



Residual Events During Use Of CPAP: Prevalence, Predictors and Detection Accuracy

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SCIENTIFIC INVESTIGATIONS

Residual Events during Use of CPAP: Prevalence, Predictors, and Detection Accuracy

Joel Reiter, MD¹, Bashar Zleik, MD¹, Mihaela Bazalakova, MD, PhD^{1*}, Pankaj Mehta, MD¹, Robert Joseph Thomas, MD, MBS¹

Introduction

- Obstructive sleep apnea is common and leads to considerable morbidity & mortality
- CPAP is the treatment of choice
- Modern PAP devices measure and store airflow & pressure data displaying:
 - CPAP efficacy
 - Hours of use
 - Air leak
 - Flow data



Introduction



Diagnostic PSG



PAP titration



PAP prescription & compliance tracking



**An Official American Thoracic Society Statement:
Continuous Positive Airway Pressure Adherence
Tracking Systems**

The Optimal Monitoring Strategies and Outcome Measures in Adults

Richard J. Schwab, Safwan M. Badr, Lawrence J. Epstein, Peter C. Gay, David Gozal, Malcolm Kohler, Patrick Lévy, Atul Malhotra, Barbara A. Phillips, Rene M. Rosen, Kingman P. Strohl, Patrick J. Strohl, Edward M. Weaver, and Terri E. Weaver; on behalf of the ATS Subcommittee on CPAP Adherence Tracking Systems

Introduction

- CPAP adherence tracking systems intuitively seem useful; however, there are few studies ...
- CPAP usage can be reliably determined... and should be routinely examined
- ... need to understand the different definitions for apneas and hypopneas... leak from each manufacturer
- The value... for clinical decision making... is unclear... research is indicated
- Current clinical care systems are not optimally configured for examining data
- Nomenclature... AHI_{FLOW} should be used

Introduction



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For customers using SmartCards or SD Cards with EncoreAnywhere, please visit the [EncoreAnywhere prerequisites](#) page for instructions on installing the required data card software.

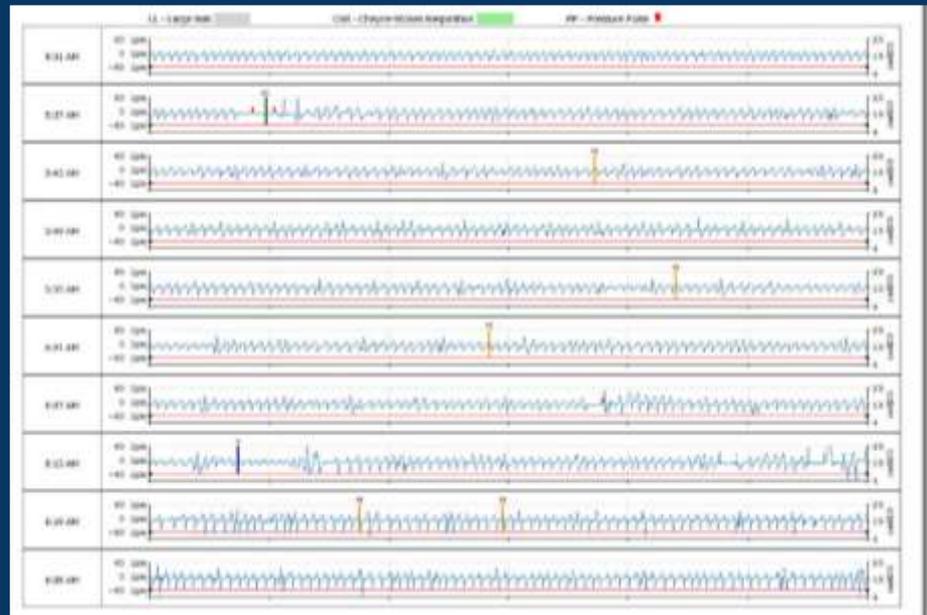
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MEMBER LOGIN

Username

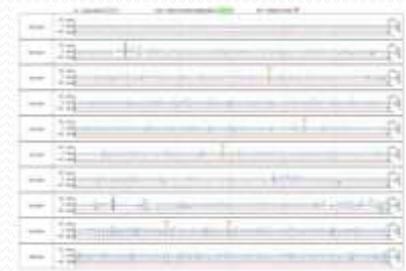
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Introduction

