Pediatric Seminar

Adenotonsillectomy and Health Care Utilization
in Children with Snoring and Mild Sleep Apnea

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Adenotonsillectomy and Health Care Utilization in Children With Snoring and Mild Sleep Apnea

A Randomized Clinical Trial

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Overview of Pediatric SDB

- **Sleep-disordered breathing (SDB)** affects 6%–17% of children
  - Ranges: primary **snoring** + **obstructive sleep apnea (OSA)**
  - Behavioral, neurocognitive, cardiovascular, metabolic effects
- Previous studies (matched controls)
  - **Health care utilization** (HCU) is **elevated** in untreated **moderate-to-severe OSA**
  - Treatment is associated with decreased HCU
- Mechanisms linking treatment to HCU remain unclear
  - May relate to **better sleep**, **immune function**, and **reduced inflammation**

Health Care Utilization (HCU) Implications

- HCU reflects individual disease burden + societal health resource use
- **Prior** studies mostly **retrospective** or **observational**
- **Limited data** on HCU in **mild pediatric SDB**
- Vital for health planning and resource allocation

The PATS Trial Design

- Pediatric Adenotonsillectomy Trial for Snoring (PATS)
- **Randomized, multicenter, 12-month trial,**
  June 29, 2016, and February 1, 2021,
  data: June 2022 to April 2024.
- **459** children aged **3–13** with **mild obstructive SDB**

The PATS Trial Design

- **Early adenotonsillectomy(eAT)** **vs.** **watchful waiting with supportive care (WWSC)**
- Co-primary outcomes: **executive function** and **attention** (**no significant** difference)
- Secondary outcomes: **behavior, quality of life, blood pressure** (showed **improvement**)

Objective of Present Analysis

- To assess if eAT reduces health care utilization
- **HCU** defined as:
  - **All-cause** health care encounters
  - **Number of prescriptions** issued
- Targeted the broader impact of mild SDB treatment
- Sought to inform both clinical and health policy decisions

Methods: Study Design and Participants

- Multicenter, randomized, parallel-arm trial (PATS)
- Children aged **3–13 years** with **mild SDB**
  - **(1)caregiver report of habitual snoring occurring most of the sleep period on ≥3 or more nights per week for 3 or more months and**
  - **(2)diagnostic PSG indicating an apnea index ≤ 1/ hr, AHI ≤ 3/hr, , SpO2 ≤ 90% associated with obstructive events.**

Methods: Study Design and Participants

- **Randomized 1:1** to early adenotonsillectomy (eAT) or watchful waiting with supportive care (WWSC)
  - Stratified by site, age (<5 vs ≥5), overweight status, and race
- Enrolled from 7 academic pediatric centers (2016–2021)
- Registered at ClinicalTrials.gov (NCT02562040), followed CONSORT guidelines

Health Care Utilization (HCU) Data Strategy

- Primary HCU outcomes:
  total **health care encounters** + **prescriptions**
- Diagnosis codes used: ICD-9 and ICD-10
  - 519 codes grouped into 21 descriptive and 8 analytic clinical categories
  - Medication classes grouped into 6 analytic categories
    - if multiple category, choose one, order: (1) anti-infective,(2)respiratory and corticosteroids,(3)dermatological, (4) analgesics and anesthetics, (5) behavioral and mood (6)other
- Excluded: medical devices, supplies, lotions; included: vitamins/electrolytes (other)

Adenotonsillectomy

- Complete bilateral tonsillectomy and removal of obstructing adenoid tissue
- Performed by cold dissection, monopolar electrocautery or any other recognized surgical technique.

