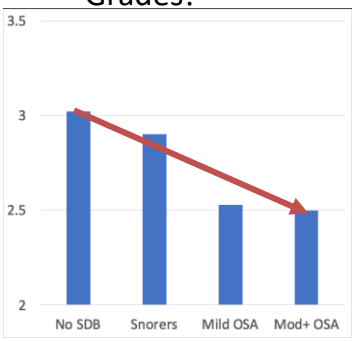
Grades!



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Beebe, Sleep 2010

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Sleep Disordered Breathing

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- Breathing concerns + Symptoms
  - Snoring to obstructive sleep apnea (OSA)
  - Also includes periodic breathing, CSA
- 10-12% kids snore
- Only 2-3% with OSA

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Obstructive Sleep Apnea

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- Diagnosed by polysomnogram (PSG, sleep study)
- Repetitive obstruction of airway during sleep
  - Either complete (apnea) or partial (hypopnea)
- Hypopneas must be associated with
  - Oxygen desaturations
  - Sleep disruption
- More often hypopneas with children, premenopause
  - Reduced airflow AND oxygen desaturation OR arousal

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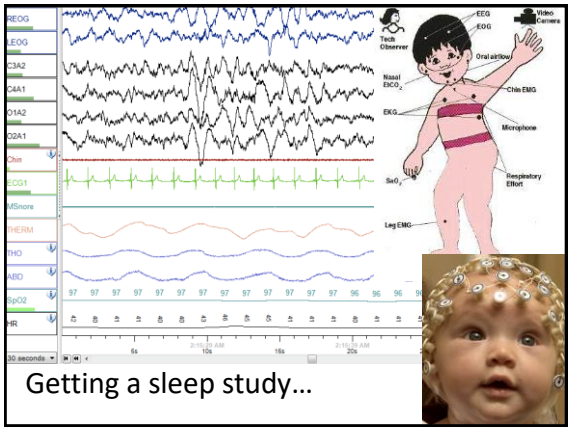

Getting a sleep study…

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Sleep Study

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Sleep Study

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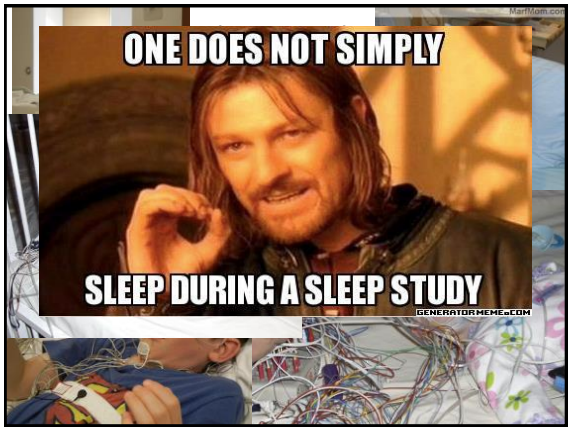
ONE DOES NOT SIMPLY
SLEEP DURING A SLEEP STUDY

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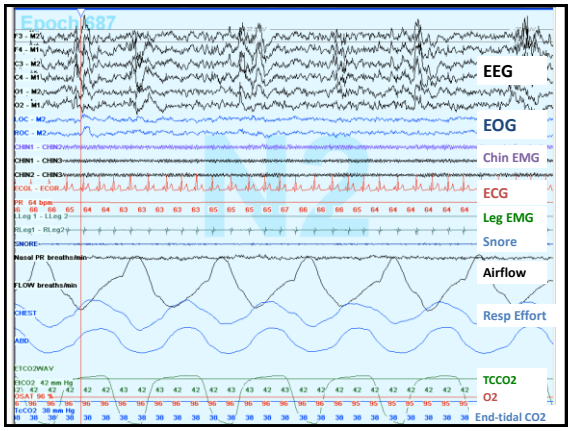
EEG
EOG
Chin EMG
ECG
Leg EMG
Snore
Airflow
Resp Effort
TCCO2
O2
End-tidal CO2

