Pediatric Obstructive Sleep Apnea Diagnosis:

Current State and Up & Coming

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Disclosure of Conflict of Interest
(over the past 2 years)

SOCIÉTÉ CANADIENNE DE THORACOLOGIE

CANADIAN THORACIC SOCIETY

Joanna E MacLean

- ❑ I have no conflict of interest.
- ❑ I am chairing the Guideline Development Committee for the Diagnosis of Pediatric Obstructive Sleep Apnea

Learning Objectives

1. Compare different approached to the diagnosis of pediatric obstructive sleep apnea.
2. Evaluate the best approach to the diagnosis of pediatric obstructive sleep apnea in a given context.
3. Consider new tools to assist in the diagnosis of obstructive sleep apnea..

Defining Obstructive Sleep Apnea

- International Classification of Sleep Disorders(3rd ed):
  - Sleep related breathing disorders
    - Obstructive sleep apnea
    - Central sleep apnea syndromes
    - Sleep related hypoventilation disorders
    - Sleep related hypoxemia disorder
    - Isolated symptoms and normal variants: snoring
- **Pediatric OSA**: Symptoms + OMAHI ≥ 1 event/h **OR**

  Obstructive hypoventilation (P_aCO_2 >50 mmHg for >25% +)

Epidemiology of Pediatric OSA

TABLE 6. DEFINITION OF OBSTRUCTIVE SLEEP APNEA AND ESTIMATED POPULATION PREVALENCE

Criteria for OSA Diagnosis	Location	No.	Age	Prevalence (%)
AHI ≥ 10	United States (42)	126	2–18 yr	1.6
RDI ≥ 10	Spain (22)	100	12–16 yr	2.0
AHI ≥ 5 or apnea index ≥ 1	Greece (50)	3,680	1–18 yr	4.3
AHI ≥ 5	United States (19)	5,728	5–7 yr	5.7
AHI ≥ 5	United States (20)	850	8–11 yr	2.5
AHI > 3	Italy (64)	895	3–11 yr	1.0
AHI > 3	Turkey (65)	1,198	3–11 yr	0.9
AHI ≥ 1	Thailand (66)	755	9–10 yr	1.3
AHI ≥ 1	Thailand (13)	1,008	6–13 yr	0.7
AHI > 1	Singapore (57)	200	6.4 ± 4 yr	0.1
ODI ≥ 5	Italy (21)	604	3–6 yr	13.0
ODI > 3	Iceland (41)	454	6 mo–6 yr	2.9

Definition of abbreviations: AHI = apnea–hypopnea index; RDI = respiratory disturbance index; ODI = oxygen desaturation index.

Lumeng, Chervin 2008. Proceedings ATS:5;242-52

Current Pediatric OSA Guidelines

Group/Discipline	Country/Region	Year	Age
*ASA/Sleep	Australasia	2017	child
ERS/Resp	Europe	2017	1-23 mos
ERS/Resp	Europe	2016	2-18 y
AAPD/Dental	USA	2016	0-18 y
BMA/FCM/ENT	Brazil	2014	1-18 y
APA/Sleep	USA	2012	1-18 y
*AAOHNS/ENT	USA	2011	2-18 y
SEPAR/Resp	Spain	2011	child
*AASM/Sleep	USA	2011	child

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*SEPAR/Resp	Spain	2011	child

1. Polysomnography is the standard

- Clinical history is not a good predictor of OSA
  - No single or group of clinical factors are sufficient to diagnose OSA
  - No difference in tonsillar size between OSA and non-OSA
  - Less than half of children with obesity have OSA, most of this is mild OSA

- In-lab Polysomnography - for the diagnosis of OSA in children
  - Expensive, limited or no access in many areas
  - Childhood AdenoTonsillectomy (ChAT) study (RCT, otherwise healthy, 5-9 yo)
  - Polysomnographic variables do not correlate baseline or post-treatment morbidity:
    - Sleepiness, Behaviour, Quality of Life
  - Polysomnography alone may not be a good measures of OSA severity/morbidty