- Study hypothesis:
 - Device algorithms capture far fewer events than those apparent on manual analysis of flow data
- Study aims:
 - Compare device vs. manual residual events
 - Identify predictors of residual apnea



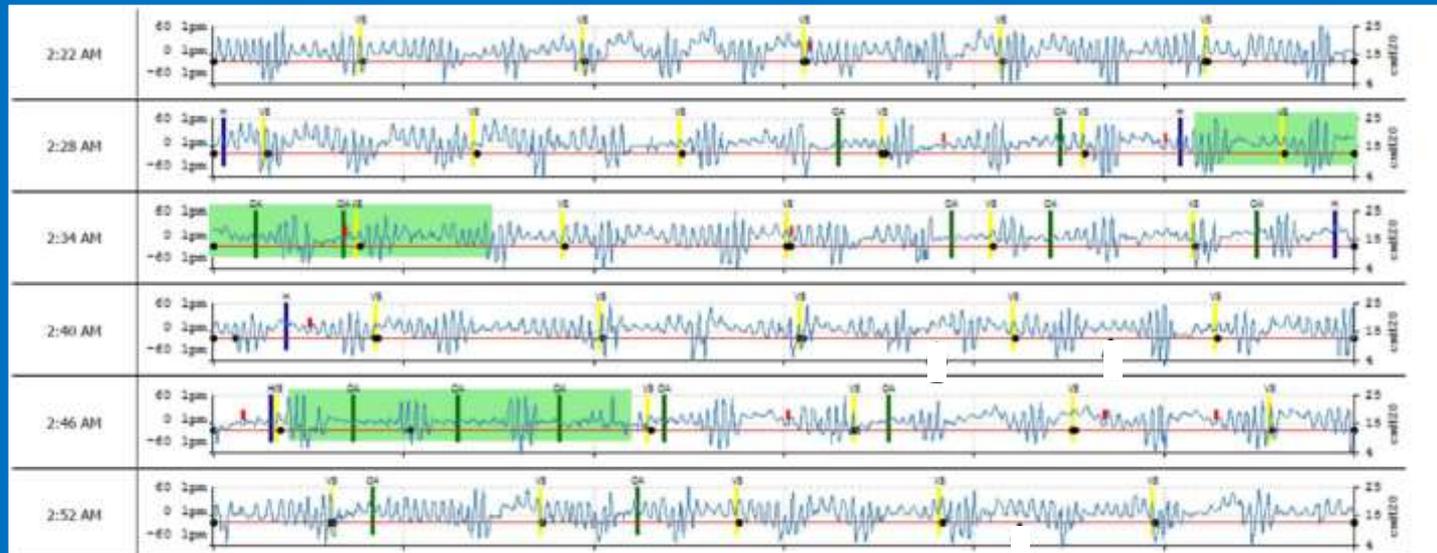
Methods

- Database:
 - Study conducted at the Beth Israel Deaconess Medical Center, Boston, MA
 - EncoreAnywhere™ online database queried for data between January & June 2013
 - Devices - REMstar Auto, BiPAP Pro, BiPAP Auto, BiPAP Auto SV Advanced
- Subject selection and supportive data:
 - PAP compliance - ≥ 3 months, ≥ 4 hours/night (average)
 - Most recent high-resolution flow data sample printed
 - Data divided randomly between 5 physicians and manually scored
 - Baseline data from medical record:
 - Age, gender, race, BMI, comorbidities, medications, baseline PSG/titration
 - Device, mode, O₂ supplementation

Methods

- Scoring

- Automatic detection - closed/open airway apnea, hypopnea, vibratory snoring, periodic breathing
- Manual scoring - events scored if clear reduction in signal amplitude ($\geq 30\%$) or flow limitation with recovery breaths
- Periodic breathing - nights tagged as present/absent



Results - Patient characteristics

Patient Characteristics (n=217)	
Age	54.7 ± 14.2
BMI	33.1 ± 7.7
Male	136 (63%)
Caucasian	184 (84%)
Hypertension	99 (45.6%)
Diabetes	30 (13.8%)
Heart failure	8 (3.7%)
Ischemic heart disease	18 (8.2%)
CPAP use period (days)	218 ± 32

