OSA

Definition:

Disorder of breathing during sleep characterized by recurrent complete obstruction (apnea) or partial obstruction (hypopnea) with disruption of normal oxygenation, ventilation, and sleep patterns.

- *OSA is at the end of the **spectrum of pediatric obstructive sleep-disordered Breathing**:*

Primary snoring	Habitual snoring >3 nights per week *without* apneas, hypopneas, frequent arousals, or gas exchange abnormalities (prevalence, 7.45%)
Upper airway resistance syndrome	Snoring, increased work of breathing, and frequent arousals *without* recognizable obstructive events or gas-exchange abnormalities
Obstructive hypoventilation	Snoring plus elevated end-expiratory carbon dioxide partial pressure in the absence of recognizable obstructive events
OSA syndrome	Recurrent events of partial complete upper airway obstruction (hypopneas, obstructive or mixed apneas) with disruption of normal oxygenation, ventilation, and sleep patterns (prevalence, 1%–5%)

OSA=obstructive sleep apnea.
Courtesy of Catherine Kier, MD, FAAP, FCCP, DABSM, AE-C, of Stony Brook Children's Hospital.

Prevalence: 1-5% of children and adolescents have evidence of OSA.

Symptoms:

Nightly snoring (often with intermittent pauses, snorts, or gasps) and disturbed sleep.

Complications:

- Neurocognitive complications: Decline in school performance, poor concentration.
- Cardiovascular: HTN, pulmonary HTN, core pulmonale.
- Neurological: Morning headache.
- Growth failure.
- Metabolic: Metabolic syndrome, T2DM, insulin resistance, obesity.
- Nocturnal enuresis.

Risk factors:

- Adenotonsillar hypertrophy (MOST COMMON).
- Obesity.
- Craniofacial abnormalities (e.g., midface hypoplasia, nasal deformities, micro/retrognathia, glosoptosis, macroglossia).
- Neuromuscular disorder (e.g., hypotonia).
- Allergic rhinitis.
- Positive FHx.
- H/O prematurity.

Diagnosis:

History and P/E:

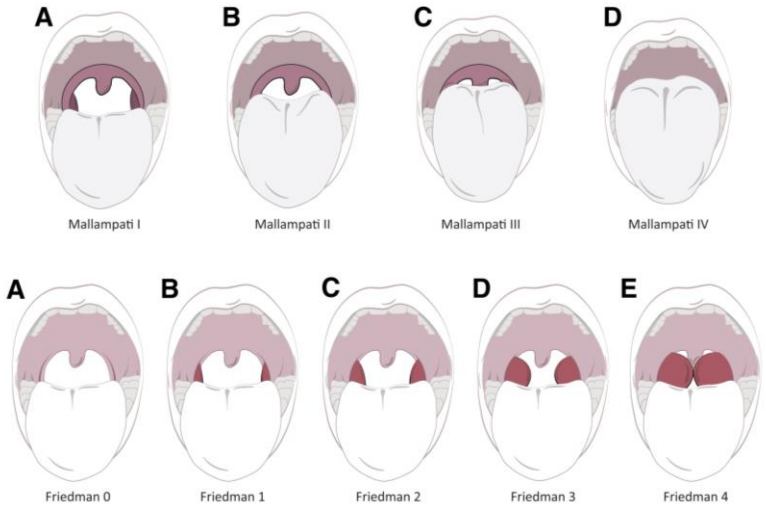
History:

- AAP recommends screening all children and adolescents for snoring (OSA is very unlikely in the absence of nightly snoring).
- History should focus on daytime and night-time symptoms:
    - **Nighttime symptoms:** Snoring, pauses in breathing, arousals, increased WOB, cyanosis, gasping, paradoxical breathing, nocturnal diaphoresis, and nocturnal enuresis.
    - **Daytime symptoms:** Daytime sleepiness (frequent napping), fatigue, behavior/learning problems (including attention-deficit/hyperactivity symptoms), poor ability to concentrate and morning headache.
- Obtain history about risk factors for OSA (e.g., symptoms of adenotonsillar hypertrophy like mouth breathing when sleep, obesity, FHx of OSA, prematurity, allergic rhinitis, hypotonia).