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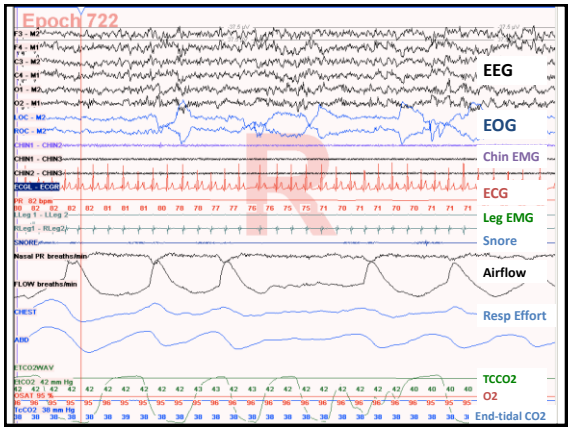

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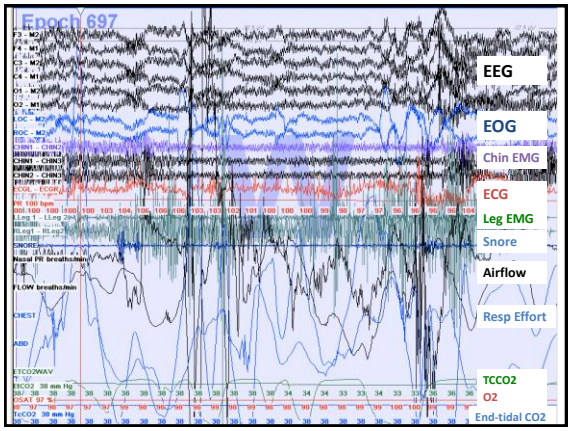

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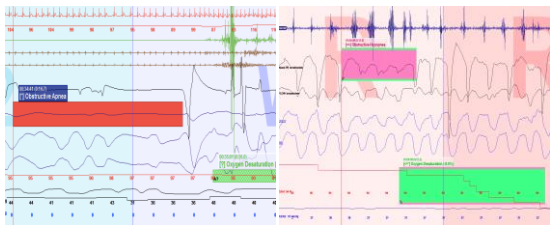
Obstructive Sleep Apnea =

Obstructive Apnea + Obstructive Hypopnea



Courtesy of Dr. B.H.Hughes

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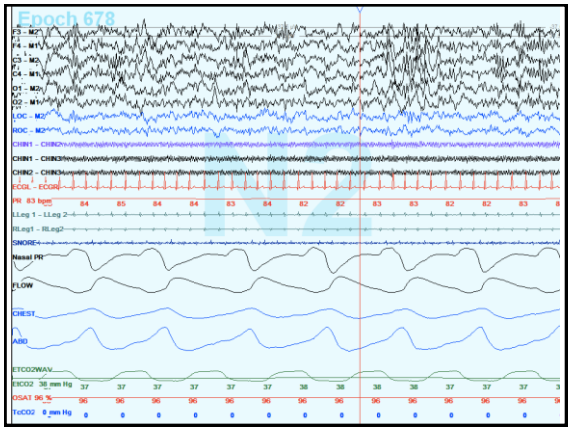
Epoch 678

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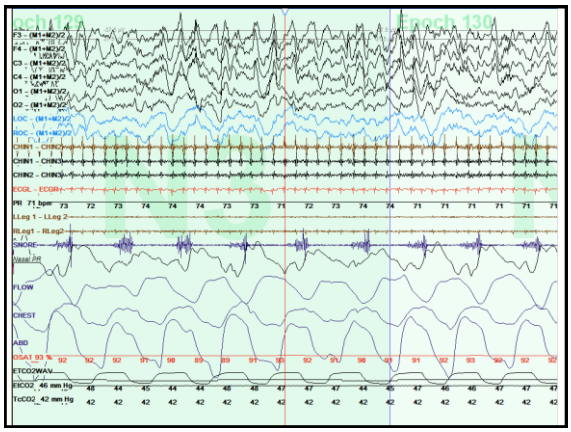
Epoch 130

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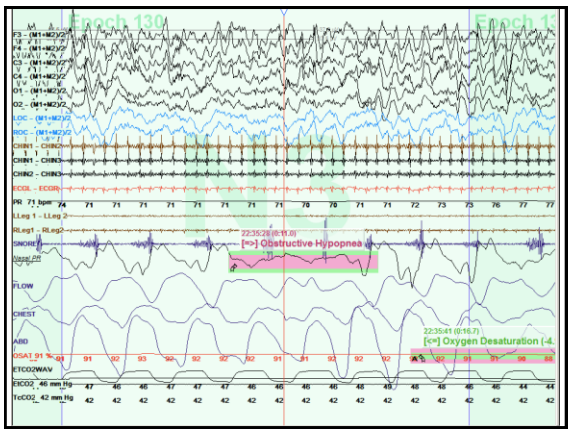
Epoch 130
[=>] Obstructive Hypopnea
[<=] Oxygen Desaturation