Results - Polysomnography variables

	Baseline PSG	Titration PSG
Total sleep time (minutes)	278.9 ± 144.1	289.2 ± 91.8
Sleep efficiency (%)	76.7 ± 16.3	77 ± 14.7
N1 (%)	19.4 ± 15.9	11.1 ± 7.6
N3 (%)	12.4 ± 11.8	13.4 ± 11
REM (%)	11 ± 9.1	20.5 ± 10.6
Arousal index (events per hour)	32.1 ± 31.2	19.3 ± 14.9
RDI (events per hour)	60.2 ± 31.8	25.9 ± 18.4
AHI (events per hour)	41.7 ± 31.6	15.9 ± 15.5
AHI4% (events per hour)	27 ± 28.2	4.3 ± 7.1
Central apnea index (events per hour)	3.5 ± 8	3.5 ± 6.5
Oxygen 3% desaturation index (events per hour)	24.5 ± 25.3	8.7 ± 8.8
Minimum saturation (%)	81.3 ± 8.3	87.3 ± 5.7
Time under 90% saturation (minutes)	5 ± 11.4	5 ± 19.7
Periodic Limb Movement Index (events per hour)	17.8 ± 27	15.1 ± 24.1
PLM arousal index (events per hour)	8.2 ± 15.5	4.1 ± 9

Results - Database analysis

APAP Data	
Nightly use - 4 week average (h)	6.3 ± 1.5
Fixed pressure	76 (35%)
Residual apnea - auto detection AHI_{FLOW} (event/hour)	
Total	4.4 ± 3.8
Auto mode	4.4 ± 3.1
Fixed mode	7.4 ± 5.4

Results - Database analysis

- Predictors of residual apnea:

	Odds Ratio (CI)	p
Predictor of manual $AHI_{FLOW} \geq 5/h$		
Baseline PSG CAI	1.5 (1.1-2)	0.01
Baseline PSG CAI $\geq 5/h$	5 (2.2-13.8)	<0.001
Predictor of manual $AHI_{FLOW} \geq 10/h$		
Baseline PSG CAI	1.14 (1.1-1.3)	0.03

Unchanged adjusting for age, gender, race, baseline N1, sleep efficiency and diagnostic AHI

Discussion

- PSG AHI Vs. Device AHI_{FLOW}
 - Overall good correlation however:
 - Vendor algorithms vary, and there are no specific guidelines for detection
 - For a cutoff of AHI>10/h sensitivity 0.58; specificity 0.94
 - Good agreement for apneas less for hypopneas
 - Therefore - auto-detection may overestimate efficacy
- Inadequate control may lead to poor compliance

RESPIRATORY EVENT DETECTION BY A POSITIVE AIRWAY PRESSURE DEVICE

<http://dx.doi.org/10.5955/sleep.7991>

Respiratory Event Detection by a Positive Airway Pressure Device

Richard B. Berry, MD¹; Cate A. Kushida, MD, PhD, RPSGT²; Meir H. Kryger, MD³; Haideliza Soto-Calderon⁴; Bethany Staley, RPSGT⁵; Samuel T. Kuna, MD⁶

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INTERNAL MEDICINE

ORIGINAL ARTICLE

Comparison between the Apnea-Hypopnea Indices Determined by the REMstar Auto M Series and Those Determined by Standard In-Laboratory Polysomnography in Patients with Obstructive Sleep Apnea

Yukiko Ikeda¹, Takatoshi Kasai¹, Fouze Kawana², Seishi Kanagi¹, Hisashi Takaya¹, Sugao Ishiwata¹ and Keiji Nambu¹

Sleep Breath (2013) 17:109-101
DOI 10.1007/s11325-012-0870-x

ORIGINAL ARTICLE

The accuracy of autotitrating CPAP-determined residual apnea-hypopnea index

Aykut CIBI - Basen Uzun - Ugur Bilge

Journal of Clinical
Sleep Medicine

Evaluation of the Apnea-Hypopnea Index Determined by the S8 Auto-CPAP, a Continuous Positive Airway Pressure Device, in Patients with Obstructive Sleep Apnea-Hypopnea Syndrome

