Perioperative Upper Airway Considerations in Pediatric Obstructive Sleep Apnea

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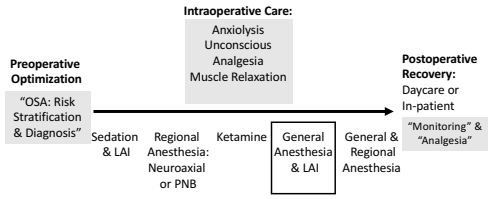
Conflict of Interest

- None to declare

OBJECTIVES
At the end of this session audience members will be able to:

- Understand how OSA related upper **airway structure, function and related pathophysiology** impact anesthetic management in children.
- List **key limitations** of published pediatric OSA associated **management guidelines**.
- Appreciate a **role for anti-inflammatory agents** to **modulate** perioperative respiratory adverse events **(PRAEs)** in children with OSA.

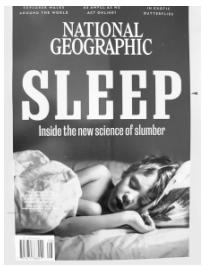
Perioperative Care & Anesthesiology



LAI=Local Anesthetic Infiltration; PNB=peripheral nerve Block

Murto K. *Anesth Analg* 2018

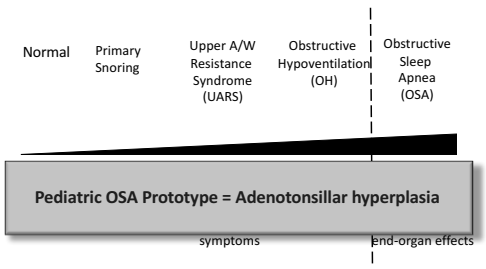
Obstructive Sleep Disordered Breathing (SDB)



- "A syndrome of upper airway dysfunction during sleep characterized by snoring and/or increased respiratory effort that result from increased **upper airway resistance** and **pharyngeal collapsibility**"

Kaditis AG *Eur Respir J* 2016

SDB Spectrum



Pediatric OSAS & Societal Impact

- **Common**
  - 1-5% of children; ↑ with obesity
  - ? Surgical prevalence
  - M>F & age phenotypes
  - Secondary & associated morbidity
- **↓ socioeconomic status**
- **Expensive**
  - ↓School and job performance
  - ↑ healthcare utilization
  - Altered CVS health trajectory
- **Shorter life span**
- **Treatment & health trajectory**

Jennum P et al. *Thorax* 2013

Pediatric mortality after adenotonsillectomy

Source	Years	15-30 Day Death Rate (per 10,000)
Adenotonsillectomy		
US (Brown K Anesth Analg 2014)	1970s	0.3-0.6
US out-patient (Shay S Laryngoscope 2015)	2010	0.6
US in-patient (Allareddy V Clin Pediatr 2016)	2001-10	4
Canad		2
Swed		24

Pediatric Prediction Tools for Perioperative Morbidity & Mortality: "Pulmonary or Respiratory Disease"
(Subramanyam R *Anesth Analg* 2015; Nasr VG *Anesth Analg* 2017)

The Elephant in the Room: Lethal Apnea at Home after AT Brown K *Anesth Analg* June 2014

Death or Neurologic Injury After Tonsillectomy in Children with a Focus on Obstructive Sleep Apnea: Houston, We Have a Problem!

Charles J. Coté, MD,* Karen L. Posner, PhD,† and Karen B. Domino, MD, MPH†

The Laryngoscope © 2013 The American Laryngological, Rhinological and Otological Society, Inc.

