Pediatric Obstructive Sleep Apnoea

Primary Care Paediatrician
Secretary General, Israeli Ambulatory Paediatric Society
Coordinator Primary Care, Global Consensus in Paediatrics and Child Health
Pediatric Obstructive Sleep Apnoea differs from adult OSA in epidemiology, mechanisms of obstruction, adverse effects, diagnostic criteria & recommended treatments.

Associated with poor quality of life, medical complications, increased healthcare use, somnolence, prone to accidents, cognitive dysfunction, impaired school performance, behavioral problems (including ADHD), metabolic effects and more.
Advances in understanding the underlying pathophysiological mechanisms and improved approach to diagnosis & management have resulted in an abundance of publications.

1960s: 11
1970s: 82
1980s: 689
1990s: 1012
2000s: 3166
A clinical practice guideline intended for the use of primary clinicians, based on data gathered from 3166 articles from 1999 to 2010.
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Specialist in Sleep Medicine
Specialist in Paediatric Pulmonology
Specialist in E.N.T.
Neonatologist
Informatician
Clinical Psychologist
Biostatistician
Epidemiologist
Neuropsychologist

Only One Attending (General) Pediatrician in the Children Hospital Philadelphia
• Background & Overview
  • Etiology
  • Epidemiology
  • Diagnosis
  • Workup
  • Treatment Options
  • Summary
CHARLES DICKENS describes an overweighted hypersomnolent boy in *THE POSTHUMOUS PAPERS OF THE PICKWICK CLUB*

WILLIAM HILL describes an OSAS sufferer child: “the stupid lazy child who frequently suffers from headaches at school, breathes through his mouth instead of his nose, snores and is restless at night, and wakes up with a dry mouth in the morning, is well worthy of the solicitous attention of the school medical officer.”

Dr. William Hill: On some causes of backwardness and stupidity in children.

1907 - SIR WILLIAM OSLER USES FOR THE FIRST TIME THE TERM "PICKWICKIAN"

1973 - CHRISTIAN GUILLEMINAULT DESCRIBES "....A new clinical syndrome, sleep apnea associated with insomnia......Repeated episodes of apnea occur during sleep. Onset of respiration is associated with general arousal and often complete awakening, with a resultant loss of sleep. An important clinical implication is that patients complaining only of insomnia may be suffering from this syndrome".

1976 - FIRST REPORT OF PEDIATRIC OSA

WHAT IS OSAS?
A disorder of breathing during sleep, characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnea) that disrupts normal ventilation during sleep and normal sleep patterns.

WHAT IS A CAT?
A cat is a small, furry, domesticated carnivorous feline often kept indoor as a pet.
OSAS is one of several **Sleep-disordered breathing (SDB)**

The clinical spectrum of repetitive episodes of complete or partial obstruction of the airway during sleep ranging from snoring to apnea.

**IT'S ESSENTIAL TO DIFFERENTIATE ONE FROM THE OTHER!**
**Sleep-disordered breathing (SDB)**

- **Primary Snoring (PS)**
  noisy sleep w/o obstructive apnea, or frequent arousals from sleep, or gas exchange abnormalities.

- **Obstructive Hypoventilation Syndrome (OHS)**
  Persistent partial upper airway obstruction assoc. with gas exchange abnormalities, rather than discrete, cyclic apneas.

- **Upper Airway Resistance Syndrome (UARS)**
  Increasingly negative intrathoracic pressures during inspiration that lead to arousals and sleep fragmentation.

- **Obstructive sleep apnea (OSA)**
THE HALLMARK OF OSAS

Plus 3 more components:
Interruption hypoxia
Episodic hypercapnia
Sleep fragmentation

none pathognomonic as, for example, snoring without OSAS - which is more common, may lead also to sleep fragmentation

Hypopnoea: decreased airflow, i.e. episodes of shallow breathing during which airflow is decreased by at least 50%, usually accompanied by some degree of oxygen desaturation, which can be minor and transient

Apnoea: cessation of air flow
Physiologic recording methods differentiate 3 types

- **OBSTRUCTIVE APNEA/HYPOPNEA:**
  the individual makes respiratory efforts but no airflow occurs because of upper airway obstruction.