P/E:

- P/E should focus on the risk factors and complications of OSA.
    - There may be findings related to adenotonsillar hypertrophy (refer to the **Mallampati score and Friedman tonsil scale**), craniofacial deformities, neuromuscular disorder, and allergic rhinitis.
    - Evidence of complications of OSAS may be present (e.g., HTN, an increased pulmonic component of S2 sound indicating pulmonary HTN, and poor growth (although conversely, some children with OSAS are obese).

Mallampati score and Friedman tonsil scale



The Mallampati score, although principally intended to help estimate the relative difficulty of intubation in preoperative patients, is also useful in assessing the contribution of the upper airway anatomy to obstructive sleep breathing. The Friedman tonsil scale is useful for describing the size of tonsils in children, with a score of 0 representing surgically removed tonsils and a score of 4 describing large tonsils that meet at the midline.

Nocturnal Polysomnography:

- **Gold standard** investigation.
- Can be performed satisfactorily in children of **any age**, providing that appropriate equipment and trained staff are used.
- Pediatric studies should be scored and interpreted using **age-appropriate criteria** as outlined in the American Thoracic Society consensus statement on pediatric polysomnography (refer to the diagnostic criteria for OSA below).
- To have reliable data:
    - The patient should have at **least 5 hr of sleep** during the study.
    - **Supine index** should be optimal (decreased supine index may underestimate the AHI as OSA tends to worsen with supine positioning).
- Pros:
    - Can confirm the diagnosis of OSA.
    - Can distinguish OSA from other conditions in the spectrum of pediatric obstructive sleep-disordered beathing.
    - Can objectively determine the severity of OSA based on the AHI and nadir of O2 desaturation (refer to classification of sleep apnea severity in children based on the AHI below).
    - Can help determine the risk of postoperative complications (refer to the risk factors for postoperative complications below).
    - Can help diagnose RLS by looking at PLM index and the arousal index resulting from them:
        - Mild: PLM index 5-25/hr.
        - Moderate: PLM index 26-50/hr.
        - Severe: PLM > 50/hr or PLM arousal index > 25/hr.
- Cons:
    - No clear correlation between polysomnographic parameters and adverse outcomes in children with OSA.
    - There is a shortage of facilities that perform pediatric polysomnography and specialists who can perform and interpret the study.

Diagnostic Criteria for OSA

A. The presence of ≥1 of the following:	1. Snoring 2. Labored, paradoxical, or obstructed breathing during the child's sleep 3. Sleepiness, hyperactivity, behavioral problems, or learning problems
B. Polysomnography demonstrates 1 or both of the following:	1. One or more obstructive apneas, mixed apneas, or hypopneas per hour of sleep *OR* 2. A pattern of obstructive hypoventilation, defined as ≥25% of total sleep time with hypercapnia ($PaCO_2$ > 50 mm Hg) in association with ≥1 of the following: snoring, flattening of the inspiratory pressure waveform, or paradoxical thoracoabdominal motion

Criteria A and B must be met.
Reprinted with permission from The International Classification of Sleep Disorders. *3rd ed.*

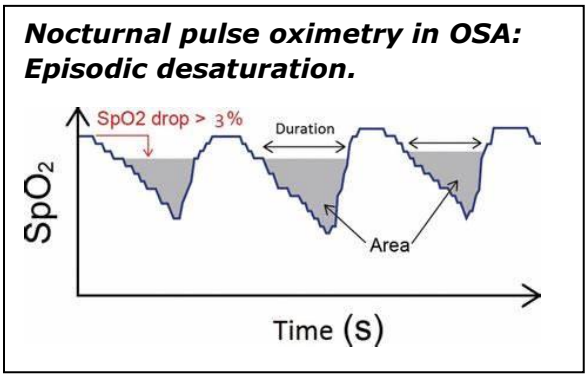
Classification of Sleep Apnea Severity in Children Based on the AHI