Mortality and Major Morbidity After Tonsillectomy: Etiologic Factors and Strategies for Prevention *Laryngoscope* 2013

Julie L. Goldman, Rob

Anesthesia- and opioids-related malpractice claims following tonsillectomy in USA: LexisNexis claims database 1984–2012

Rajeev Subramanyam[1], Vidya Chidambaran[1], Lili Ding[2], Charles M. Myer III[3] & Senthilkumar Sadhasivam[1]

Pediatr Anesth 2014

1 Department of Anesthesia, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA

OSA associated with increased respiratory complications & dose-response evident

Adenotonsillectomy Complications: A Meta-analysis *Pediatrics* 2015

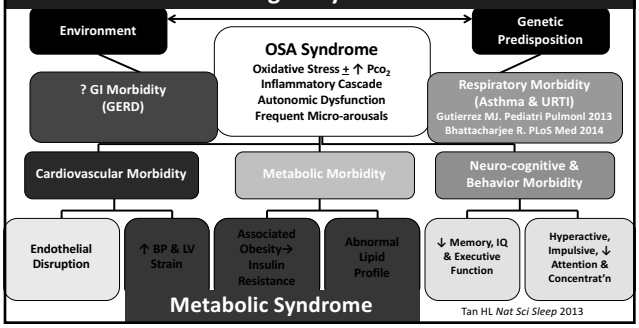
Graziela De Luca Canto, DDS, MsC, PhD[1,3], Camila Pachêco-Pereira, DDS[1], Secil Aydinoz, MD[2], Rakesh Bhattacharjee, MD[2], Hui-Leng Tan, MBBS[2], Leila Kheirandish-Gozal, MD, MSc[2], Carlos Flores-Mir, DDSC, MSc, DSc, RCDC(C)[3], David Gozal, MD, MBA, FAAP[2]

The Laryngoscope

Impacts of Disease Severity on Postoperative Complications in Children With Sleep-Disordered Breathing

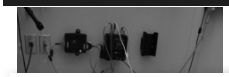
Kun-Tai Kang, MD, MPH; I-Sheng Chang, MD; Chia-Chen Tseng, MD; Wen-Chin Weng, MD, PhD; Tzu-Yu Hsiao, MD, PhD; Pei-Lin Lee, MD, PhD; Wei-Chung Hsu, MD, PhD

End-Organ Dysfunction



Tan HL *Nat Sci Sleep* 2013

Polysomnography (PSG) is diagnostic "Gold Standard"



"DIAGNOSTIC" SEVERITY is based on the following:

- PSG data-Apnea-hypopnea index

Severity of OSA	Adult AHI	Pediatric AHI
None	0–5	0
Mild OSA	6–20	1–5
Moderate OSA	21–40	6–10
Severe OSA	> 40	> 10

- **Limited access and expensive**

Pediatric management guidelines are confusing…

PSG Indications
"Everyone"----------Prescriptive----------Not really necessary

AHI Diagnostic Threshold for "Severe" OSA=↑Risk for PRAE?
Yes----------No----What does "severe" mean?----Not acknowledged

PSG Alternatives Acceptable?
Yes----------No----------Not acknowledged

OSAS diagnosis is moving out of the sleep lab

Questionnaires

- Symptoms not diagnostic
- Physical findings "unreliable"

"Relevant Asthma Endotype?"

- Include associated co-morbidities (define endotype)

Other options

- **Single-channel recordings**
  - Oximetry ± airflow or ECG
- **Home-based sleep studies**
  - PSG and polygraphy
- **Biological Markers** (De Luca Canto G *Sleep Med Rev* 2015)
  - Blood
  - Urinary-most promising
  - Salivary
  - Exhaled condensate

Gozal D *Curr Opin Pulm Med* 2015

"Typical" tonsillectomy disposition planning

Definition "Severe" OSA leading to ↑ risk of PRAE: NO CONSENSUS

Unknown how PRAE risk modulated by associated pathophysiology, age, comorbidities, skill of providers (and opioids)

Intensive care unit admission criteria: NO CONSENSUS

Monitor according to local practice

Does risk for PRAE vary by procedure?