- **CENTRAL APNEA/HYPOPNEA:**
  an interruption in both airflow and breathing effort.

- **MIXED APNEA/HYPOPNOEAE:**
  has both central & obstructive components (e.g. an event beginning with a central apnea and followed immediately by one or more obstructed breaths.)
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Anatomic narrowing

Muscle weakness

Abnormal mechanical linkage between dilating muscles and airway walls

Abnormal neural regulation
The upper airway is a pliant tube whose sidewalls consist of muscle and other soft tissues.

During wakefulness, neural input to a number of small muscle groups in the pharynx maintains muscle tone and airway patency.

With sleep, an increased resistance to airflow normally accompanies muscular relaxation of these muscle groups. Most people compensate for these changes.

Individuals with certain anatomic problems will have repeated episodes of partial/complete upper airway obstruction when they sleep.
Obstruction may occur at one or more levels, including:

- the nasopharynx (area from the nose to the hard palate)
- the mouth
- the velopharynx (space behind the palate)
- the retroglossal region (area behind the tongue)
- the hypopharynx (region between the tongue base and larynx)
- the larynx
• **Infant larynx** is superior in neck, cone-shaped, narrowest at subglottic cricoid ring, softer & more pliable, may be gently flexed or rotated anteriorly
• **Epiglottis** is shorter and more angled over glottis
• **Vocal cords** are slanted, the anterior commissure is inferior and the vocal process is 50% of length
• **Infant tongue** is larger
- Prevalence of Paediatric OSAS: 1.2% (vs. adult 5.7%).
- Prevalence of snoring in children: ~10% (in infants 5%).
- Estimates of OSAS + snoring: 12%
- Age: most children 2-10 y, mean age 14 m. (coinciding with adenotonsillar lymphatic tissue growth).
- Gender: before puberty equal. After puberty M>F
- Environmental & Family history add risk, especially familial history of OSAS, snoring, allergies and exposure to environmental tobacco smoke.
- Prematurity adds risk.
- Socio-economic strata has its influence and adds risk
Prevalence is higher among Asian & Black children (up to 3.5X). This high frequency of OSAS exists also among adult Asian population, indicating the influence of anthropometric characteristics of the craniofacial structures as a racial predisposing factor. On the other hand Hispanic adults suffer also more than Whites from OSAS but among children, OSAS prevalence is equal.
PREDISPOSING FACTORS IN PEDIATRIC OSA

Children may suffer from more than one risk factor and the degree to which each factor will contribute will differ among patients.
In adults obesity is the most powerful risk factor for OSAS and essentially the only factor where intervention strategy has shown results.

Other "adult" risk factors are:
- Alcohol consumption
- Smoking
- Nasal congestion
- Estrogen depletion in Menopause
Obesity increases the risk for OSA X 4-5, mainly by the fatty infiltration of the pharyngeal soft tissues.

In the USA, in the last 30 years (1980-2010) obesity has doubled in children and tripled in adolescents. Children 6-11y from 7% to nearly 18% Adolesc. (12-19y) from 5% to 18%. 
OSAS

- Obesity
  - Alterations in Upper Airway Anatomy and Function, Lung Mechanics and mechanism and Ventilatory Control

- Sympathetic Discharge
  - Oxidative Stress

- Hypertension

- Insulin Resistance
  - The incidence of type 2 Diabetes Mellitus among OSAS patients is 30%

  - Impaired Glucose Tolerance
  - Dyslipidemia
  - Impaired Thrombolysis

- Atherosclerosis - End Organ disease

- Inflammation
2. Facial, oral, and throat eccentricities in congenital syndromes and diseases, including storage diseases

| Down synd. | Klippel-Feil synd. | Achondroplasia |
| Pierre Robin anomaly | Beckwith-Wiedemann | Laryngomalacia |
| Crouzon synd. | Apert synd. | MucoPSD |
| Treacher-Collins synd. | Prader Willi synd. | Congenital |
| Marfan synd. | Hallermann-Streiff | Hypothyroidism |