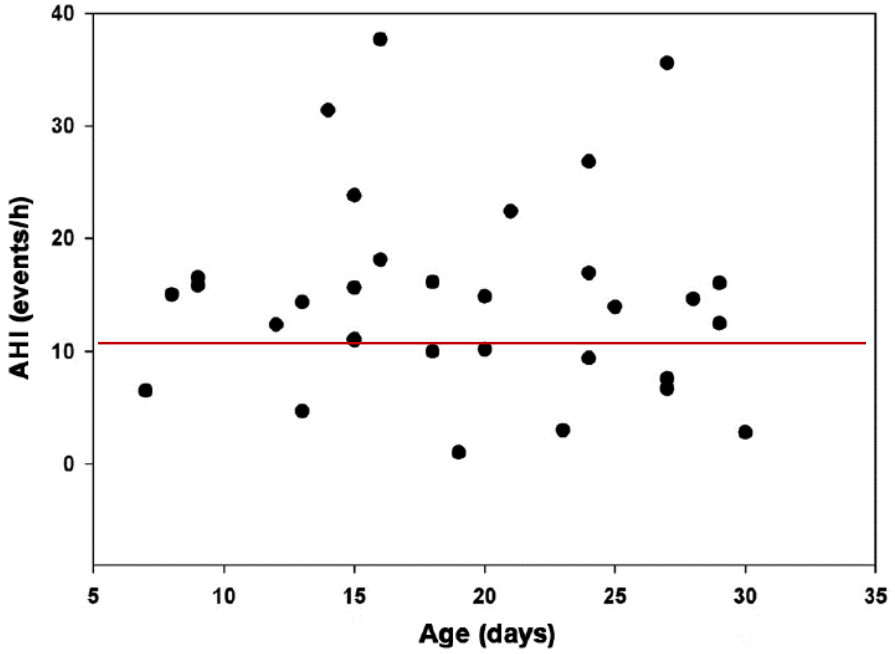
Marcus et al. N Engl J Med 2013;368:2366-2376
MacLean et al. Sleep Med 2018;47:44-50
Rosen et al. Pediatrics 2015:137; Pii: E20160016

2. Infants are different from children

N = 30
Full term
Healthy infants
Polysomnography
< 30 days of age

AHI range: 0-37 events/h

Figure 3—Distribution of AHI by age of newborns.



AHI = apnea-hypopnea index.

Daftary 2019. JCSM;15:437-443

2. Infants are different from children

Variable	Daftary	Brockman	Duenas-Meza	Brockman	Scholle
n	30	37	106	37	22
Age group	<30 days	1 month	<45 days	3 months	1.1-1.7 y
Above sea level	732 ft		5250 ft		
AHI (events/h)	14.9	7.8	21.4	4.9	2.8
ODI (events/h)	17.6	8.2	REM 91.7 NREM 47.1	7.5	0.1

Daftary 2019. JCSM;15:437-443.

2. Infants are different from children

- N = 233, <2 yo undergoing polysomnography
- OSA diagnosis: AHI > 1 event/h vs physician diagnosis

TABLE 4—Severity Classification of SDB by Age Group Using AHI Criteria and Physician Classification

	<6 months		6–12 months		12–24 months	
	AHI Criteria* (%)	Physician (%)	AHI Criteria* (%)	Physician (%)	AHI Criteria* (%)	Physician (%)
Normal	0	28.2	0	34.3	0	19.4
Mild	1.5	35.9	16.7	45.7	32.7	41.8
Moderate	16.2	15.4	42.6	5.7	32.7	17.9
Severe	82.4	20.5	40.7	14.3	34.6	20.9

DeHaan 2015. Ped Pulm 50:1346-53

3. Some testing is better than none

- Alternatives to Polysomnography:
  - Questionnaires – Pediatric Sleep Questionnaire (Chervin)
  - Home sleep apnea testing – not recommended in children (AASM)
  - Overnight oximetry
  - Airway imaging:
    - lateral neck x-ray,
    - magnetic resonance imaging (MRI), *need specialist expertise
  - Drug-induced sleep endoscopy (DISE), *need specialist expertise
  - Video, PTT, PAT, biomarkers,

