Conflict of Interest

I do not have any conflict of interest to report

Goals

1. To identify specific neurologic and genetic conditions that place pediatric patients at risk of sleep disorders

1. To review the main polysomnographic features in these conditions
Facts about Pediatric OSA

- Prevalence: 2-3%
- Peak incidence in pre-school age
- Girls = Boys
- Variable symptoms
  - Night time: snoring, restless sleep, position changes
  - Daytime sleepiness, hyperactivity, inattention
- Variable site of UAR: tonsils, nasal septum, etc

Anatomical features which may predispose to OSA

High Arched Palate
Airway Collapse

Adenotonsillar hypertrophy
Nasal obstruction
Macroglossia
Maxillary constriction
Fat Distribution

Conditions at high Risk For OSA

- Craniofacial syndromes
- Chromosomal Anomalies
- Neuromuscular Disorders
- Storage Disorder
- Achondroplasia
- Cerebral palsy

Craniofacial Syndromes
Midface hypoplasia

Midface Hypoplasia

Obstructive sleep apnea in children with syndromic craniosynostosis: long-term respiratory outcome of midface advancement

Craniosynostosis

- Crouzon, Apert, Pfeiffer Syndrome
- Fibroblast growth factor receptor (FGFR-2)
- Chromosome 10q25-q26
- All autosomal dominant
- New mutation

- OSA prevalence from 24-88%
- NO CSA
- May present with Laryngomalacia or tracheomalacia

After surgery
Micrognathia


Nasopharyngeal airway

Goldenhar Syndrome

Goldenhar syndrome: a cause of secondary immunodeficiency? De Golovine et al. Allergy, Asthma & Clinical Immunology 2012, 8:10

- Oculoauriculovertebral syndrome
- Asymmetric hypoplasia of the mandible and malar bones
- Lung agenesis
Maxillary Hypoplasia
Smith Magenis Syndrome

- Inverted endogenous melatonin pattern in virtually all cases (96%)
- Reduced total sleep time (<7hr) in 55.6% (20/36)
- Frequent night time awakenings in 86% (31/36)


Down’s Syndrome

1. Macroglossia
2. Maxillary hypoplasia
3. Hypotonia
4. Prevalence of OSA: 31-100%

1. prolonged SL
2. reduction in REM
3. increased sleep fragmentation
Failure after T&A

- 74% Macroglossia
- 63% glossoptosis
- 63% adenoidal regrowth
- 30% enlarged lingual tonsils
- 22% hypopharyngeal collapse

Fragile X

- Most common inherited cause of Mental Retardation
- 30% meet criteria for autism
- Insomnia
- Circadian Misalignment

Fragile X is the most common inherited cause of mental retardation, with 30% of individuals meeting criteria for autism. Additional symptoms include insomnia and circadian misalignment.
1. Increase in N3
2. Decreased REM
3. Increased first REM latency
4. Decreased total sleep
5. No consensus on Risk of apnea

Achondroplasia

- Macrocephaly
- Frontal bossing
- Short stature
- Rhizomelia
- Midface hypoplasia
- Large fontanelles
- Hypotonia
- Thoracolumbar kyphosis
- Foramen magnum stenosis

A Three-Month-Old Achondroplastic Baby with both Obstructive Apneas and Central Apneas
Prader Willi

- Hypotonia
- Decreased spontaneous arousal
- Hyperphagia (hypothalamic dysfunction)
- Short stature (growth hormone deficiency)

Prader Willi Syndrome, Volume 14 | Number 1 | January 2012 | Genetics in medicine

Prader Willi

- Central Hypersomnia
  - Sleep Onset REM
  - No other symptoms of narcolepsy
  - EDS
- Risks for sleep disordered breathing:
  - Obesity
  - Kyphoscoliosis
  - Hypotonia
  - Impaired ventilatory control
• Central apnea
• Hypoventilation
• Decreased arousal response to hypoxia/hypercapnia


Chiari Malformation
Chiari-Malformation

- 60% SDB
- 58% obstructive
- 17% Central
- Causes
  - Mechanical compression of the medulla
  - Muscle weakness
  - Obstructive hydrocephalus

Spina Bifida

Table 1: Identified cause of death in patients with myelomeningocele reported to the spina bifida charity (total number of deaths: N = 800)

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>No of patients (%)</th>
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<tbody>
<tr>
<td>Sleep-disordered breathing</td>
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<td>Respiratory failure</td>
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<td>Medical complications</td>
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<td>Tracheotomy</td>
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<td>Death</td>
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<td>Obstructive complications</td>
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<td>Respiratory arrest</td>
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<td>Fluid loss</td>
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<td>Sepsis</td>
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<tr>
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Sleep-disordered breathing in patients with myelomeningocele: the missed diagnosis, Developmental Medicine & Child Neurology 1999, 41: 40–43
Spina Bifida

1. Walters et al found Mild OSA in 42%
2. Moderate-severe in 20%
3. May have CSA
4. May have hypoventilation
5. Restrictive Pulmonary Disease
6. Decreased muscle tone
7. Intrinsic pharyngeal

Cerebral Palsy

- Interrupted Sleep (multifactorial)
- Daytime Sleepiness
- Sleep Disordered breathing
Traumatic Brain Injury

13 y/o MVA a year ago.