3. Neuromuscular diseases with abnormal muscle tone or muscular dysfunction in the pharyngeal constrictors:

- Achondroplasia
- Laryngomalacia
- MucoPSD
- Congenital Hypothyroidism

4. Other conditions with tendency towards OSAS due to reflux, near-aspiration and reasons yet unclear to Medicine:

- Oropharyngeal papillomatosis
- GER
- Sickle cell diseases
- CF
- Osteopetrosis
• Background & Overview
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HISTORY AND ANAMNESIS

OSAS is unlikely in the absence of snoring. Sleep history screening for snoring should be part of routine health care visits and if snoring history is elicited, the physician should obtain more detailed sleep history. The problem is that although anamnestic features suggestive of OSAS are typical and usually absent from those without OSAS, the accuracy of distinguishing OSAS from benign snoring is poor, even when the diagnostic interview is conducted by a sleep specialist, not exceeding a sensitivity/specificity of 50-60%.

Anamnesis is age related and should focus on the three main components

Sleeping  Breathing  The awaken child

Deepti Sinha & Christian Guilleminault
Indian J Med Res 131, Feb 2010 pp311-320

Anamnesis is age related
And should focus on the three main components
Sleep patterns: 
*Keeping a diary with bed and rise times, naps, can be very informative*

Unusual sleeping positions/postures (e.g. hyperextended neck)
Awakenings, restlessness, excessive sweating.

- Nightmares and night terrors *(OSAS is worse during REM sleep, which is associated with dreaming. Patients may recall dreams which include imagery about suffocation or drowning. OSAS may stand behind night terrors that occur in non REM sleep phases)*

Enuresis *is common among children with OSAS.*
*In addition patients with OSAS report frequent use of the bathroom at night (nocturia).*
Ask about breathing difficulties and/or abnormal breathing during sleep, including obvious nocturnal airway obstruction or apnea.

Snoring, audible intermittent gasps, heroic snorts, paradoxical chest and abdominal wall movements, labored breathing with retractions, cyanosis.
Morning symptoms:
- Difficulty getting up in the morning
- Morning headaches, complaints of dry mouth, grogginess, disorientation and an unrefreshed feeling.

Daytime bizarre behaviour/attention problems
- Fatigue, irritability, inattention, hyperactivity, aggressiveness & discipline problems, decreased attention span, emotional withdrawal.

Excessive daytime sleepiness (EDS) and hypersomnolence

Poor growth and weight gain

Daytime mouth breathing due to ademotonsillar hypertrophy
Physical Examination

Vital signs:
BP, height, weight, BMI

Face:
- Craniofacial anomalies
- Midfacial hypoplasia
- Flat nasal bridge
- Facial asymmetry
- Adenoid face

Jaw
- Size (micrognathia)
- Position (retrognathia)

Nose
- Signs of allergic rhinitis
- Nasal polyps/growths
- Septal deviation

Mouth:
- Size of tongue
- Soft and hard palate
- Dentition
- Uvula
- Size, shape & position of tonsils

Voice
- Weakness or hoarseness
  (as sign of vocal cord problems)

Neck
- Masses, jugular venous distention

Chest and back
- Pectus Excavatum & narrow chests
- Severe scoliosis

Tonsil size is graded from 0 to 4.
Size 0 denotes surgically removed
Size 1 - tonsils hidden within pillars
Size 2 - tonsils extending to pillars
Size 3 - tonsils beyond pillars
Size 4 - extending to midline.
• Polysomnogram (PSG)
• Polysomnogram (PSG)

- Should be performed without sedation/sleep deprivation
- In a child-friendly environment
- By personnel trained in recording/scoring pediatric PSG's
- Should be interpreted by physicians with expertise in pediatric sleep medicine as children have (compared with adults):
  - more obstructive hypoventilation
  - fewer obstructive apneas
  - desaturation with shorter events
  - higher respiratory rate
  - lower functional residual capacity
  - smaller oxygen store


