

# Improving PAP adherence

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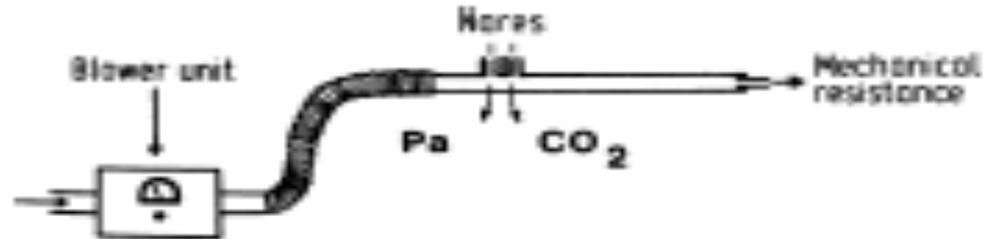


## CPAP: an evolutionary treatment for OSA

The first CPAP machine  
was invented by Collin  
Sullivan in 1981  
assembled from parts of  
vacuum cleaner



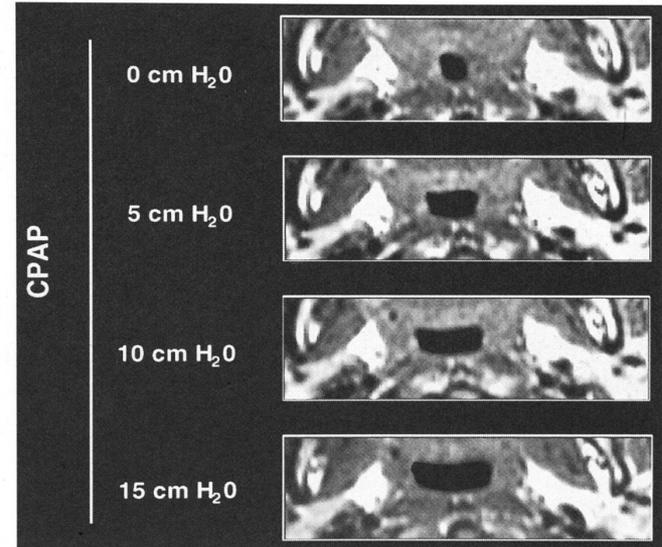
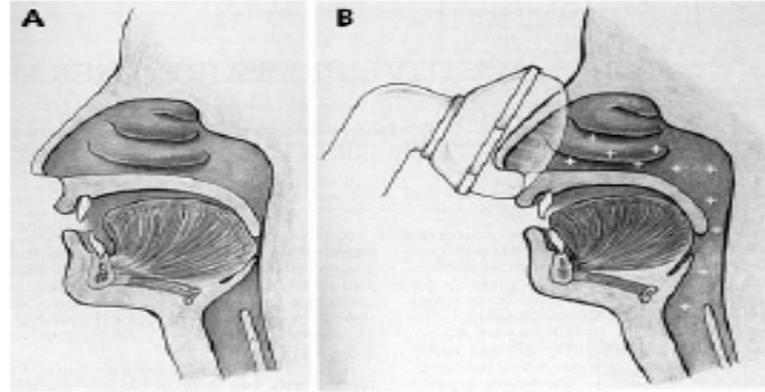
- The original CPAP device was described by Collin Sullivan in 1981, consisted of a vacuum blower motor with variable speed control. “HEAVY & LOUD”



*Sullivan CE, et al. Lancet 1981*

# Positive pressure and the upper airway

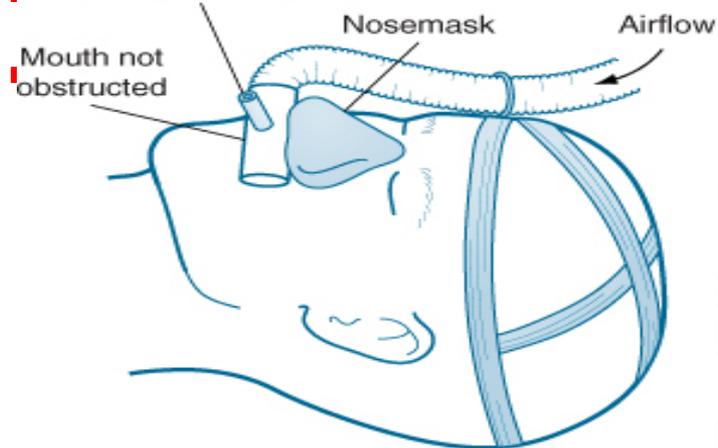
- ***Pneumatic splint*** Positive pressure provides a stent to offset the oropharyngeal collapse
- ***Increases in the functional residual capacity*** with increases in pharyngeal patency



# Components of CPAP

- Machine

- Expiratory resistance



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- Current status of CPAP use
- Determining the adherence: what is the adherence rate?
- Predictors of adherer vs non-adherer
- Interventions to improve PAP adherence
  - Equipment and technology
  - Behavioral and psychological aspects
  - Long-term follow ups

## Current status of CPAP use

- Obstructive sleep apnea (OSA) is a common disease affecting 4-9% of the general population, leading to many fatal and non-fatal cardiovascular disease, accidents, and mortality.
- When used as prescribed, Continuous Positive Airway Pressure (CPAP) reduces daytime sleepiness, normalizes sleep architecture, and improve OSA-specific health outcomes.
- Although, CPAP is considered to be the standard first line treatment for OSA, the adherence rate is still low making treatment outcome suboptimal both in RCT and cohort.