	AHI, NO. OF EVENTS PER HOUR	
SEVERITY	PEDIATRIC	ADULT
Normal	≤1	≤5
Mild	1 to ≤5	5 to ≥15
Moderate	>5 to ≤10	>15 to ≤30
Severe	>10	>30

AHI=apnea-hypopnea index.
Adapted with permission from Dehlink E, Tan H-L. Update on paediatric obstructive sleep apnoea. J Thorac Dis. *2016;8(2):224–235.*

Nocturnal pulse oximetry:

- Pros:
  - Can be diagnostic if results are positive in the presence of symptoms.
  - Widely available and easily accessible.
- Cons:
  - Have a poor predictive value if results are negative. Thus, children with negative study results should undergo a more comprehensive evaluation.
  - The cost efficacy of these screening techniques is unclear and would depend, in part, on how many patients eventually required full polysomnography.
  - Cannot reliably quantify the severity of OSA; if positive, nocturnal polysomnography has to be done to quantify severity.
  - Cannot differentiate the causes of desaturations (e.g., OSA, CSA or mixed SA).



Morning gas:

- Helps determine Co2 retention that occurs with OSA.

Lateral neck X-ray:

- One of the methods to diagnose adeno-tonsillar hypertrophy (best method to diagnose tonsillar hypertrophy is P/E and adenohypertrophy is a scope by ENT).
- In the context of typical symptoms of OSA and OSA sequalae with evidence of adeno-tonsillar hypertrophy, a formal diagnosis via a sleep study may not be necessary.

Treatment:

<u>Lifestyle and diet modification:</u>

- Weight loss in children/adolescents with overweight/obesity through lifestyle and diet modification can improve OSA (common to see improvement in AHI with 5-10% weight loss).
- Clinicians should recommend weight loss in addition to other therapy if a child/adolescent with OSAS is overweight or obese.
- The aid of a *nutritionist* can be particularly helpful in these cases.
- Better sleep quality by optimizing OSA control could help patients lose weight.

Non-invasive PAP:

CPAP:

- Delivers a single set pressure (EPAP – also called PEEP or CPAP pressure).
- Pressure is optimally set during a CPAP titration study in the sleep laboratory, wherein pressure is gradually up titrated until resolution of the apneic or hypopneic events is observed in real-time.
- High CPAP pressure during expiration may not be tolerated; modern CPAP devices may be equipped with an expiratory pressure release mode, which emulates Bi-level by dropping the CPAP pressure by some amount (typically 2–3 cmH2O) during exhalation.
- Indications: If symptoms/signs or objective evidence of OSAS persists after adenotonsillectomy or if adenotonsillectomy is not performed.

BPAP:

- Provides different inspiratory and expiratory airway pressures (EPAP and IPAP), which may be better tolerated in patients because the lower EPAP permits easier exhalation.
- Indications: Chronic respiratory failure, CSA, and failure of CPAP to treat OSA.

COMFORT MEASURES:

- Mask fitting: Good mask fit is crucial to delivering appropriate pressures and preventing leak thus improving long-term patient adherence (as leak may be bothersome to the patient).
- The use of a "ramp" with modern PAP units: A pressure ramp instructs the CPAP or Bi-level unit to slowly increase pressure over time so that the patient does not experience the full force of the PAP device until they are fully asleep.

ADHERENCE:

- Non-adherence to PAP is a common problem in both pediatric and adolescent patients.
- Diagnosis: Objective monitoring of adherence, by using the equipment software, is important.
- Management:
    - Optimizing comfort measures.
    - Behavioral therapy: May be beneficial in acclimating patients to the mask in young children and in fostering long-term adherence.

Pharmacological treatment:

- **Nasal corticosteroids:**
    - May have some benefit in OSA in which tissue inflammation (particularly of the adenoid tissue) contributes to the obstruction.
    - Indicated for children with mild OSA in whom adenotonsillectomy is contraindicated or for children with mild postoperative OSA.
    - Duration: 3 months and then R/A.