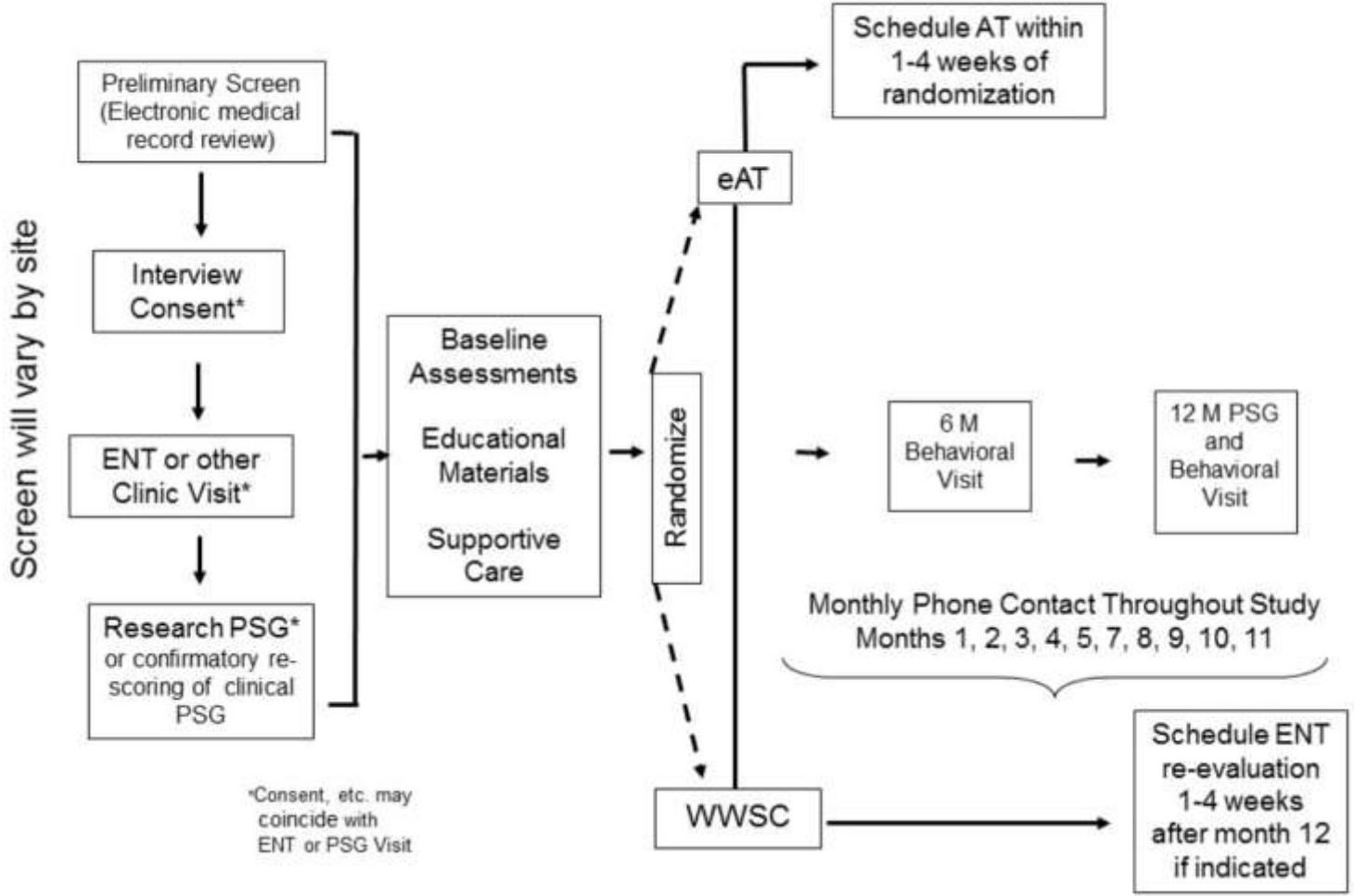
Statistical Analysis

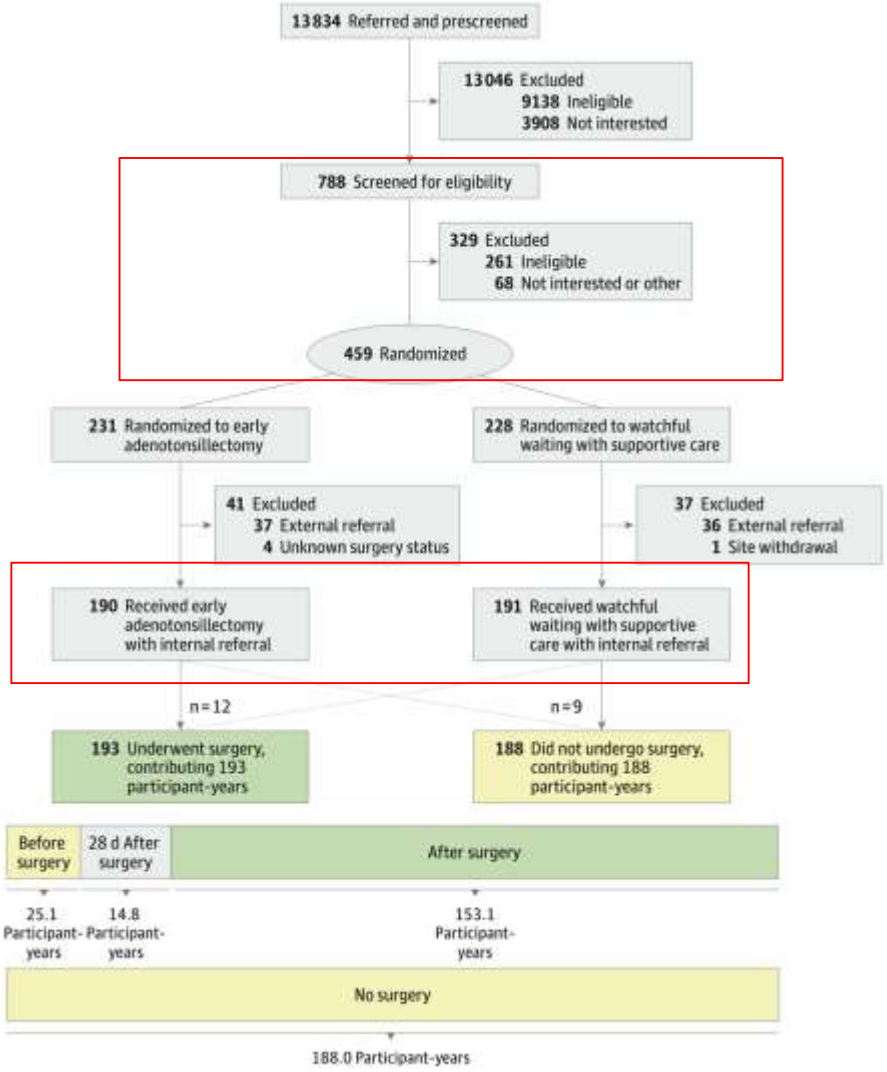
- Powered to detect HCU rate differences with **>99% power**
- Main comparisons: eAT vs WWSC on encounters and prescriptions
- Used zero-inflated Poisson models adjusted for site and stratification variables
- Excluded first 28 days post-op to isolate long-term effect
- Sensitivity analyses included the immediate 28-day post-op period

Results: Participant Flow and Baseline

- n=**459** randomized: **231** to eAT, **228** to WWSC
- **381** included in HCU analysis (**190** eAT, **191** WWSC)
- Exclusions due to incomplete data or site withdrawal
- Median age: **6 years** (IQR 4–8); 50% female

2.2. Study Schema





Reasons for exclusion:
AHI out of range;
severe, **chronic health problems**;
use of study-restricted **medications**;
no report of habitual snoring; **tonsillar size less than 2** on Brodsky scale; and lack of clinical equipoise.