# Flattened Trends of CPAP use over the 2 decades

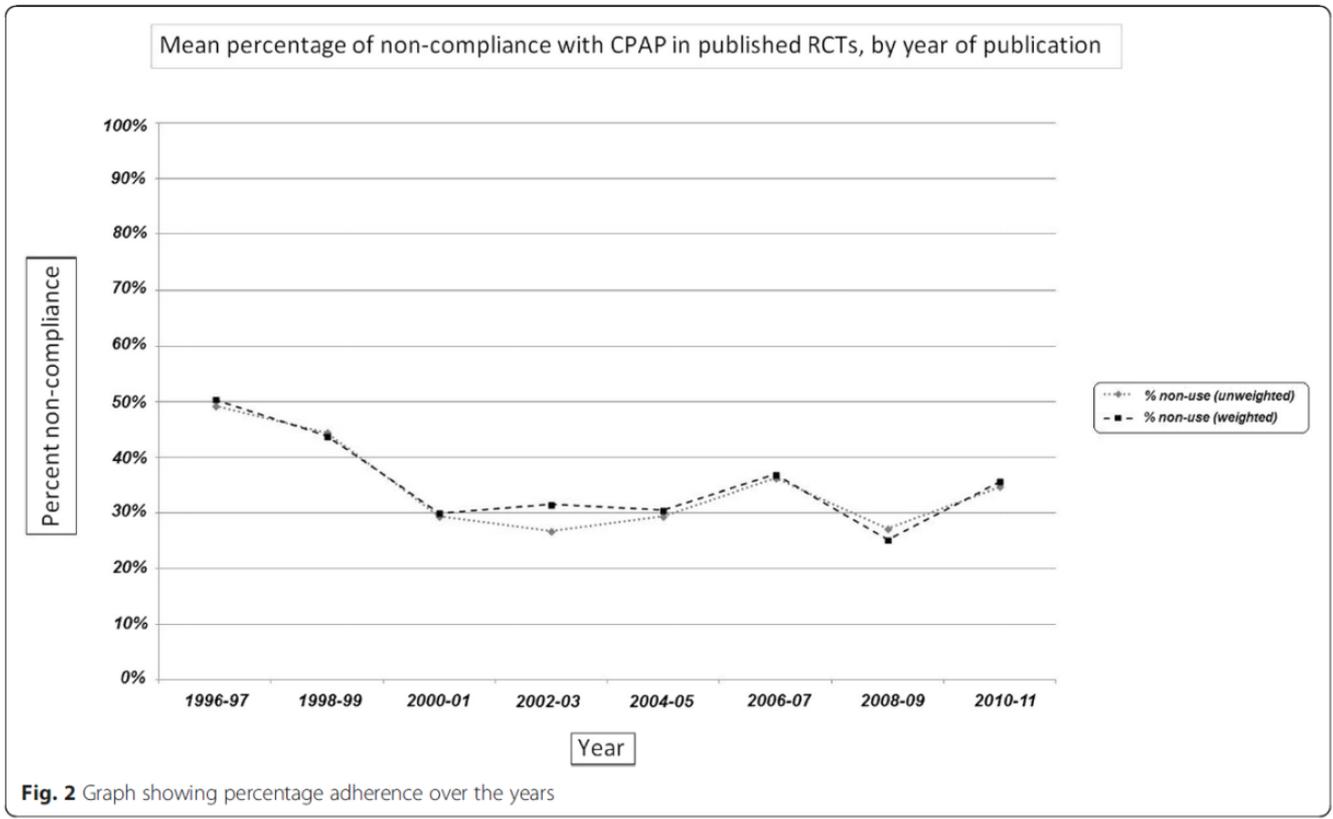


Fig. 2 Graph showing percentage adherence over the years

- 82 RCTs, Cohorts were included in the meta-analysis
- Weighted mean CPAP use was 4.46 and 36.3% non-adherence rate
- Behavioral intervention increases the mean use about 1 hour (4.7vs3.5 hours)
- Self reported adherence were overestimated by 32.7% compared to machine download data

# CPAP acceptance and adherence rates in Asia: Cohort data

Author/year	Country	Severity of OSA	Study period	Acceptance Rate (%)	Adherence Rate (%)
Lee, 2017	Singapore	Moderate-Severe	1 year	57.8	52.6
Wang Y, 2012	China	Severe	30 months	67	65
Hui DS, 2001	Hong Kong	Moderate, Severe	3 months	100	72
Tokunaga, 2013	Japan	Moderate, Severe	19 months	91	90
Tanahashi, 2012	Japan	Mild, moderate, severe	6 months	87	38
Hussain, 2014	Pakistan	Mild, moderate, severe	1 year	80	76
Yang MC, 2013	Taiwan	Mild, moderate, severe	9 months	40	64
Ramathibodi Sleep Center, 2018*	Thailand	Mild, moderate, severe	6 months	85	60

*Lee, et al. Sleep Sci 2017;10:57-63*

*\*Pengjam, et al. submitting for publication*

## Defining the adherence definition

- Many studies referred to adherence as “using > 4 hours for more than 70% of the time”. However adherence should be defined based on evidence of improve in clinical outcome.
- Hours use to improve clinical outcome differ according to various outcomes
  - Daytime symptoms: sleepiness, functional outcomes
  - Cardiovascular outcomes:
  - Diabetic outcomes:

## Controlling daytime symptoms

- **Hours of CPAP use require to control daytime symptoms**
  - 4 hours/night for self-reported sleepiness
  - 6 hours/night for objective sleepiness
  - 7.5 hours/night for functional status
  - 5.2 hours/night for memory impairment