Kazuko Ueno, RPSGT¹; Takatoshi Kasai, M.D., Ph.D.¹; Gregory Brewer, MSBE²; Hisashi Takaya, M.D.¹; Ken-ichi Watanabe, M.D.¹; Seishi Kanagi, M.D., Ph.D.¹; Fouze Kawana, B.Sc., RPSGT³; Sugao Ishiwata, M.D., Ph.D.¹; Keiji Nambu, M.D.¹

¹Sleep Center, Jikei University Hospital, Tokyo, Japan; ²Department of Clinical Physiology, Jikei University Hospital, Tokyo, Japan; ³Canfield LAL, Glenloch Bay, NSW, Australia

Discussion

- Simultaneous APAP titration and PSG
 - 58% achieved good control of OSA
 - Predictors of PSG AHI were:
 - Hx of cardiac disease
 - Elevated CAI and arousal index on baseline diagnostic study
 - Although AHI median & range (IQR) from device (7.0, 3.9-11.6/h) and PSG (7.8, 3.9-14.4/h) were similar, case-by-case agreement was poor (chi-square < 0.001)
- Conclusion:
 - Close f/u of APAP titration needed
 - Device AHI does not reliably assess control and PSG assessment may be required if clinical response to treatment is poor

Conclusions

- High resolution data on stable compliant CPAP shows that:
 - Residual events are common
 - Events are poorly detected by devices
 - Devices missed
 - ~Half of mild residual apnea patients
 - ~ $\frac{3}{4}$ of moderate residual apnea patients
 - Baseline PSG central apnea index the only predictor of residual apnea

Home Sleep Testing in Peds

- Classification of portable sleep monitoring:
 - Type 1 - Fully attended PSG (≥ 7 channels)
 - Type 2 - Unattended PSG (≥ 7 channels)
 - Type 3 - Respiratory Polygraphy (4-7 channels; airflow, respiratory effort, saturation)
 - Type 4 - 1-2 channels only, traditionally at least one is oximetry



Home Sleep Testing in Peds

Type 2 - unattended PSG (≥ 7 channels)

- 5-12 year old; 162 - 201 subjects
- >91% acceptable, thermistor/press transducer mostly lost
- But:
 - No video, no CO_2
 - Population studies
 - Only 9 compared w/PSG
- Conclusion - possible in the research setting

EPIDEMIOLOGY AND SLEEP

Feasibility of Using Unattended Polysomnography in Children for Research— Report of the Tucson Children's Assessment of Sleep Apnea Study (TuCASA)

James L. Goodwin MS,¹ Paul L. Enright MD,¹ Kris L. Kaeding PhD,¹ Gerald M. Rosen MD,² Wayne J. Morgan MD,¹ Ralph F. Fregosi PhD,¹ Stuart F. Quan MD¹

¹Respiratory and Sleep Disorders Centers, Departments of Medicine and Pediatrics, University of Arizona College of Medicine, Tucson, AZ;
²Department of Pediatrics, University of Minnesota School of Medicine, Minneapolis, MN

 
Journal of Clinical
Sleep Medicine
<http://dx.doi.org/10.5664/jcsm.2012>

Feasibility of Comprehensive, Unattended Ambulatory Polysomnography in School-Aged Children

Carole L. Marcus, MBBCh, FAASM¹, Joel Taylor², Sarah N. Bogan, PhD¹, Helen S. Roberts, MSc¹, Gillian M. Nixon, MD^{1*},
Indra Narang, MD¹, Rakesh Dharwadkar, MD¹, Margit J. Davies, MBBCh^{1*}, Rosemary S.C. Horne, PhD¹,
Meeson Chouinard¹, K. Jeremy Gibbins, BSc¹, Joanne Day, BSc^{1*}, Elizabeth Axtal, MD¹, Lee W. Doyle, MD^{1*},
Gillian F. O'car, MBBCh, MD¹, Judy D'lane¹, Lorne Costello, BA¹, Ruth Bradford¹, Barbara Schmitt, MD^{1**},
for the Collaborative for Apnea of Prematurity-Sleep Trial (CAP-S)