Table 1. Baseline Descriptive Characteristics According to Study Arm

Characteristic	Analytic sample, No. (%)		Excluded, No. (%)	
	eAT (n = 193)	WWSC (n = 188)	eAT (n = 38)	WWSC (n = 39)[a]
Age, median (IQR), y	6 (4 to 8)	6 (4 to 8)	5 (4 to 8)	7 (5 to 8)
Sex				
Female	103 (53.4)	89 (47.3)	19 (50.0)	19 (48.7)
Male	90 (46.6)	99 (52.7)	19 (50.0)	20 (51.3)
Ethnicity				
Hispanic/Latinx	30 (15.5)	25 (13.3)	11 (28.9)	9 (23.1)
Non-Hispanic/Latinx	163 (84.5)	163 (86.7)	27 (71.1)	30 (76.9)
Race				
American Indian/Alaska Native	2 (1.0)	1 (0.5)	0 (0.0)	0 (0.0)
Asian	1 (0.5)	5 (2.7)	1 (2.7)	1 (2.6)
Black/African American[a]	54 (28.0)	53 (28.2)	8 (21.7)	8 (20.5)
More than 1 race	9 (4.7)	7 (3.7)	1 (2.7)	3 (7.7)
White	127 (65.8)	122 (64.9)	27 (72.9)	27 (69.2)
Study site				
Ann Arbor, Michigan	29 (15.0)	30 (16.0)	11 (28.9)	14 (35.9)
Cincinnati, Ohio	40 (20.7)	44 (23.4)	0 (0.0)	0 (0.0)
Cleveland, Ohio	31 (16.1)	29 (15.4)	4 (10.5)	2 (5.1)
Dallas, Texas	34 (17.6)	29 (15.4)	15 (39.5)	13 (33.3)
Norfolk, Virginia	28 (14.5)	26 (13.8)	5 (13.2)	7 (17.9)
Philadelphia, Pennsylvania	31 (16.1)	30 (16.0)	3 (7.9)	3 (7.7)
BMI *z* score, median (IQR)	0.7 (−0.1 to 1.5)	0.5 (−0.4 to 1.5)	0.7 (−0.3 to 1.1)	0.5 (−0.2 to 1.4)
BMI category				
Healthy weight	110 (57.0)	112 (59.6)	25 (65.8)	23 (59.0)
Underweight	7 (3.6)	9 (4.8)	1 (2.6)	2 (5.1)
Overweight	36 (18.7)	30 (16.0)	9 (23.7)	6 (15.4)
Obese	40 (20.7)	37 (19.7)	3 (7.9)	8 (20.5)

Baseline characteristics were balanced between groups

Maternal education[b]				
High school diploma or less	37 (19.4)	33 (17.6)	8 (21.1)	8 (20.5)
Some college	81 (42.4)	74 (39.4)	16 (42.1)	13 (33.3)
4-y College or greater	73 (38.2)	81 (43.1)	14 (36.8)	18 (46.2)
Annual household income[b]				
<$30 000	63 (35.4)	48 (27.4)	10 (27.8)	6 (17.7)
≥$30 000	115 (64.6)	127 (72.6)	26 (72.2)	28 (82.3)
Asthma at baseline[b]				
Yes	43 (22.3)	50 (26.6)	9 (23.7)	6 (15.4)
No	148 (77.7)	138 (73.4)	29 (76.3)	33 (84.6)
ADHD medication at baseline[b]				
Yes	10 (5.2)	6 (3.2)	1 (2.6)	1 (2.7)
No	183 (94.8)	182 (96.8)	37 (97.4)	36 (97.3)
Tonsil grade				
II	68 (35.2)	77 (41.0)	12 (31.6)	19 (48.7)
III	106 (54.9)	98 (52.1)	24 (63.2)	18 (46.2)
IV	19 (9.8)	13 (6.9)	2 (5.3)	2 (5.1)
Modified ESS total score[b]				
<10/24	145 (76.7)	140 (74.5)	30 (78.9)	32 (82.0)
≥10/24	44 (23.3)	48 (25.5)	8 (21.1)	7 (18.0)
AHI, median (IQR), events/h	0.5 (0.3 to 1.1)	0.6 (0.3 to 1.2)	0.5 (0.1 to 1.1)	0.6 (0.2 to 1.0)

Total Health Care Encounters

- **eAT** group had **1.25 fewer** encounters/**year** (95% CI, −1.96 to −0.53)
- Driven by **fewer office visits (−0.77)** and **outpatient procedures (−0.44)**
- Adjusted annual encounter rates: **2.7 (eAT)** vs **3.9 (WWSC)**
- Largest reductions seen in:
  - **Respiratory (−0.33)**
  - **Sleep-related (−0.32)**
  - Other (−0.36) categories
- Small reductions also seen in **dermatology**