*Weaver, TE, et al. Sleep 2007;30:711-719*

*Antic NA, et al. Sleep 2011;34:111-119*

*Zimmerman ME, et al. Chest 2016;130:1772-1778*

# Optimal Adherence for controlling Cardiovascular Outcomes

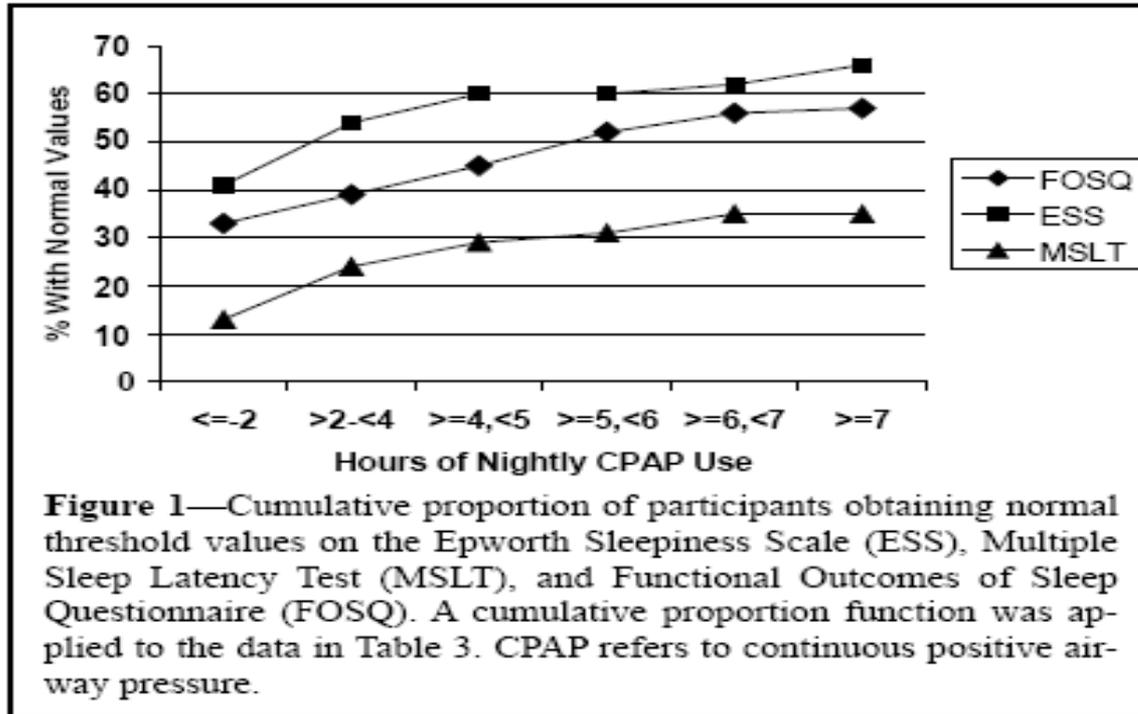
- **Surrogate outcome: blood pressure**
  - lowering effect of CPAP from meta-analysis of RCTs showed reduction in SBP -3.2 mmHg , DBP-2.87 mmHg
  - Every 1 hour of CPAP use was associated with 1.4 mmHg reduction in mean BP
- **Sleepier patients may experience greater reduction from CPAP**
  - Each 5-point increase in baseline ESS was associated with a reduction in SBP 1.9 mmHg ( $p=0.06$ ) and DBP of 1.4 mmHg ( $p=0.04$ )

*Schein, et al. Journal of Hypertension, 2014*

*Haentjens P, et al. Arch Intern Med 2007;167::757-764*

*Montesi SB, et al. J Clin Sleep Med. 2012;8:587-596*

## Relationship Between Hours of CPAP Use and Achieving Normal Levels of Sleepiness and Daily Functioning.



# CPAP use hour for controlling cardiovascular outcomes

- In a cohort studies, CPAP adherence had shown to reduce cardiovascular morbidities and mortalities compared to nonadherence in men, women, and elderly.
- Although, large scale RCTs reported negative results on cardiovascular morbidity and mortality based on intention-to-treat analysis, with average CPAP use 3.3 and 5 hours/night.
- It is too early to conclude that CVS risk is not attributable from OSA, but may be the level for beneficial CPAP use has not been reached.

*Marin, JM, et al. Lancet 2005;365:1046-1053*

*Campos-Rodriguez, et al. Ann Intern Med.2012;156:115-122*

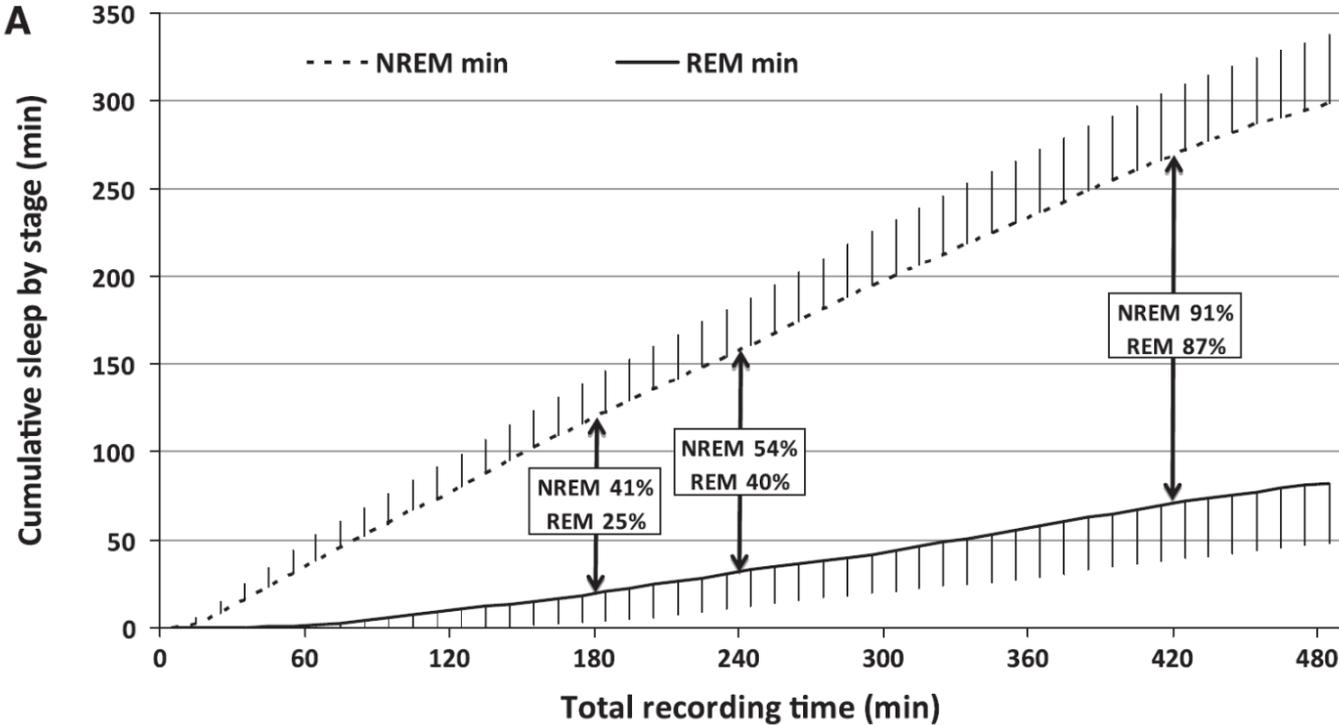
*Marinez-Garzia, MA, et al. Am J Respir Crit Care Med. 2012;146:909-916*