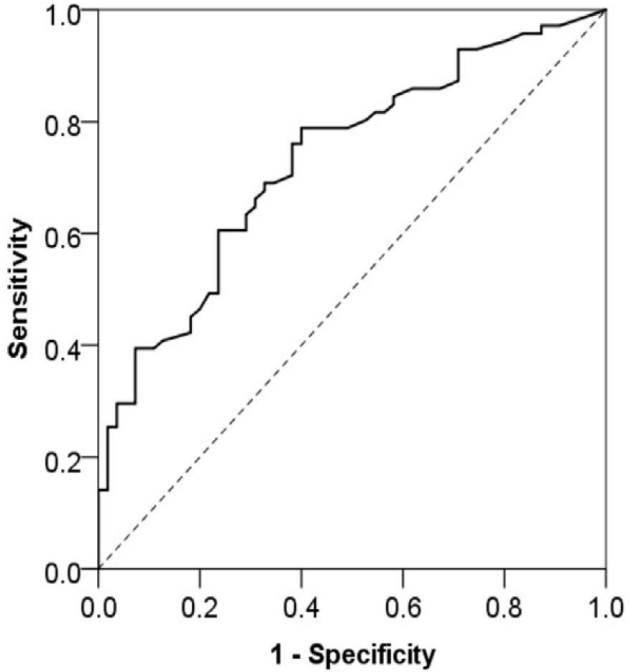
- When to use alternatives?
  - Depends on context, availability of testing

Chervin et al. Sleep Med 2000:1;21-32
Kirk et al. J Clin Sleep Med 2017:13; 1199-1203
Hornero et al. Am J Resp Crit Care 2017:196:1591-98
Collu et al Int J Pediat Otorhinolaryngol 2018;108;113-9
Fleck et al. Pediatr Radiol 2018;48:1223-1233

3. Some testing is better than none

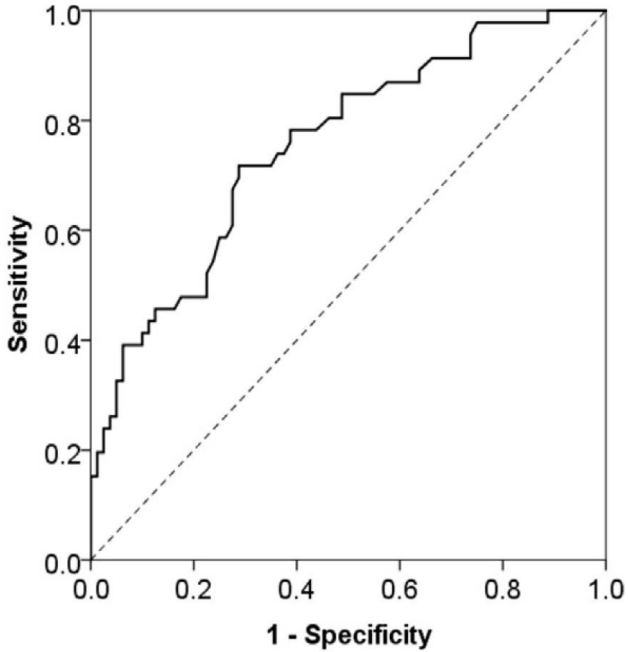
Nocturnal Oximetry: Oxygen Desaturation Index (ODI): ≥6 events/h

OSA: OMAHI>2 events/h



AUC: 0.73 (95% CI 0.64-82)

Mod/Sev OSA: >5 events/h



AUC: 0.75 (95% CI 0.67-0.84)

MacLean et al. Sleep Med 2018:47:44-50

Canadian Guideline for Pediatric OSA

- Focus on diagnosis
- Systematic review + Guideline
- Multi-disciplinary: Lead by CTS
  - Canadian Sleep Society
  - Canadian Pediatric Society
  - Canadian Society of Otolaryngology – Head & Neck Surgery
  - College of Family Physicians of Canada
- Education & Advocacy
- Release date: March 2020 (on-line publication)

Are there gaps?

- Access to polysomnography is limited to non-existent
  - 2014 Canadian survey: Polysomnography in 6 of 13 provinces/territories
- Limitations of polysomnography:
  - Manual, at best 80% agreement between scorers (for sleep)
  - Definitions of OSA not related to mechanisms
  - Does not inform treatment choice or predict treatment outcomes
- Other options compared to polysomnography

- Need for new approaches

Katz et al. Peds Child Health 2014:19;367-72-32

Multi-factorial, heterogeneous disorder

- Multi-factorial, heterogeneous
  - Multiple factors; combination
  - Different sets of factors in different children

- Key OSA pathophysiology:
  - Anatomical upper airway compromise
    - Necessary but not sufficient
  - Impair upper airway muscle response
  - Low arousal threshold
  - High ventilatory control sensitivity