Table 2. Health Care Encounters Occurring With and Without Surgery

Encounter	Counts per participant per year, No.[a]		Mean (95% CI)[b]		
	Surgery	No surgery	Surgery	No surgery	Difference
All encounters	2.67	3.53	2.65 (2.17 to 3.12)	3.89 (3.27 to 4.52)	−1.25 (−1.96 to −0.53)
By encounter type					
Office visits	1.85	2.58	1.87 (1.50 to 2.24)	2.64 (2.12 to 3.16)	−0.77 (−1.39 to −0.15)
Inpatient hospitalizations[c]	0.20	0.20	0.18 (0.07 to 0.30)	0.25 (0.12 to 0.39)	−0.07 (−0.24 to 0.10)
Emergency and urgent care[c]	0.26	0.28	0.26 (0.15 to 0.37)	0.24 (0.14 to 0.34)	0.02 (−0.12 to 0.16)
Outpatient procedures[c]	0.36	0.48	0.33 (0.15 to 0.52)	0.78 (0.38 to 1.17)	−0.44 (−0.73 to −0.15)
By category[d]					
Allergic, excluding allergic rhinitis	0.10	0.07	0.13 (0.05 to 0.21)	0.09 (0.00 to 0.18)	0.04 (−0.09 to 0.16)
Behavioral/developmental, mood	0.22	0.38	0.24 (0.10 to 0.38)	0.28 (0.09 to 0.47)	−0.04 (−0.24 to 0.16)
Infectious, excluding respiratory	0.18	0.17	0.20 (0.11 to 0.29)	0.16 (0.08 to 0.24)	0.04 (−0.08 to 0.16)
Neurological, headache/migraine	0.28	0.32	0.32 (0.16 to 0.49)	0.20 (0.10 to 0.29)	0.13 (−0.06 to 0.31)
Respiratory, otitis media	0.71	0.86	0.70 (0.52 to 0.88)	1.03 (0.74 to 1.32)	−0.33 (−0.64 to −0.02)
Sleep	0.12	0.24	0.14 (0.05 to 0.23)	0.46 (0.26 to 0.65)	−0.32 (−0.55 to −0.09)
Trauma/injury	0.11	0.24	0.13 (0.04 to 0.21)	0.46 (0.26 to 0.65)	−0.09 (−0.25 to 0.07)
Other	0.95	1.23	0.97 (0.72 to 1.20)	1.33 (0.99 to 1.60)	−0.36 (−0.75 to 0.03)

Prescription Reduction

- Total **prescriptions/year** reduced by **2.53** (95% CI, −4.12 to −0.94) with eAT
- Greatest reductions in:
  - **Analgesics/anesthetics (−0.81)**
  - **Dermatological meds (−0.54)**
  - **Respiratory meds (−0.50)**
  - Other category (−0.43)

By condition[b]	Surgery, No.		No surgery, No.	
Allergic, excluding allergic rhinitis	15	0.10	14	0.07
Behavioral/developmental	11	0.07	26	0.12
ADHD	18	0.12	27	0.13
Mood	5	0.03	29	0.14
Infectious, excluding respiratory	28	0.18	36	0.17
Neurological	34	0.22	53	0.25
Headache/migraine	9	0.06	16	0.08
Respiratory lower	25	0.16	22	0.10
Respiratory upper	45	0.29	92	0.43
Asthma	18	0.12	47	0.22
Otitis media	20	0.13	23	0.11
Sleep	18	0.12	52	0.24
Cardiovascular	0	0.00	6	0.03
Dermatological	5	0.03	15	0.07
Gastrointestinal	15	0.10	33	0.15
Genitourinary	10	0.07	17	0.08
Mouth/teeth/jaw	4	0.03	1	0.00
Stature	11	0.07	17	0.08
Trauma/injury	17	0.11	53	0.25
Wellness, including immunization	63	0.41	81	0.38
Other	38	0.25	92	0.43