*Barbe F, et al. JAMA. 2012;307:2161-2168*

*McEvoy RD, et al. N Eng J Med. 2016;375:919-931*

*Peker Y, et al. Am J Respir Crit Care Med 2016;194:613-620.*

## Association of Obstructive sleep Apnea in Rapid Eye Movement Sleep with Reduced Glycemic control in Type 2 Diabetes: Therapeutic Implication



- REM AHI was associated with increasing level of HbA1C (p=0.008), but not NREM AHI (p=0.76)
- The model predicts
  - 4 hour** of CPAP use leave 60% of the REM sleep untreated with **0.25% reduction in HbA1c**
  - 7 hour** of CPAP use would cover **>85%** of REM sleep with decrease in HbA1c by **1%**

- In Type2 DM, OSA during REM sleep may influence long-term glycemic control and metabolic effect of CPAP maynot be achieved with typical adherence of 4 hour/night

*Grimaldi, D, et al. Diabetes Care. 2014;37:355-363*

# Impact of OSA during REM sleep on hypertension and cardiovascular disease

- Data from Wisconsin Sleep Cohort showed that **OSA isolated to REM sleep (REM AHI>15 with NREM AHI<5)** was independently associated with prevalent and incident hypertension and non-dipping of nocturnal BP.
- Those with prevalent CVS disease at baseline, having **REM OSA** had hazard ratio of **2.56(95% CI 1.46-4.47 for composite CVS disease**.
- Another study also showed that **severe OSA isolated to REM sleep doubles the risk for recurrent CVS risks**
- **Adherence rate among REM-OSA** (23.3%;3.8 ±1.8 hrs) maybe **lower** compared to non-stage specific OSA (33.3%;5.1 ±2.1 hrs) in a 1 year cohort study.

*Mokhlesi B, et al. 2015 Thorax;70:1062-1069*

*Aurora RE, et al. Am J Respir Crit Care Med 2018;197:653-660*

*Almeneessier A, et al. J Thorac Dis 2017;9:3755-3765*

## Other considerations

- Adherence is often considered as hours used per night, not as proportion of total sleep time. 4-hour use = insufficient to cover the whole night and especially during REM sleep
- Even in the absence of CVS effects, CPAP treatment in OSA has impact on sleepiness, mood, and functional status, it is important to focus on **increasing CPAP adherence as a key focus.**

## Predictors of adherence/nonadherence

- In a retrospective cohort of 695 patients with newly diagnosed OSA prescribed for CPAP with median follow up of 3 years. Data showed adherence rate of **89% for severe OSA, 71% for moderate OSA, and 55% for mild OSA.**
- Predictors for **CPAP nonadherence** were **AHI (HR 0.963,  $p<0.001$ ), ESS (HR 0.963,  $p=0.001$ ), and smoking (HR 1.576,  $p=0.022$ )** after adjusting for age, gender, and comorbidity

# Types of adherent and nonadherent CPAP users

## ■ Adherent CPAP user

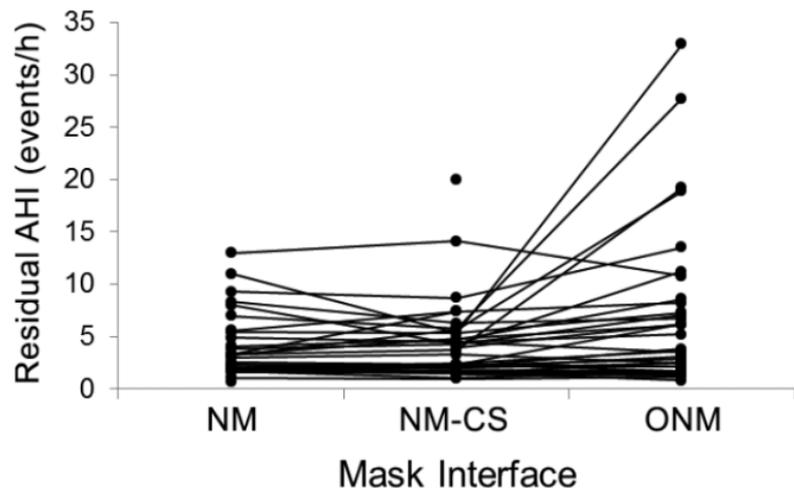
- Define risks associated with OSA
- Identify outcome expectation from outset
- Have fewer barriers than facilitators
- Facilitators less important later with treatment use
- Develop goals and reasons for CPAP use
- Describe positive belief in ability to use CPAP even with potential or experienced difficulties
- Proximate social influences prominent in decisions to pursue diagnosis and treatment