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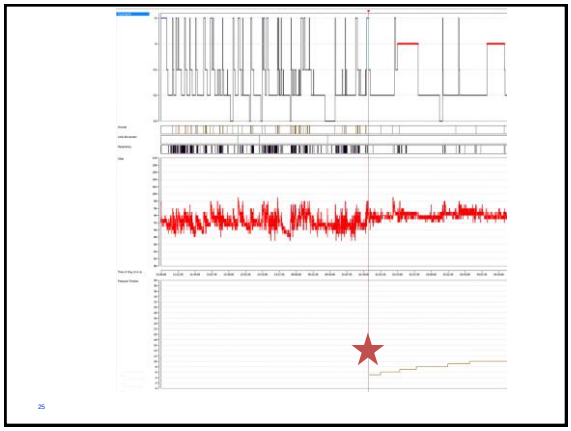

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Pediatric OSA Criteria

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- Obstructive apnea-hypopnea index (***/hr)=
  # episodes of obstruction per hour of sleep time
- Severity guidelines (specific to peds):
  - AHI 1 – 1.9/hr = Borderline…
  - AHI 2 – 4.9/hr = Mild
  - AHI 5 – 9.9/hr = Moderate
  - AHI ≥10/hr = Severe
- Compare to adult thresholds:
  - AHI 5-14.9/hour mild
  - AHI 15-29.9/hour moderate
  - AHI >=30/hour severe

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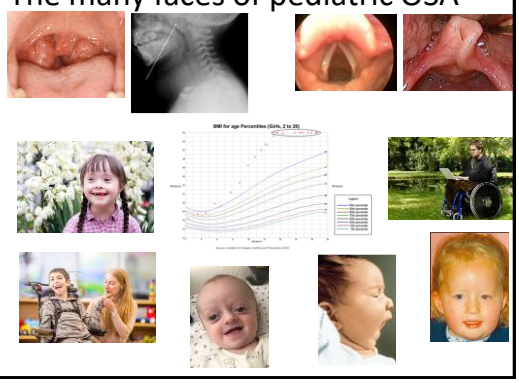
The many faces of pediatric OSA



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Cause of OSA varies with age

- Infants:
  - **Laryngomalacia** & other extrathoracic congenital airway anomalies
- Toddler through early school age:
  - **Adenotonsillar hypertrophy**
  - Obesity
  - Anatomic/genetic predisposition
- Adolescents:
  - **Obesity**
  - Anatomic/genetic predisposition
  - Adenotonsillar hypertrophy

- *Condition-specific: Down syndrome, Pierre Robin & other craniofacial, Prader-Willi, metabolic disorders, neuromuscular disorders, cerebral palsy*

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OSA treatment improves outcomes

- **Adenotonsillectomy** remains firstline tx
- Medical management
- Orthodontia
- Weight loss
- Positional therapies
- Supplemental oxygen
- Continuous Positive Airway Pressure (CPAP)
- Novel therapies…

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How good is T&A?

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- It depends on:
  - Age
    - The younger the better
  - BMI
    - About 1/2 of obese kids will persist
  - Comorbidities
    - Particularly asthma
  - OSA severity
    - More severe, less likely to resolve
- CHAT (NEJM 2013)
  - 79% resolved (vs 46% in watchful waiting group…)

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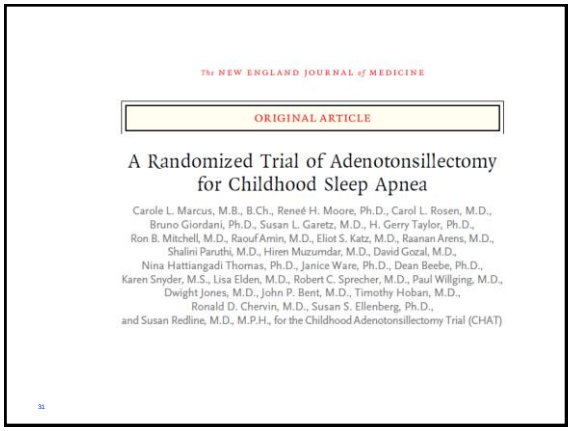