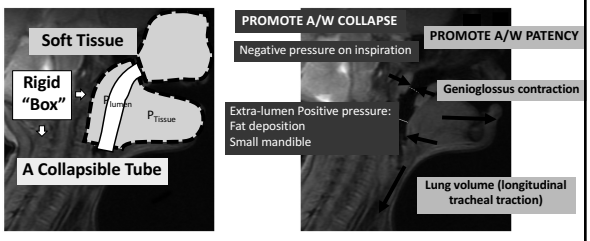
Schwengel DA Anesthesiology Clin 2014

OSA age-related airway phenotypes

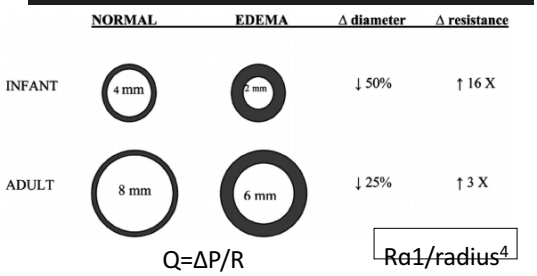
Pediatric OSA Endotypes	Infant (0-<2 yrs)	Child (2-8 yrs)	Pre-teen/Teen (9-21 yrs)
Lymphoid hyperplasia (adenoids +/- tonsils)	+/-	+++	+
Soft tissue			
Obesity	+/-	++	+++
"Genetic" (e.g. Hurler's, Prader-Willi, Beckwith-Wiedemann)	++	+++	+
Craniofacial Syndromes			
Vault & Mandible (e.g. Craniosynostosis & P Robin)	+++	++	+/-
Foramen Magnum (e.g. Arnold-Chiarii)	++	++	+/-
Neuromuscular (e.g. C palsy & Trisomy 21)	+	+++	++
Prematurity (< 32 wks)	+++	+	-
Inflammatory (e.g. Asthma & Sickle Cell Dis.)	+/-	+++	++

Schwengel DA *Anesthesiology Clin* 2014

Factors contributing to airway patency and collapse in pediatric OSA



Relationship between air flow & resistance



$Q=\Delta P/R$

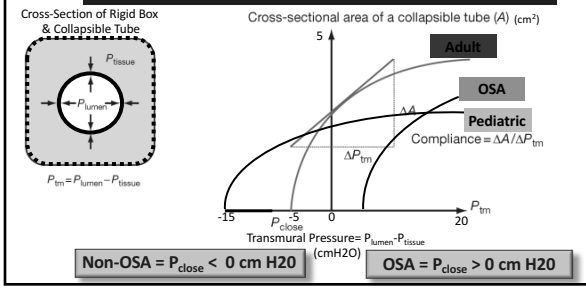
$R \alpha 1/radius^4$

Pharyngeal wall tension, tracheal traction & abdominal pannus

Does dysfunctional neuro-motor control of the upper airway have a role?

- Day vs night time obstruction
- ↑EMG genioglossus activity
- Not all children with anatomical obstruction have OSA
- Variable OSA cure rate following adenotonsillectomy

Pathophysiology of pediatric OSA: Structural lab model Isono S. *Encyclopedia Sleep* 2013



Non-OSA = P_{close} < 0 cm H20 | **OSA = P_{close} > 0 cm H20**

OSA and upper airway neuromotor control

Upper Airway Findings	Receptor (Location)	OSA Phenotypes: Infant (0-<2 yrs)	Child (2-8 yrs)	Pre-teen/Teen (9-21 yrs)
Collapsibility (genioglossus)	CO2 (Brain Stem) Mechano (airway)	High	High	High
Ventilatory drive	O2 (Peripheral) CO2 (Brain Stem)	?	Normal	?
Arousibility "Airway Self-	O2 (Peripheral) CO2 (Brain Stem)	Blunted	Blunted	Blunted to high
Ventilatory "Loop Gain"				igh