## ■ Nonadherent CPAP use

- Unable to define risks associated with OSA
- Describe few outcomes expectations
- Do not recognize own symptoms
- Describe barriers as more influential on CPAP use than facilitators
- Facilitator of treatment absent or unrecognized
- Describe low belief in ability to use CPAP
- Describe early negative experiences with CPAP, reinforcing low belief in ability to use CPAP
- Unable to identify positive responses to CPAP during early treatment

# Comparing efficacy, mask leak, patient adherence and patient preference of 3 different CPAP interfaces to treat moderate to severe OSA

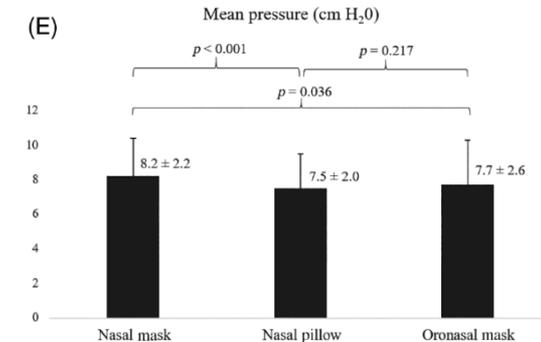
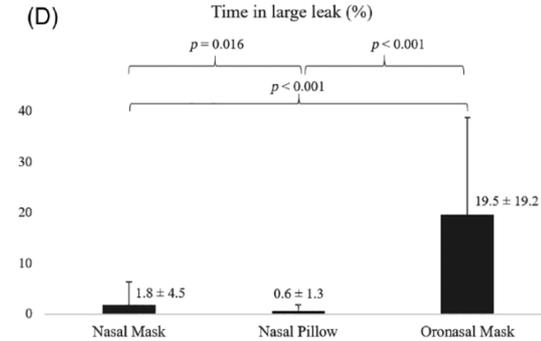
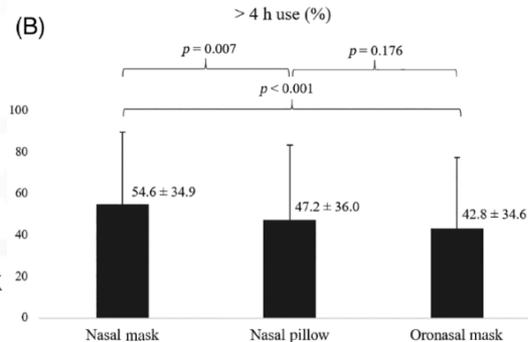
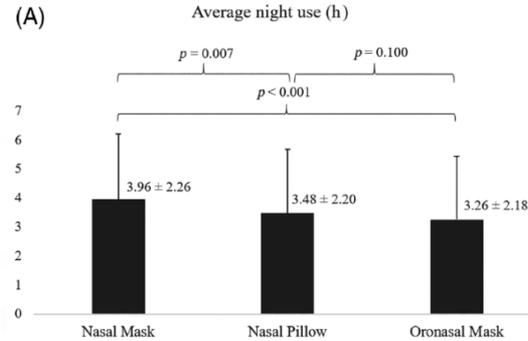
**Figure 2**—Residual AHI with each mask interface type.



- A Cross-over RCT for 4 weeks randomly assign to nasal mask (NM), nasal mask-chinstrap (NM-CS), and oronasal mask (ONM)
- CPAP adherence was not different, but residual AHI was higher in ONM than NM and NM-chinstrap.
- Patient satisfaction/preference, and quality of sleep were better for NM with fewer leaks and mask fit problem
- Nasal mask (+/- chinstrap) should be first choice for OSA patients with CPAP

# Choosing the right mask for your Asian patients with sleep apnoea: A randomized crossover trial of CPAP interfaces

- A randomized crossover trial of mask interfaces in CPAP therapy in moderate to severe OSA with nasal mask, pillow mask, and oronasal mask (n=85)
- Patients had **better adherence with nasal mask compared to oronasal mask and pillow**
- **Residual AHI was higher in oronasal masks compared to pillow and nasal masks**
- **Nasal mask are the preferred interface during CPAP initiation.** However, in subgroup of patients with lower NOSE score showed best adherence with oronasal mask



Factors	
<b>Disease and patients characteristics</b>	<ul style="list-style-type: none"> <li>-Disease severity</li> <li>- Sleepiness (higher CPAP use)</li> <li>- Insomnia-phenotype (lower CPAP use)</li> <li>- Upper airway/nasal patency</li> <li>- REM OSA vs non-stage specific OSA</li> </ul>
	Ethnics (white versus minority)
	Socio-economic status, education level Reimbursement vs out-of-pocket
<b>Device related</b>	Heated humidification Auto-CPAP, Flexible pressure
<b>Side effect</b>	Early troubleshooting Airleak, mask discomfort, intolerance, nasal congestion/dryness, skin redness/ulceration, gastric distention, eye discomfort, irritation, noisy machine
<b>Psychological factors</b>	Claustrophobia, personality type, social support

## A Brief Survey of Patients' First Impression after CPAP Titration Predicts Future CPAP Adherence: A Pilot Study

Jay S. Balachandran, M.D.<sup>1</sup>; Xiaohong Yu, M.D.<sup>2</sup>; Kristen Wroblewski, M.S.<sup>3</sup>; Babak Mokhlesi, M.D., M.Sc., F.A.A.S.M.<sup>1</sup>

<sup>1</sup>Sleep Disorders Center; Section of Pulmonary and Critical Care, Department of Medicine, <sup>2</sup>Department of Psychiatry,

<sup>3</sup>Department of Health Studies, Biostatistics Laboratory, University of Chicago, Chicago, IL