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CHAT Study

- Randomized trial of AT vs watchful waiting in 5-9 year old children with OSA (AHI >2)
  - N= 397
  - Mean age 6.5y
  - Race: 53% Black, 37% white, 9% Other
  - 46% obese
  - Baseline AHI 4.5 (WW) to 4.8 (AT)

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CHAT Study

- Major findings
  - OSA "cured" (AHI <2, OAI <1) in:
    - 79% of AT group
    - 46% of WW group
  - Signs/symptoms improved by AT vs WW:
    - Conner's score (impulsivity, emotional lability)
    - BRIEF Score (executive function)
    - PSQ
    - PedsQL
    - (Trend in improved NEPSY)

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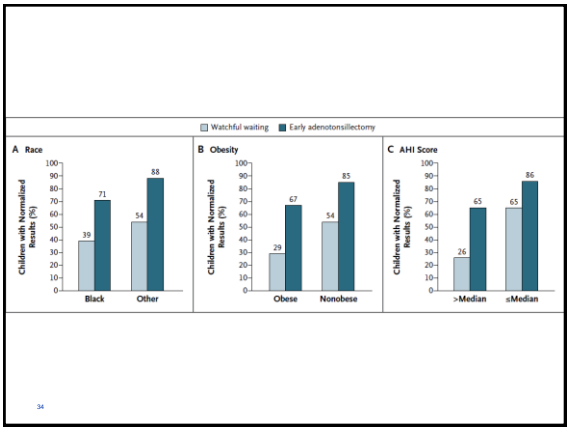

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Advantages of medical therapy

- It's not surgery!
- It's not CPAP!
- Can start right away
- May help some (symptoms, sleep study findings)

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Intranasal corticosteroids

	Study 1	Study 2	Study 3
Medication	Fluticasone	Budesonide	Mometasone
N	25	80	50
Age	1-10 y	6-12 y	6-18 y
Change in OAHI	10.7→5.8 (p=0.04)	3.7→1.3 p<0.0001	2.7→1.7 (p=0.01)
Change in adenoid	N	Y	N
Change in symptoms	N	N/A	Snoring only

- Study 1: Brouillette, J Pediatr 2001
- Study 2: Kheirandish-Gozal, Pediatrics 2008
- Study 3: Chan, Sleep Med 2015

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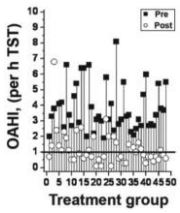
Kheirandish-Gozal, Pediatrics 2008

- 54% had normalized OAHI (<1)
- Improvement sustained 6 weeks after stopping mometasone
- No difference in response for:
  - Non-obese vs obese
  - Allergic symptoms vs no
  - Younger vs older (6-12 y range)
- Caveats/Limitations:
  - These patients had big adenoids
  - Tonsil size not reported
  - Symptoms not reported



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Oral montelukast

	Study 1	Study 2
N	46	92
Age	2-10 y	2-10 y
Change in OAHI	6.0→3.6 (p=0.07)*	9.2→4.2 (p<0.001)
Change in symptoms	Yes (night)	N/A
Change in adenoid	Y (81%→57%)	Y (2.4→2.0)
Change in tonsil	N/A	Y (2.7→2.3)

- Study 1: Goldbart, Pediatrics 2012
- Study 2: Kheirandish-Gozal, Ann Am Thorac Soc 2016

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How good are medications?

- Improve non-severe OSA, pre-T&A
- Long-term benefit and effects unknown

- Intranasal steroids
  - Fluticasone, mometasone, budesonide
  - Nosebleeds, headaches, dryness common

- Oral leukotriene receptor antagonist – Montelukast (Singulair)
  - Behavior/mood changes, nightmares

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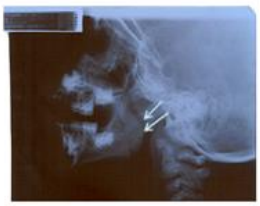

PRE POST

Montelukast (Singulair)

- Effective for non-severe OSA, ***pre*** and post-T&A
- Behavior/mood changes, nightmares

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Medical therapy: Our take

- Can be used:
  - While awaiting definitive evaluation/treatment*
  - If minimal/no OSA on PSG, but significant symptoms
- Consider comorbidities:
  - SDB + Allergic Rhinitis:
    - Consider nasal saline irrigation + intranasal corticosteroids
  - SDB + Persistent Asthma or refractory AR
    - Consider oral montelukast

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When to get the dentist involved?