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PEDIATRIC POLYSOMNOGRAPHY
PSG PARAMETERS

No universally accepted PSG normal reference values

- **Apnea**: Pause in respiration lasting more than two breaths (vs. at least 10 seconds in adults).
- **Hypopnea**: Reduction of airflow by 50% for 2 respiratory cycles accompanied by reduction of saturation by 3% or arousal from sleep.
- **AHI**: Sum of Apneas and Hypopneas per hour of sleep.
  - AHI >1.5 or >1/hour is most often used to identify children up to 12 years with OSA.
- **RDI**: Sum of Apneas, Hypopneas, and respiratory event-related arousals per hour of sleep.
- **Oxygen saturation**: <91% or change in nadir O2 from baseline >9%
- **Maximal ETCO2**: >54
## Pediatric OSA - Severity

<table>
<thead>
<tr>
<th>Severity</th>
<th>AHI</th>
<th>SpO2 Nadir%</th>
<th>Peak ETCO2</th>
<th>PEAK ETCO2 &gt; 50 Torr % TST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>1-4</td>
<td>86-91</td>
<td>&gt;53 torr</td>
<td>10-24</td>
</tr>
<tr>
<td>Moderate</td>
<td>5-10</td>
<td>76-85</td>
<td>&gt;60 torr</td>
<td>25-49</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;10</td>
<td>&lt;75</td>
<td>&gt;65 torr</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>
• Polysomnogram (PSG)

• Home Oximetry Testing

• Imaging

• Audio taping/Video taping

• Abbreviated (Nap) Polysomnography
Home Oximetry Testing

Readily available
Relatively inexpensive
Excellent positive predictive value - 97%*

BUT

Poor negative predictive value - 47%*
Subject to presence of significant artifact
(reduction maybe accomplished by simultaneous heart rate measurement and Pletysmography waveform)

Disorders with predominant sleep disruption and hypercapnia will be missed.

*Brouillette RT et al. Pediatrics 2000
- Polysomnogram (PSG)
- Home Oximetry Testing
- Imaging
- Audio taping/Video taping
- Abbreviated (Nap) Polysomnography
Decisions regarding diagnosis and treatment of apnoea due to adenotonsillar hypertrophy should not rely on the roentgen degree of obstruction but on good observation of sleep situations.

Michael Friedman

MRI

Advantages

Excellent soft tissue anatomy
Multiple planes
No ionizing radiation
Beautiful pictures

Disadvantages: Cost, age and weight limitations, need to sedate, noise, claustrophobia, Not practical

The Frequency of Lingual Tonsil Enlargement in Obese Children

“Overlap Region” adenoid/tonsils/and soft palate overlap

Arens et al. AJRCCM 2003
• Polysomnogram (PSG)

• Home Oximetry Testing

• Imaging

• Audio taping/Video taping

• Abbreviated (Nap) Polysomnography
Audio and video taping at home have been studied as alternatives. Audio taping has been shown to have up to 75% predictive value and video taping up to 83%. However, these studies will detect those with significant apnoea but will not detect hypopnoea or flow limitation. Furthermore, discrepancies from different centers make this method unreliable.

- Polysomnogram (PSG)
- Home Oximetry Testing
- Imaging
- Audio taping/Video taping
- Abbreviated (Nap) Polysomnography
Child may not achieve natural sleep and then REM sleep may not be captured.

Severity may be underestimated - Events usually worsens as the sleep progress.

Excellent positive predictive value - 77-100%*
Poor negative predictive value - 17-49%*

Useful if results are positive.
False positive results in patients with coexistent medical problems (obesity, asthma).

ANY CHILD WITH AHI > 5 NEEDS INTERVENTION

ADENOTONSILLECTOMY IS THE FIRST LINE OF THERAPY

- Other surgical treatments only in specific cases
  - Turbinate reduction
  - Craniofacial surgery
  - Mandibular advancement (e.g. in Pierre Robin)
  - Lefort osteotomies and maxillary distraction.
  - Uvulopalatopharyngoplasty- Not a good idea in children
  - Tracheostomy
Presence of additional risk factors is not a contraindication to adenotonsillectomy.