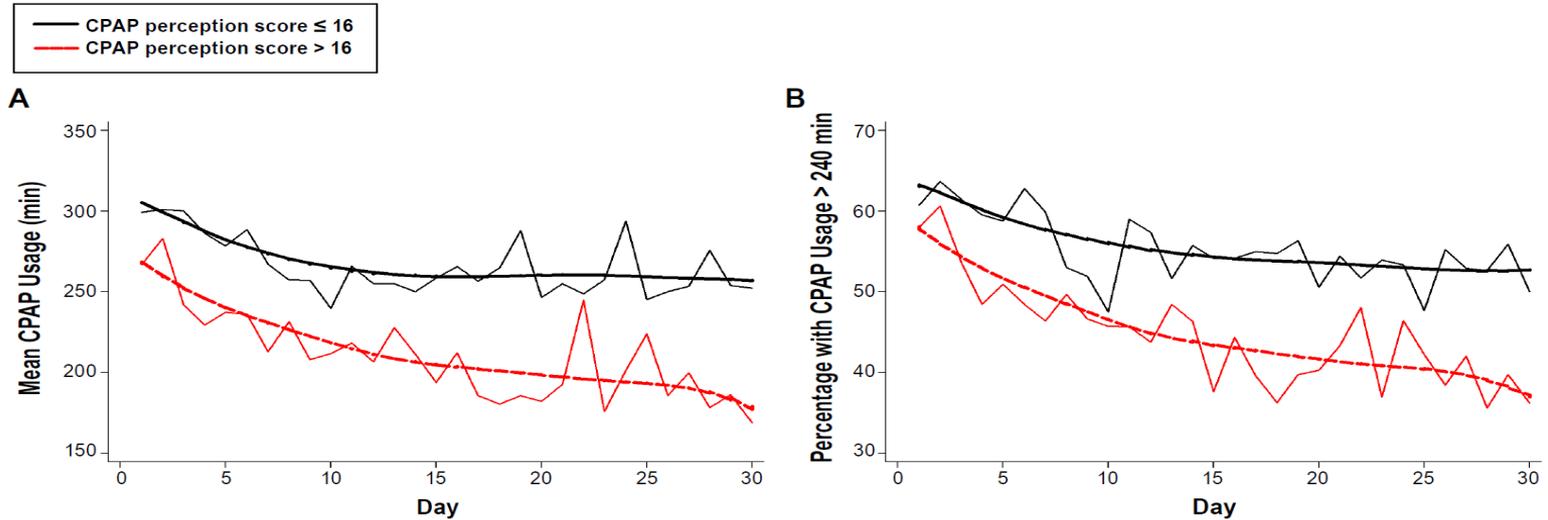
1. How much difficulty did you have tolerating CPAP?
2. How uncomfortable was the mask?
3. How uncomfortable was the CPAP pressure?
4. What is the likelihood of you wearing the equipment at night almost every night?
5. How beneficial do you think CPAP is going to be for your health and sleep?
6. What is your attitude towards CPAP therapy?

**Table 3**—Stepwise linear regression model of mean CPAP adherence over the first 30 days of therapy

	Beta coefficient (minutes)	95% CI	p value
CPAP perception score (per each point in a scale of 4 to 40)	-3.3	-5.5, -1.0	0.005
African American race	-46	-80, -12	0.007
Non-sleep specialist ordering PSG	-69	-108, -31	< 0.001

*Balachandran, et al. J of Clin Sleep Med 2013*

**Figure 2**—CPAP perception score predicts nightly CPAP use and percentage of patients with  $\geq 4$  hours nightly CPAP use



The mean CPAP perception score was used to create two categories of patients: poor CPAP perception (scores  $> 16$ ) and good CPAP perception (scores  $\leq 16$ ). Higher scores on the CPAP perception score were associated with decreased nightly CPAP usage (**A**)  $p = 0.001$ . Similarly, higher scores on the CPAP perception score were associated with a decreased percentage of patients using CPAP  $\geq 4$  hours each night (**B**)  $p < 0.001$ . Lowess smooth curves were added to summary plots to aid in assessment of trends.

# Factors that determine CPAP adherence

## ■ Pretreatment:

- Referral source: patients, bedpartner, physician
- Knowledge of OSA, and perception of CPAP treatment
- Involvement of bedpartner in education and treatment initiation
- patient' s tendency of problem solving
- assessment of claustrophobic tendencies
- Evaluation of nasal resistance
- Exposure to CPAP before initiation of therapy

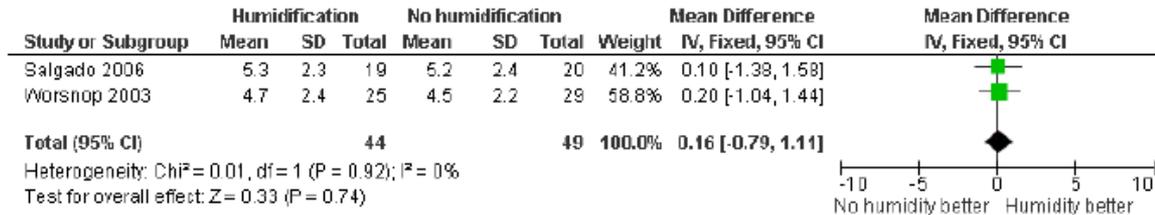
## With treatment initiation

- Heated humidification
- Early follow-up
- Assessment of CPAP use and associated outcomes
- Assessment of patient perception of treatment and symptom-related treatment response
- Troubleshooting problems immediately- especially the first week of treatment
- Evaluation for residual sleepiness
- Retitrate if residual events suspected

# Humidification

There were conflicting findings between studies. Two parallel group found no significant difference in machine usage, whereas a cross-over study found a significant difference

**Figure 10. Forest plot of comparison: 4 Heated humidification + fixed pressure CPAP versus fixed pressure CPAP alone, outcome: 4.1 Machine usage (hours/night) - 1st arm parallel studies.**



*Pressure modification for improving usage of CPAP machine in adults with obstructive sleep apnoea. Cochrane Review 2009*