- Roof of the mouth is Floor of the nose
  - High-arched or narrow palate
  - Prominent overbite, crossbite

- Rapid Palate Expansion:
  - Widens narrow, high-arched palate
  - After about 7yrs, usually enough adult teeth to anchor
  - Expensive, uncomfortable(?), not well studied

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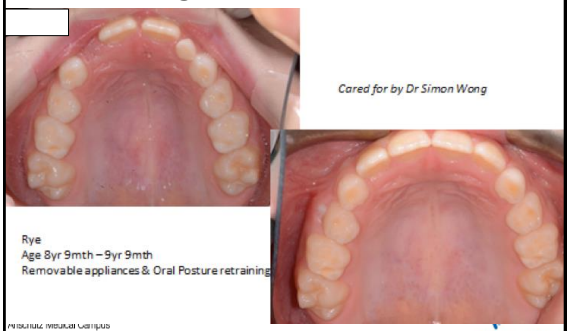
When to get the dentist involved?



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OSA Screening

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AAP Practice Guideline

All children & adolescents should be screened for snoring

Marcus, Pediatrics 2012

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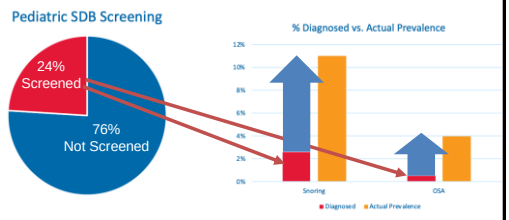
Actual Practice



Erichsen, Clin Pediatr 2012 Lumeng & Chervin, Proc Am Thorac Soc 2008

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How to Screen for OSA?

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How to ask about snoring

- "All children & adolescents should be screened for **snoring**"

Symptom category	Item[a]	Odds ratio	*P*-value
Snoring			
Frequency	A2: usually snores	10.8	0.0004
	A3: always snores	10.5	0.0006
Quality	A4: snores loudly	10.4	<0.0001

Chervin, Sleep Med 2000

- **Does your child snore more than 3 nights per week?**
- **Does your child ever snore loudly?**

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Obstructive Sleep Apnea

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Consider OSA if:

- Nighttime symptoms
  - Habitual snoring
  - Mouth breathing, gasping, choking, coughing
  - Frequent arousals, restless, funny positions
  - Enuresis, especially secondary
- Daytime symptoms
  - Morning headaches
  - Daytime sleepiness or unrefreshed sleep
  - Hyperactive…
- Risk factors
  - Big tonsils, obesity, overbite, atopy, syndromic…

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Three Strikes Rule

In an otherwise healthy non-obese 2- to 7-year-old, consider direct ENT referral (without PSG) if:

1) Snoring (loud *or* ≥ 3 nights/week)
2) Daytime symptoms (see Chervin PSQ)
3) Enlarged tonsils

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OSA persists after T&A…

- CPAP is effective
  - Overcomes pharyngeal closing pressure…
- …But adherence is poor
  - Requires facial seal
  - Frequent adverse events
  - May require significant desensitization
  - PAP variations don't help
    - One exception: addition of humidity

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CPAP:

EFFICACY & ADHERENCE

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CPAP Efficacy

TABLE 2 **Polysomnographic Parameters**

	Baseline	On PAP	*t* (DF)	*P*
Arousal index, *n*/h	17 ± 23	7 ± 2	1.85 (18)	.08
AHI, *n*/h	27 ± 32	3 ± 5	3.44 (19)	.003
Mean Sao_2, %	95 ± 6	97 ± 2	1.87 (18)	.08
Sao_2 nadir, %	77 ± 17	89 ± 6	3.82 (19)	.001

Polysomnographic parameters at baseline and on PAP, after 6 months of home PAP, are shown for the 20 patients who returned for the 6-month polysomnogram. All data are displayed as mean ± SD. Accurate sleep staging could not be obtained in 2 children with developmental delay/neurologic abnormalities. There was a highly significant improvement in the AHI and Sao_2 nadir on treatment and a trend for an improvement in the arousal index and mean Sao_2.