- All patients with a history of whip-lash had sleep-disordered breathing
- Pain and neurologic sequelae disrupted sleep and led to a decrease in total nocturnal sleep
- Mechanism postulated: direct damage to CNS sleep/awake regulatory centers.
- No correlation with Hypocretin levels
- Circadian misalignment if SCN affected.
- Medications: Anticonvulsants, muscle relaxants
### Seizure Disorders

**Symptom**

- Increased sleep fragmentation
- Daytime sleepiness
- Higher BMI
- Dec TST, Dec REM

**Cause**

- Seizure frequency
- Anti-epileptic medication
- SDB (up to 63%)
- PLMS
- CSA

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### Higher Risk of OSA

1. Male Gender
2. Older age
3. Late age of epilepsy onset
4. High BMI
5. Excessive Daytime Sleepiness
6. Comorbid Neurologic conditions (Angelman syndrome, Rett Syndrome)

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### Angelman Syndrome

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</table>

*K. Pelc et al. / Sleep Medicine 9 (2008) 434–441*
**TT syndrome**

- Nocturnal laughter
- Bruxism
- Increased awakenings
- No increased SDB reported. Breathing disturbances occur during awake.  
  - 67% hyperventilation with central apnea and desaturations.

**CSA**

- Partial Seizures can spread to brain stem
- Generalized tonic can cause diaphragmatic and glottic spasm
- Ventilatory instability
- CO2 wash out after hyperventilation
- Sympathetic instability (tachycardia)
- SUDEP more common in sleep, young and uncontrolled seizures.

**Effects of Seizure Tx**

- Worsen OSA: VNS, Benzodiazepines, valproic acid (obesity)
- Insomnia: Lamotrigine, Etosuximide, tiagabin, Zonisamide
- EDS: carbamazepine, gabapentin, levetiracetam, phenobarbital, phenytoin, topiramate, valproate, vigabatrin
Neuromuscular Disorders

Acid Maltase deficiency:
Accumulation of glycogen in lysosomal vacuoles (skeletal, cardiac, liver, nervous system)

POMPE:
Hypotonia
Respiratory failure by 1 year

Myotonic Dystrophy

Daytime Sleepiness and REM Sleep Characteristics in Myotonic Dystrophy: A Case-Control Study SLEEP, Vol. 34, No. 2, 2011 Huan Yu, MD, PhD et al.

Daytime Sleepiness and REM Sleep Characteristics in Myotonic Dystrophy: A Case-Control Study SLEEP, Vol. 34, No. 2, 2011 Huan Yu, MD, PhD et al.
Myotonic Dystrophy

Higher frequency of:
• daytime sleepiness and fatigue
• apnea index
• SOREMPs
• REM sleep
• REM density
• PLMW
• PLMS.

Respiratory Indications for Polysomnography in Children

Practice Parameters for the Respiratory Indications for Polysomnography in Children

- PSG is indicated when the clinical assessment suggests the diagnosis of obstructive sleep apnea syndrome (OSAS) in children. (Standard)
- PSG is indicated following adenotonsillectomy to assess for residual OSAS in children with preoperative evidence for moderate to severe OSAS, obesity, craniofacial anomalies that obstruct the upper airway, and neurologic disorders (e.g., Down syndrome, Prader-Willi syndrome, and myelomeningocele). (Standard)
- PSG is indicated when the clinical assessment suggests the diagnosis of congenital central alveolar hypoventilation syndrome or sleep related hypoventilation due to neuromuscular disorders or chest wall deformities. It is indicated in selected cases of primary sleep apnea of infancy. (Guideline)
- Children treated with mechanical ventilation may benefit from periodic evaluation with PSG to adjust ventilator settings. (Option)
- Children treated with tracheostomy for sleep related breathing disorders benefit from PSG as part of the evaluation prior to decannulation. These children should be followed clinically after decannulation to assess for recurrence of symptoms of sleep related breathing disorders. (Option)
### Summary

- Midface hypoplasia: Crouzon, Apert, Pfeiffer
- Micrognathia: Treacher Collins, Pierre Robin and Goldenhar
- Smith Magenis: Reverse Melatonin, maxillary hypoplasia
- Achondroplasia: CSA and OSA, foramen magnum stenosis
- Chiari Malformation and spina bifida: CSA, OSA and hypoventilation

### Summary

- Neuromuscular Conditions: hypotonia, muscle weakness, hypoventilation
- Hypersomnia: Prader Willi, Traumatic Brain Injury
- Seizure disorder: multifactorial sleep disturbances. (Angelman and Rett syndrome)
- Down syndrome Increased OSA

### Questions