## Intervention to improve CPAP adherence:

### A structured, multidisciplinary, cost-effective model for long term CPAP

- Technological components
- Educational and behavioural components
- Telemedicine

# Humidifiers

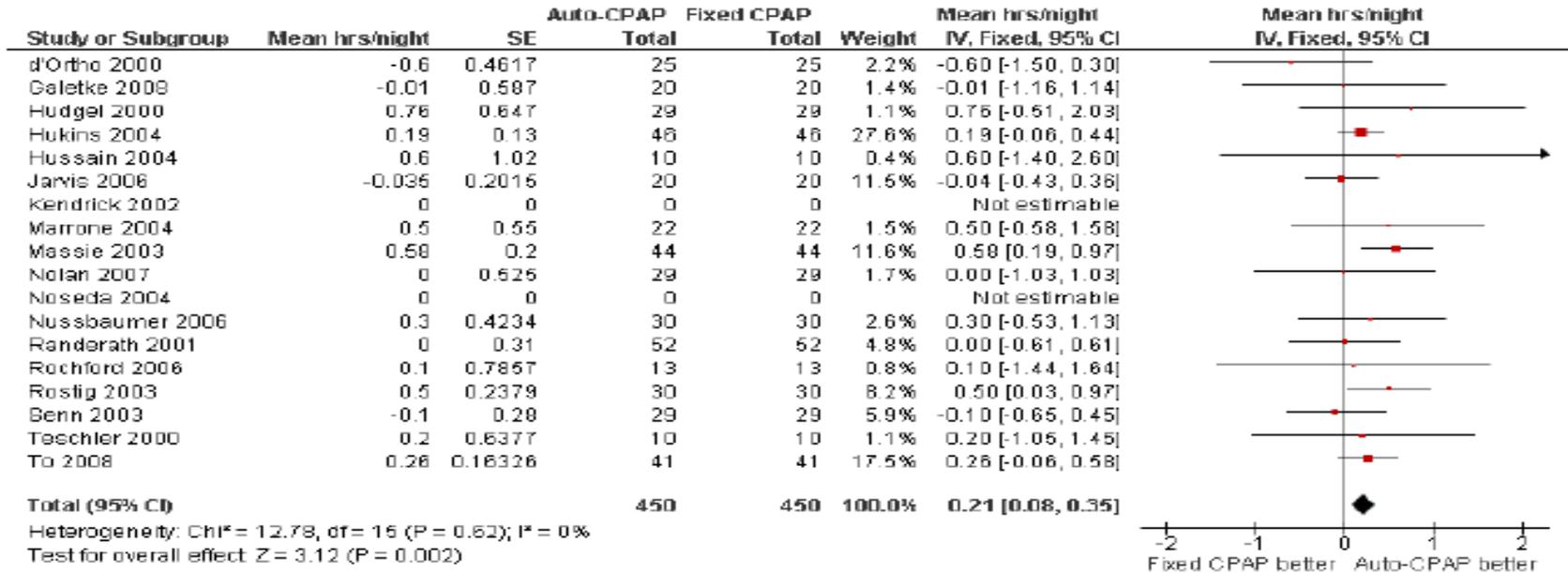
- RCT, Cross-over study of 38 OSA pts. With 3 interventions of heated humidity, cold passover humidity, and washout period. (3 wk treatment, 2 wk wash-out)
- CPAP use with heated humidifier was greater than CPAP use with cold passover humidity and CPAP alone ( 5.52 ±2.1vs4.93 ± 2.2, p=0.008).
- No difference found for **compliance between CPAP alone and CPAP cold passover.**
- Patients reported were more satisfaction with heated humidity, awaking feeling more refreshed, less dryness of throat ( p≤0.05)without difference in side effect, ESS.

# Humidification

- Prospective Randomized cross over study done in Thailand
- 20 moderate to severe OSA subjects with nasopharyngeal symptoms
- Even in a tropical climate area, CPAP adherence and quality of life appeared to improve when heated
- humidification was employed in subjects with moderate to severe OSA with nasopharyngeal symptoms post-split-night polysomnography. The improvement may be related to a reduction in the dry throat/sore throat symptom.

*Soudorn C, Muntham D, Reutrakul S, Chirakalwasan N. Respir Care. 2016 May 24.*

**Figure 3. Forest plot of comparison: 1 Auto-CPAP versus fixed CPAP, outcome: 1.2 Machine usage - cross-over studies.**



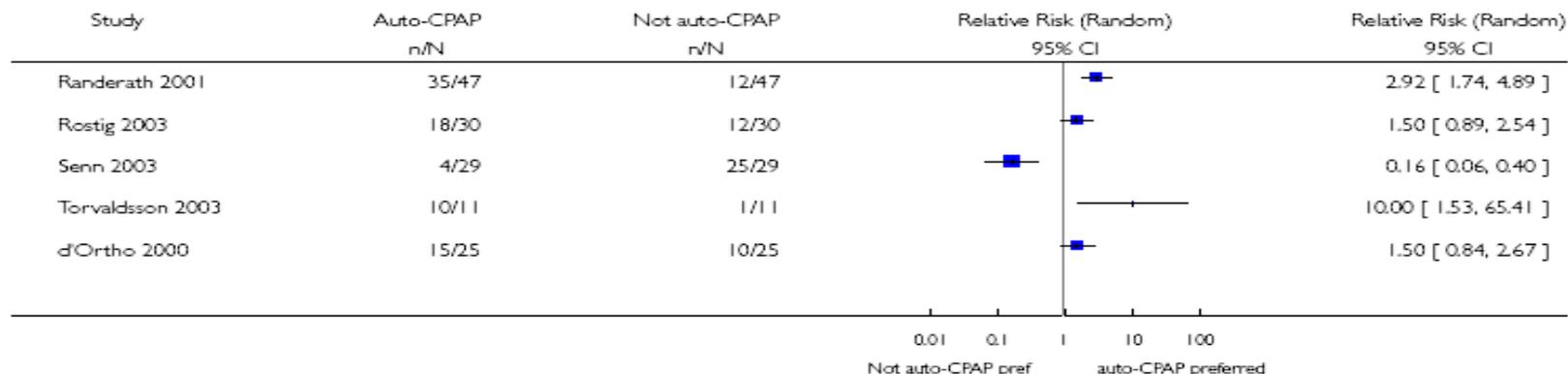
*Pressure modification for improving usage of CPAP machine in adults with obstructive sleep apnoea. Cochrane Review 2009*