Marcus CL, Pediatrics 2006

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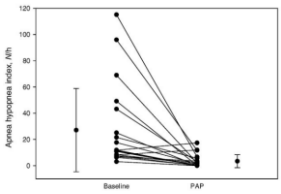
CPAP Efficacy



Marcus CL, Pediatrics 2006

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CPAP Adherence

	Patients (n=20 553)
Age, years	13·0 (3·7)
PAP use and adherence	
Patients actively using PAP over 90 days	12 699 (61·8%)
Patients meeting CMS adherence criteria	9504 (46·3%)
Proportion of days with ≥4 h use	45·1 (33·3%)
Use per session, h	5·2 (2·6)
Daily use across all days, h	3·9 (2·8)

Data are mean (SD), or number (%). CMS=Centers for Medicare and Medicaid Services. PAP=positive airway pressure.

Table 1: **Summary patient data extracted from the AirView database**

Bhattacharjee R, Lancet Digit Health 2020

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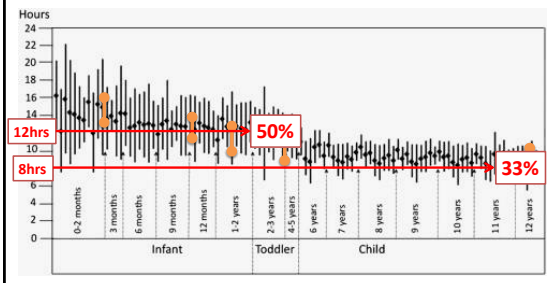
How Much Time We Spend Sleeping



Meta-analysis with tens of thousands of kids' and "normal" sleep duration National Sleep Foundation recommendations

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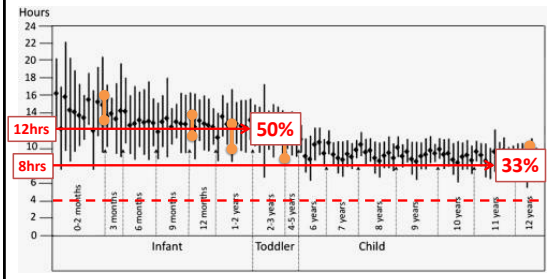
How Much Time We Spend Sleeping



Meta-analysis with tens of thousands of kids' and "normal" sleep duration National Sleep Foundation recommendations

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Shout Out!

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- Behavioral Sleep Clinic
  - Sleep psychologists with emphases on:
    - CPAP desensitization (STARS Clinic)
    - Sleep hygiene
    - CBT-i
    - Actigraphy

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Pediatric OSA Summary

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- Sleep is important enough to spend 33% of your time doing it
  - (66% of your time if you're a sleep doc)
- Sleep apnea is common, comorbid but treatable
- Sleep apnea is improved by opening the airway
  - Tailor treatments to the patient

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Thank you!

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- Stephen Hawkins, MD
- stephen.hawkins@childrenscolorado.org
- CHCO Sleep Nurses' Line: 720.777.6601

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Additional Sleep Resources

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- American Academy of Pediatrics' Pediatric Sleep Apnea Guidelines
  - Peds OSA Guidelines 2012
- National Sleep Foundation
  - www.sleepfoundation.org
- Centers for Disease Control & Prevention
  - www.cdc.gov/sleep
- American Academy of Sleep Medicine
  - www.aasmnet.org
- CHCO Sleep Study Video
  - www.childrenscolorado.org
- Bonus slides…

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Prevent SIDS/SUID

- Always put babies on their backs for *every* sleep
  - Tummytime is great while awake, supervised
- Keep the crib/bassinet simple (boring, bare, basic)
  - No toys, stuffed animals, etc. in bed
  - Nothing fluffy, squishy, cuddly, cozy…
- Share the room but not the bed
- Keep the room (and baby) cool (~65°)