Adenotonsillar Growth

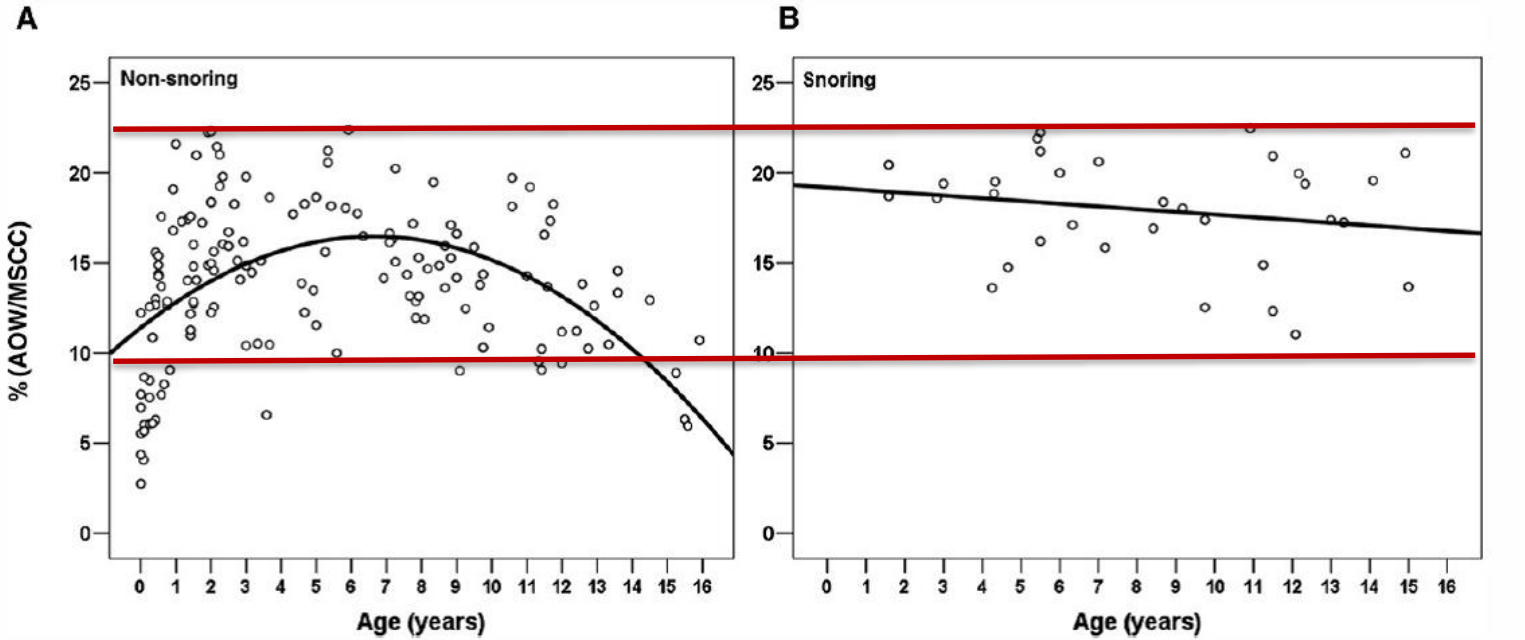


Figure 2. **A,** Curve fitting (children without snoring) and **B,** line fitting (children with snoring) for the association of percentage AOW/MSCL with age. For children without snoring, $R^2 = 0.22$, $P < .01$; for children with snoring, $R^2 = 0.04$, $P = .27$.

Papaioannou et al. 2013. J Pediatr:162;269-74

Weinstock. Sleep 2014;37:261-269

OSA phenotypes

UNDERLYING MECHANISM

Fundamental biological process, including genes, gene processing, environment, that underlie the disease