There is no clinical relation between the size of tonsils and adenoids and the presence of OSAS and degree of OSAS.

Tonsillectomy is not curative in all cases of OSAS but "cures" 60-70% of children with significant tonsillar hypertrophy.

In 25% there will remain some residual OSA.

Among obese patients tonsillectomy is effective in only 10-25% of them.

Re-assessment of high risk groups with post-operative polysomnography is recommended.

Efficacy data for partial tonsillectomy are limited despite multiple studies showing reduced postoperative bleeding and recovery time.

1. Age Younger than 3 years
2. Severe OSAS on PSG, AHI>10
3. Pulmonary hypertension
4. Congenital heart disease
5. FTT
6. Prematurity, CLD.
7. Recent URI
8. Morbid Obesity
9. Trisomy 21
10. Craniofacial abnormalities
11. Neuromuscular disorders, CP
12. Asthma
Medical treatments

- Weight loss or Bariatric Surgery

- The child should be finished growing (usually 13-15y).
- Parents and patient must understand and be willing to follow many changes in lifestyle they will all need to make after surgery.
- The teen has not been able to lose weight while on a diet and exercise program for at least 6 months, while under the care of a physician.
- The teen has not used any illegal substances (alcohol or drugs) during the 12 months before surgery.
Medical treatments

- Weight loss or Bariatric Surgery
- Continuous positive airway pressure
Almost always may be an alternative to surgery especially in non-surgical candidates or after surgical failure, but also in patients with Morbid Obesity and Complex OSA.

Has a local and systemic anti-inflammatory effect, acts as a pneumatic splint, stimulates ventilation and reduces activity of inspiratory, upper airway muscles and diaphragm.

Restores sleep, promotes weight loss

Improves cardiac function, Suppresses GERD

Decreases AHR

FDA has approved it for children > 30 kg

Main problems:

- Difficulty wearing
- Skin breakdown
- Nasal congestion
- Midface hypoplasia
- Compliance (patients must understand they need to use their machines every night and each time they nap).
Medical treatments

– Intranasal steroids (modest effects)
Medical treatments

Montelukast for Children With Obstructive Sleep Apnea: A Double-blind, Placebo-Controlled Study
Aviv D. Goldbart, Sari Greenberg-Dotan and Asher Tal
*Pediatrics*; originally published online August 6, 2012;
DOI: 10.1542/peds.2012-0310

- Leukotriene antagonist (for mild cases)

**ClinicalTrials.gov**
A service of the U.S. National Institutes of Health

**Effect of Montelukast Therapy in Obstructive Sleep Apnea (OSA) Children (32543)**

This study is currently recruiting participants.
Verified September 2011 by University of Chicago

Sponsor:
University of Chicago

Collaborator:
Merck

Information provided by (Responsible Party):
Leila Gozal, University of Chicago

ClinicalTrials.gov Identifier:
NCT01027806
First received: December 7, 2009
Last updated: September 17, 2011
Last verified: September 2011
History of Changes
Medical treatments

- Weight loss or Bariatric Surgery
- Continuous positive airway pressure
- Intranasal steroids
- Leukotriene antagonist (for mild cases)
- Oral appliances
- Positional therapy
- Snore aids
Screening for OSAS
As part of routine health maintenance visits, clinicians should inquire about snoring. If in the affirmative or if a child/adolescent presents with signs or symptoms of OSAS a more focused evaluation should be performed.

Polysomnography
A snoring child/adolescent or one having classical complaints/findings should either obtain a PSG or be referred to a sleep specialist/ENT for extensive evaluation.

Alternative Testing
If PSG is not available, clinicians may order alternative diagnostic tests, (e.g., nocturnal video recording, nocturnal oximetry, nap PSG or ambulatory PSG.