O2 administration improves ventilatory control instability

Arens R & Marcus C. *Sleep* 2004

Upper airway collapsibility: Anesthetic agents & opioids

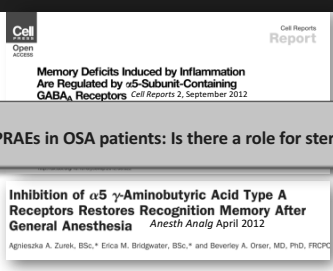
Generic Drug Name	Airway Collapse	Mechanism of Action
Midazolam	+	CNS $GABA_A$, ?α dose
Sevoflurane	+++	CNS $GABA_A$, α dose
Desflurane	+++	CNS $GABA_A$
Propofol	++	CNS $GABA_A$/NMDA, α dose
Dexmedetomidine	+/-	CNS α_2 adrenergic agonist
Ketamine	+/-	NMDA receptor antagonist; ↑EMG genioglossus (rats)

$GABA_A$ receptors-stimulation leads to myo-relaxation

Anesthetic agents enhance $GABA_A$ receptor activity

Campagna JA NEJM May 2003

$GABA_A$ receptor activity augmented by anesthetic agents in presence of IL-1


Cell Reports
Report
Memory Deficits Induced by Inflammation Are Regulated by α5-Subunit-Containing $GABA_A$ Receptors *Cell Reports* 2, September 2012

Prevention of PRAEs in OSA patients: Is there a role for steroids or NSAIDs?

Inhibition of α5 γ-Aminobutyric Acid Type A Receptors Restores Recognition Memory After General Anesthesia *Anesth Analg* April 2012

Agnieszka A. Zurek, BSc,* Erica M. Bridgwater, BSc,* and Beverley A. Orser, MD, PhD, FRCPC

Perioperative steroid administration improving adenotonsillectomy outcomes

N Eng J Med 2013

Caulfield HM Clin Otolaryngol 2012

Oxidative stress & sensitivity to opiates in pediatric OSAS

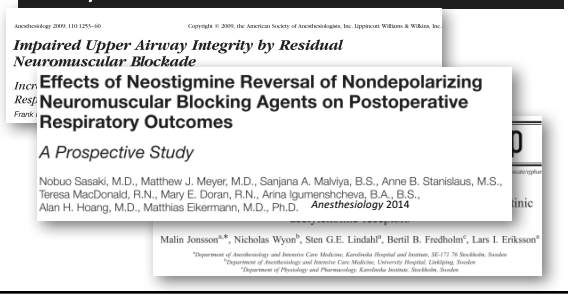
Anesthesiology 2006

Anesthesiology 2006

Pediatr Anesth 2010;20: 1078-83

Anesth Analg 2010

Muscle relaxants, reversal agents & the upper airway



Anesthesiology 2014

Summary: Perioperative Upper Airway Considerations in Children with OSA

- **PATIENT**
  - Prone to impaired airway neuro-motor function due to drugs
  - Spectrum of comorbidities secondary to OSA or "age-specific"
- **PREOPERATIVE**
  - Risk Stratification for PRAE
    - Age < 3 yrs & "significant" comorbidities
    - "Severe" OSA by Hx/Px, PSG or Overnight Pulse Oximetry
    - "Prescriptive PSG" needed?
    - "Invasiveness" of surgery & anesthesia
    - Need for postoperative opioids
- **POSITION**
  - Head up "Tracheal Tethering", avoid being supine

Summary continued

- **PROCEDURE**
  - Goals-prepare for "challenging" airway & PRAEs
  - **No one "best" anesthetic technique**;
  - "Pharyngeal sparing" approach
  - Emerge awake and consider nasopharyngeal airway
- **POSTOPERATIVE**
  - **Monitoring**
    - Continuous SpO2 preferably on room air and asleep
    - Appropriate duration unknown (2-6 hrs)
    - Significance of minor/major PRAEs during recovery unknown (Weingarten G *Anesth Analg* 2015)
  - **Analgesia**
    - Multimodal and avoid opioid infusions or "around-the-clock "
    - Optimal approach unknown (Anderson BJ *Pediatr Anesth* 2011)
  - **Parent Preparation**
    - 2019 AAOHNS Tonsillectomy Guideline

Thank you!

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