PHYSIOLOGIC PHENOTYPE

Subtype of a disease with distinct pathophysiologic traits

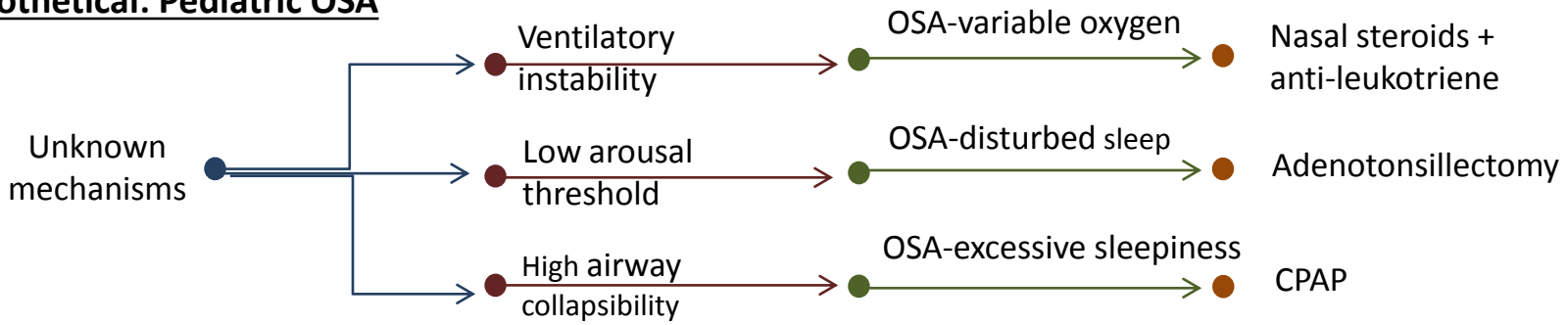
CLINICAL PHENOTYPE

Observable consequences of a disease

TREATMENT

Precision treatment based on a subtype of a disease ultimately related to the underlying mechanism

Hypothetical: Pediatric OSA



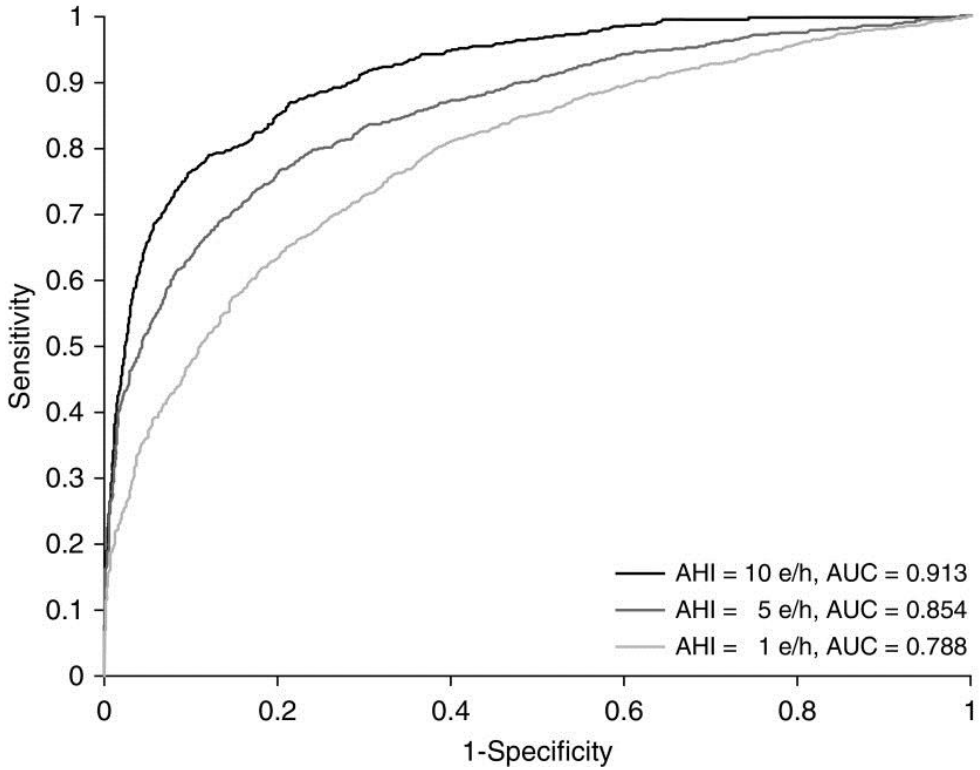
Big data/machine learning/automated

Nocturnal Oximetry

- Neural network-based signal-processing analysis
- Time and frequent domains

- Prospective cohort
- N = 4191 children
- 2 to 18 years
- Habitually snoring

- Comparator:
  - nocturnal polysomnography



Hornero et al. Am J Resp Crit Care 2017:196:1591-98

Summary

- Current:
  - Polysomnograhy - standard for diagnosis of Pediatric OSA
  - Infants are different from children
  - Some objective testing is better than none
- Up & Coming:
  - Canadian Pediatric OSA Guidelines
  - Multi-factorial, heterogeneous
  - Phenotyping, new methods of data analysis


Thank you