Adenotonsillectomy
A child with OSAS and adenotonsillar hypertrophy, and no contraindication to surgery, should be recommended adenotonsillectomy as the first line of treatment. If the child has OSAS but does not have adenotonsillar hypertrophy, other treatment should be considered. Clinical judgment is required to determine the benefits of adenotonsillectomy compared with other treatments in obese children with varying degrees of adenotonsillar hypertrophy. High-Risk Patients Undergoing Adenotonsillectomy should be monitored as inpatients postoperatively.
**Reevaluation**
Clinicians should reassess all patients with OSAS for persisting signs and symptoms after therapy to determine whether further treatment is required.

**Reevaluation of High-Risk Patients**
Clinicians should reevaluate high risk patients for persistent OSAS after adenotonsillectomy, including those who had a significantly abnormal baseline PSG, have sequelae of OSAS, are obese, or remain symptomatic after treatment, with an objective test or refer such patients to a sleep specialist.

**CPAP**
If symptoms/signs or objective evidence of OSAS persists after adenotonsillectomy or if adenotonsillectomy is not performed clinicians should refer patients for CPAP management.

**Weight Loss**
Clinicians should recommend weight loss in addition to other therapy if a child/adolescent with OSAS is overweight or obese.

**Intranasal Corticosteroids**
Clinicians may prescribe topical intranasal corticosteroids for children with mild OSAS in whom adenotonsillectomy is contraindicated or for children with mild postoperative OSAS.
Clinicians and Primary Caretakers should educate families of high risk children and adolescents for OSAS (e.g. obese, atopic, with hypertrophic tonsils and adenoids) about nutrition and weight loss, including basic weight loss information and support, an appropriate program of diet and exercise and, if needed, referral to a pediatric weight loss program.

Avoidance of alcohol and depressant recreational drugs is of outmost importance to risk children as they may worsen sleep apnea.

Extra caution and precaution should be taken during any medical or dental procedures requiring conscious sedation as children with OSAS may have serious respiratory embarrassment when given any sedative medication.

Three further recommendation by SB (that in my humble opinion the AAP should have mentioned)
Children with sleep disturbances or snoring

Look for signs and symptoms of OSAS

Nocturnal

• Labored breathing
• Observed Apnea
• Nocturnal sweating
• Restless sleep
• Secondary Enuresis

Diurnal

• Hyperactivity
• Daytime sleepiness
• Poor attention
• Morning headaches
• Morning oral symptoms
• Growth (Obesity, overweight, FTT)

• Oropharyngeal (Tonsils, teeth, mouth breathing, hyponasal speech, high arched palate, micrognathia, macroglossia, adenoidal facies)
• Atopy (allergic rhinitis, eczema)
• Cardiorespiratory symptoms

Absent

Look for other causes

• Use sleep log
• Enquire about sleep environment
• Enquire about medicines
• Consider other sleep disturbances (e.g. parasomnias, circadian rhythm sleep disorders, psychiatry disorders, narcolepsy, etc.)

Phys. Exam

Symptoms Present

Related to other disorders?

Craniofacial syndromes

Genetic /Chromosomal syndromes? (e.g. Down)

Neuromuscular disorders? CP?

Cardiorespiratory?

Chronic lung? Sickle Cell Anemia?

Central hypoventilation syndrome?

Yes

no

Evaluate for OSAS (PSG)

Taking into consideration the three main aetiologies

Tonsillar
Adenoidal Hypertrophy
Obesity
Nasal obstruction (usually due to allergic rhinitis)

Refer to the appropriate specialist

SUMMARY
Tonsillar Adenoidal Hypertrophy
Obesity
Nasal obstruction (usually due to allergic rhinitis)

Refer to the appropriate specialist

Weight loss
Bariatric Surgery
CPAP for Obese Teenagers?
Surgical Repair
Allergic Rx
Surgical Rx

תודה רבה

Thank You
Merci
Merci villmahl
Spasibo
Varah bodah shukriyyaa
Nagyon kôszônóm
Grazie
Gracias
Terima Kasih
Thank You
Terima kasih banyak-banyak
Néá'eshe
Gratia
ARIGATO
SHUKRIYA
GRACIAS
ACHIU
Shukran
Kora doshi
Toda
Obrigado
Tapadh leat

Danke schön
Ngiyabonga
Kininâskomitinaawu
Asante
Ngiyabonga

谢谢