Table 4. Prescriptions Issued With and Without Surgery

Prescription	Counts per participant per year, No.[a]		Mean (95% CI)[b]		
	Surgery	No surgery	Surgery	No surgery	Difference
All prescriptions	2.38	4.10	2.73 (2.01 to 3.46)	5.27 (3.75 to 6.78)	−2.53 (−4.12 to −0.94)
By category[c]					
Analgesics/anesthetics	0.44	0.86	0.51 (0.27 to 0.74)	1.32 (0.80 to 1.84)	−0.81 (−1.41 to −0.21)
Anti-infective	0.56	0.58	0.64 (0.43 to 0.84)	0.96 (0.49 to 1.43)	−0.32 (−0.80 to 0.16)
Behavioral/mood	0.13	0.20	0.12 (0.02 to 0.23)	0.15 (0.04 to 0.26)	−0.03 (−0.15 to 0.10)
Dermatological	0.08	0.25	0.09 (0.03 to 0.16)	0.64 (0.26 to 1.02)	−0.54 (−0.95 to −0.13)
Respiratory and corticosteroids	0.76	1.34	0.83 (0.52 to 1.14)	1.33 (0.95 to 1.71)	−0.50 (−0.93 to −0.07)
Other	0.40	0.86	0.43 (0.24 to 0.62)	0.86 (0.54 to 1.18)	−0.43 (−0.80 to −0.06)

Age-Stratified Results and Sensitivity

- Children **>5 years**:
  - **Encounters: −1.53** (CI, −2.51 to −0.56)
  - **Prescriptions: −3.05** (CI, −5.37 to −0.74)
- Children **≤5** years:
  - Encounters: **−0.94** (CI, −2.02 to 0.13)
  - Prescriptions: **−2.24** (CI, −4.60 to 0.13)
- Sensitivity analyses (**including 28-day post-op period**):
  - Slightly **smaller** encounter differences
  - Prescription differences attenuated by post-op analgesic use

Discussion: Main Findings

- Early **adenotonsillectomy** (eAT) led to:
  - **32% reduction** in health care encounters
  - **48% reduction** in prescriptions
- Equivalent to **125 fewer encounters** and **253 fewer prescriptions** per 100 children/year

Interpretation and Relevance

- Prescription trends echoed prior studies: ↓ **respiratory, anti-infective, dermatologic** agents
- Improved sleep consolidation may **reduce nocturnal scratching from pruritus**
- SDB may **exacerbate inflammatory skin diseases** (e.g., **psoriasis**)
- Treatment-related **inflammation reduction** may indirectly benefit dermatologic symptoms

Interpretation and Relevance

- Analgesics/anesthetics showed the largest prescription difference post-surgery
- **Poor sleep** increases **pain sensitivity** and spontaneous pain symptoms
- Insufficient sleep alters nociceptive processing in children
- Evidence from Cleveland Family Study links **mild OSA** to **bodily pain** and poorer physical health
- These findings support the broader health benefits of improving sleep via adenotonsillectomy

Strengths

- **First RCT** to assess **HCU** in **children with mild SDB**
- Strong design: **prospective**, **randomized**, **multisite,** diverse sample
- Recruited across **5** U.S. states, increasing generalizability
- Accounts for disparities in care access and disease severity among racial minorities
- Stratified analysis by age, BMI, and race

Limitations

- U.S. **healthcare fragmentation** limited full encounter/prescription capture
- **Excluded externally referred** patients to reduce missing data
- Prescriptions analyzed as written, not necessarily filled or used
- Tertiary center recruitment limits **generalizability** to international or community settings
- **Unblinded study design** may have biased care-seeking behaviors

Additional Considerations

- **Investigators not blinded** to group, though involved in limited care decisions
- **No sham surgery** due to ethical concerns, affecting blinding
- Small sample size may miss rare events or severe complications

Take home message

- Early adenotonsillectomy (eAT) led to:
  - 32% reduction in all-cause health care encounters
  - 48% reduction in prescription medications
- Supports the role of **screening and early intervention** in **mild pediatric SDB**
- Findings complement prior PATS trial results on behavior, sleep, and quality of life
- Recommends future studies to evaluate cost-effectiveness of eAT in this population

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