- **Montelukast (leukotriene receptor antagonist):**
    - May have some benefit in OSA in which tissue inflammation (particularly of the adenoid tissue) contributes to the obstruction.
    - Nasal corticosteroids combined with montelukast may be more beneficial for moderate OSA.
    - Duration: 3 months and then R/A.

Surgical treatment:

Adenotonsillectomy:

- First-line treatment in the management of OSA in children with adenotonsillar hypertrophy.

- Indications of adenotonsillectomy:
  - Recurrent tonsillitis:
    - Frequency criteria:
      - 7 episodes in the past year.
      - 5 episodes per year for the past 2 years.
      - 3 episodes per year for the past 3 years.
  - Recurrent peritonsillar abscess or with significant UAO.
  - PFAPA who failed conservative management.
  - OSA (AHI > 5/hr) in a child ≥ 2 years with tonsillar hypertrophy.
  - Suspected malignancy.
  - Hemorrhagic tonsillitis.

- Contraindications for adenotonsillectomy:

Absolute contraindications
- No adenotonsillar tissue (tissue has been surgically removed)

Relative contraindications
- Very small tonsils/adenoid
- Morbid obesity and small tonsils/adenoid
- Bleeding disorder refractory to treatment
- Submucus cleft palate
- Other medical conditions making patient medically unstable for surgery

- Risks of adenotonsillectomy:

Minor
- Pain
- Dehydration attributable to postoperative nausea/vomiting and poor oral intake

Major
- Anesthetic complications
- Acute upper airway obstruction during induction or emergence from anesthesia
- Postoperative respiratory compromise
- Hemorrhage
- Velopharyngeal incompetence
- Nasopharyngeal stenosis
- Death

- Risk Factors for postoperative respiratory complications in children with OSAS undergoing adenotonsillectomy:

- Younger than 3 y of age
- Severe OSAS on polysomnography[a]
- Cardiac complications of OSAS
- Failure to thrive
- Obesity
- Craniofacial anomalies[b]
- Neuromuscular disorders[b]
- Current respiratory infection

Patients may benefit from inpatient observation post-op.

- Re-accumulation of adenoid tissue: 1.3% to 26% of patients (may require subsequent surgical revision).

- Clinical re-evaluation: Indicated 6-8 weeks post-op for symptoms/signs of OSA.

- Indications for repeating PSG after adenotonsillectomy (often 3-6 months post-op):
  - Children with severe OSA before AT.
  - Children with sequelae of OSAS.
  - Children with persistent comorbid obesity.
  - Children who remain symptomatic after AT.

Tracheostomy:

- Principally indicated in cases in which a patient is failing to thrive/having complications from OSA or has otherwise been exceptionally refractory to less intensive OSA therapy.
- Tracheostomy may be helpful in cases of severe craniofacial abnormalities or neuromuscular issues.

Mandibular distraction:

- Indicated in craniofacial anomalies (i.e., retrognathia or micrognathia), causing OSA, when other interventions have failed.
- **Procedure:** Surgical separation of the mandible is paired with an implanted mechanical distraction device, which permits the controlled separation of opposing bone at a rate that promotes bone remodeling and, thus, gradual extension of the mandible, resulting in a lengthening of the lower jaw and that yields less crowding of the tongue and associated soft tissue in the oropharynx.

Tongue debulking:

- Occasionally used in patients with significant macroglossia related to syndromes such as Beckwith-Wiedemann syndrome and trisomy 21; however, this procedure is avoided when possible due to the highly vascular nature of the tongue base and the potential for surgical complication.

<u>Positioning therapy:</u>

- OSA tends to be worse when the patient is sleeping in the supine position.
- Several techniques and devices are available to decrease the time in which the child sleeps in the supine position.

References:

- *AAP CLINICAL PRACTICE GUIDELINE: Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome. Carole L. Marcus, et al. 2012.*
- *Sleep-Disordered Breathing in Children. Kevin Gipson, Mengdi Lu and T. Bernard Kinane. Pediatrics in Review 2019;40;3. DOI: 10.1542/pir.2018-0142.*