Home Sleep Testing in Peds

Type 3 - Respiratory Polygraphy

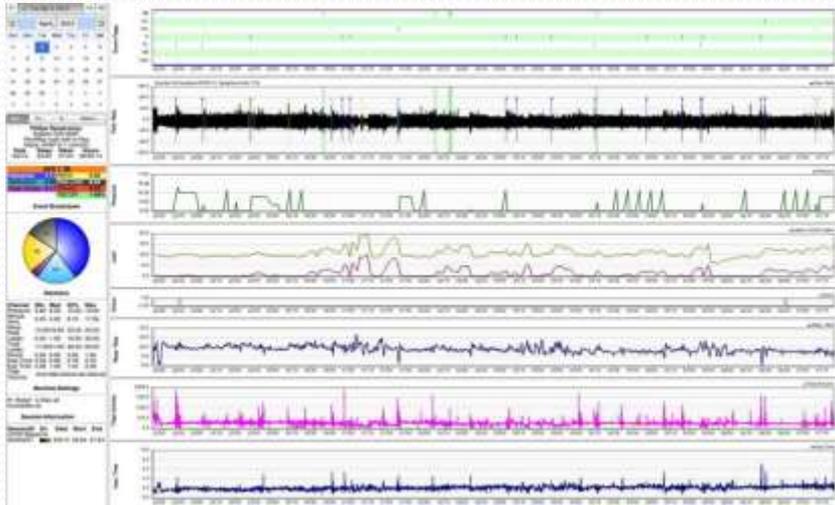


- Hypopneas leading to arousals missed
- TST overestimated
- Compared w/adults, missing several events more significant
- Studies in pediatrics are discordant
- Fair sensitivity & specificity w/high pretest probability for mod-sev disease, mild disease missed

Type 4 - Home oximetry

- High specificity, but low sensitivity, for pediatric OSA
 - A proportion of children have arousals w/preserved oxygenation
 - Restless sleep may result in artifacts mistaken for desaturations

Discussion



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Encore Anywhere™ is a complete solution for gathering and sharing patient compliance data from the web. Providing one personal compliance data file from each day!

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Member Login

MEMBER LOGIN

Username:

Password:

Log In

SleepyHead v0.9.3

This is a beta software and some functions may not work as intended yet. Please report any bugs you find to SleepyHead's SourceForge page.

CPAP Statistics as of Wednesday, November 26, 2014

944 days of CPAP Data, between 11/02/2010 and 11/26/2014

Details	Most Recent	Last 7 Days	Last 30 Days	Last 6 months	Last Year
AHI	2.59	2.60	2.32	2.04	2.91
REPA Index	0.20	0.88	0.69	0.20	0.62
Flow Limit Index	0.91	0.78	0.74	0.66	0.64
Hours per night	07:40	06:38	07:05	06:44	06:42
Average Pressure	5.00	9.00	4.94	4.89	4.28
ME% Pressure	18.60	17.60	18.60	16.60	16.20
Average Total Leaks	41.17	41.80	41.15	36.77	37.12
ME% Total Leaks	87.00	87.00	88.00	81.00	82.00

Changes to Prescription Settings:

First	Last	Days	AHI	FI	Machine	Mode	IPr	Tit	Min Pres.	Max Pres.
10/20/14	11/26/2014	29	0.91	0.68	PRS1	Auto	Auto	0.00	5.00	17.00
12/15/2013	01/01/14	78	2.20	0.64	PRS1	Auto	Auto	0.00	5.00	18.00
12/02/13	12/19/2013	4	0.91	0.41	PRS1	Auto	Auto	0.00	5.00	17.00
11/02/10	12/02/2013	32	0.40	0.00	PRS1	Auto	Auto	0.00	5.00	16.00



Questions?

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CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea

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- 2717, 45-75yo, mod-sev OSA & IHD/CVS
- Primary composite end point - CV death, MI, stroke, or hospitalization for unstable angina, HF or TIA
- After 3.7 years - 17 vs. 15.4%
- No sig difference in primary CV endpoints
- EDS, health related QOL and mood improved

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CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea

R. Doug McEvoy, M.D., Nick A. Antic, M.D., Ph.D., Emma Heeley, Ph.D., Yuanming Luo, M.D., Qiong Ou, M.D.,

- Limitations:
 - Mean CPAP use - 3.3 hours!
 - 9 centers - "for several of the participating countries, the diagnosis and treatment of sleep apnea were not well established in clinical practice when the trial began"
 - On treatment vs. intention to treat benefit
- Conclusions:
 - Secondary prevention not proven
 - Screening for asymptomatic OSA
 - RCT welcome



- Questions?