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Good Sleep Hygiene

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- Keep the bedroom dark, quiet, and cool (like a bear's den)
- Consistent bedtime and bedtime routine (like the sun & moon)
- Consistent wake time (there's no "weekend" in nature)
  - In particular, don't "sleep in" more than 2 hours
- Avoid caffeine, especially 6 to 8 hours before bedtime (even if you can fall asleep, it's still a stimulant; this just means you're sleep deprived)
- Do not nap during the day (save sleep for nighttime, or plan to not sleep as well)
  - If you do nap, limit to less than 40 minutes
- Don't use the bed for anything other than sleep (like Pavlov's dogs)
  - Manage light…

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Melatonin in Practice

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- Summary of Data
  - Improves sleep onset (and maintenance…)
  - Improves total nighttime sleep (~30 minutes)
  - Improvements in quality of life and family stress
- Dosing
  - 1-6mg given ~30min before bedtime
    - >6-9mg less likely to see additional benefit
  - Unregulated, over-the-counter in various formulations
- Adverse drug events
  - Vivid dreams, daytime somnolence, ?URI/GI illness, ?seizure

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Case #1

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- A 6 year-old African American male presents with chief complaint of nightly snoring. MOC states he sounds like an "old man" when he is sleeping. He does seem to have pauses in his breathing and will then gasp loudly. He is having difficulty in school and teachers have recommended an ADHD evaluation. No history of allergy symptoms.
- Exam: BP 94/64 HR 80 BMI 25
- HEENT nl except for 3+ tonsils, periorbital shiners, adenoid facies; no allergic salute
- Ht RRR
- Lungs CTA bilaterally

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Question #1

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- What is the next step in the management of this patient?
- 1) Order a Home Sleep Study
- 2) Order a Full Polysomnogram
- 3) Consider a 6 week trial of nasal fluticasone
- 4) Refer to ENT

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Case #2

Children's Hospital Colorado

- A 6 year-old Caucasian male presents in June for a well-child visit. When asked if the child snores, the mother states that he does snore most nights, but she does not notice any gasping for air or work of breathing. He does wake at night a couple times per week, but seems well rested in the mornings. He is very active, but she does not feel that he is more active than other 6 year-old boys. Mom is also concerned that he has some seasonal allergies.
- PE: BP 102/62 HR 92 BMI 26
- HEENT 2+ tonsils, +periorbital shiners, + nasal salute with boggy nasal turbinates
- Ht RRR nlS1S2
- Lungs CTA bilaterally

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Question #2

Children's Hospital Colorado

- What is the next step in the management of this patient?
- 1) Order a Home Sleep Study
- 2) Order a Full Polysomnogram
- 3) Consider a 6 week trial of nasal fluticasone
- 4) Refer to ENT

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Case #3

Children's Hospital Colorado

- A 14 year-old female with a BMI of 32 is in your office for a well teen visit. She mentions that at sleepovers she has been told by peers that she snores very loudly. This is embarrassing to her. She has no signs or symptoms of allergies. She is always tired, and gets occasional headaches but she also has trouble falling asleep at night and difficulty waking in the morning as a result.
- PE: Obese female BP 130/80 P73 BMI 32
- HEENT 2+ tonsils without allergic signs or sx

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Question #3

Children's Hospital Colorado

- What is the next step in the management of this patient?
- 1) Order a Home Sleep Study
- 2) Order a Full Polysomnogram
- 3) Consider a 6 week trial of nasal fluticasone
- 4) Refer to ENT

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Case 3 cont.

Children's Hospital Colorado

- You obtain a sleep study and the AHI is 9/hr. She undergoes adenotonsillectomy and returns to see you several months later with persistent daytime somnolence and difficulty sleeping through the night. She is not sure whether she still snores and parents are usually asleep by the time she falls asleep. What are next steps in the management of this patient?
- 1) Start in-home CPAP
- 2) Refer to Pulmonary
- 3) Refer back to ENT
- 4) Repeat sleep study

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Case #4

Children's Hospital Colorado

- 8 year old female with Down Syndrome is new to your practice. There are concerns that she is a mouth breather, never sleeps through the night and having recent behavioral outbursts. She has also started sleep walking.

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Question #4

Children's Hospital Colorado

- Which of the following conditions is a polysomnogram routinely indicated to rule out OSA.
- 1) Obesity
- 2) Sickle cell disease
- 3) Hypertension
- 4) Down Syndrome
- 5) Craniofacial anomalies

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