### Analysis 01.07. Comparison 01 Auto-CPAP versus fixed CPAP, Outcome 07 Patient preference (auto CPAP/not auto CPAP)

Review: Interventions to improve compliance with continuous positive airway pressure for obstructive sleep apnoea

Comparison: 01 Auto-CPAP versus fixed CPAP

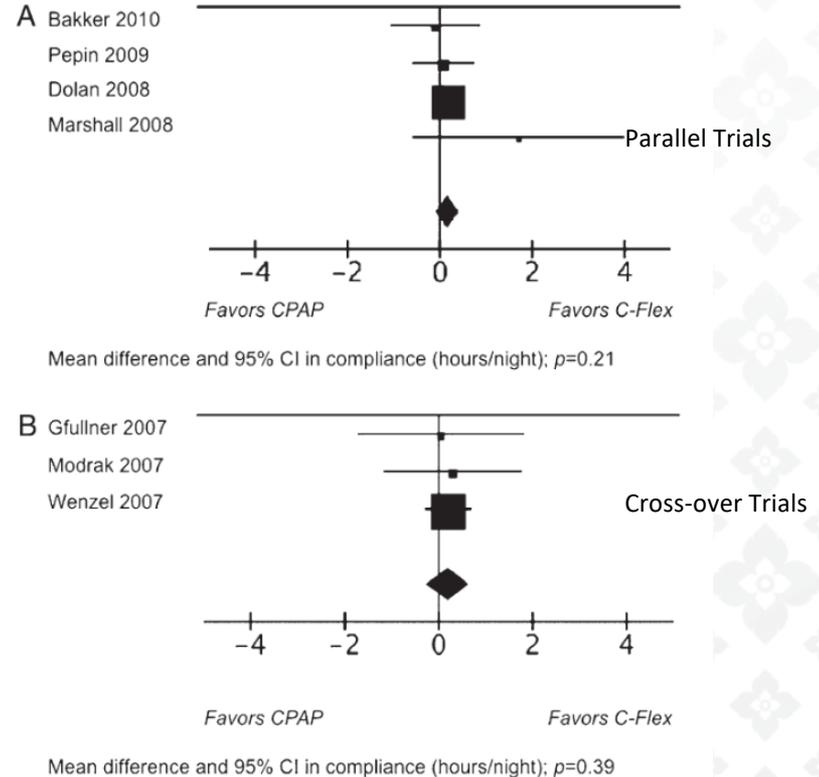
Outcome: 07 Patient preference (auto CPAP/not auto CPAP)



# Flexible Pressure Delivery Modification of Continuous Positive Airway Pressure for Obstructive Sleep Apnea Does not improve compliance with therapy: Systematic Review and Meta-Analysis

- 10 Studies (n=599) were included, data was extracted from **7 studies (n=514) using flexible pressure for OSA for meta-analysis**
- Flexible pressure did not improve compliance** compared with CPAP in either **parallel** (0.16h; 95%CI -0.90-0.41;  $p=0.21$ ) or **cross-over trials** (0.20h; 95%CI -0.26-0.66;  $p=0.21$ )

Bakker JP, et al. *Chest* 2011;139:1322-1330

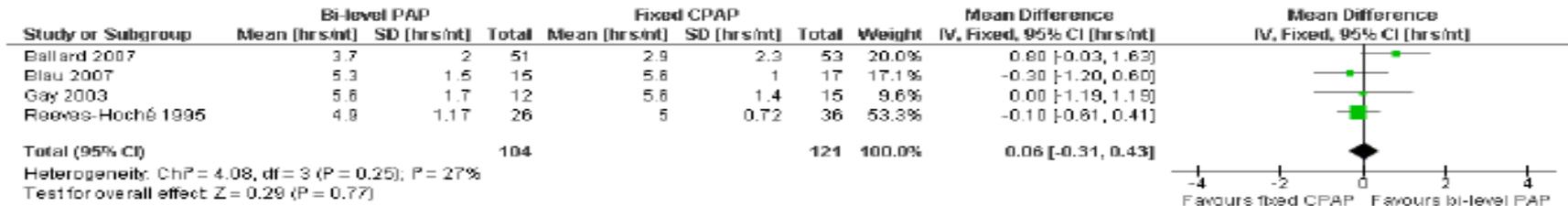


# BiPAP vs Fixed CPAP

3 studies: No significant difference in compliance.

No difference in preference in 1 study.

**Figure 7. Forest plot of comparison: 2 Bi-level PAP versus fixed CPAP, outcome: 2.1 Machine usage (hours/night) - 1st arm/parallel studies [hrs/nt].**



# The Efficacy of a Brief Motivational Enhancement Education Program on CPAP Adherence in OSA

## A Randomized Controlled Trial

Agnes Y. K. Lai, DN; Daniel Y. T. Fong, PhD; Jamie C. M. Lam, MD, FCCP; Terri E. Weaver, PhD; and Mary S. M. Ip, MD, FCCP

- A RCT of 100 newly diagnosed OSA patients random into either brief motivational enhancement education program or usual care (control)
- Program focus on enhance **subject's knowledge, motivation, and self-efficacy** by means of 25-min video, 20-min patient center interview, and 10-min telephone follow-up.
- Outcomes were **self-reported sleepiness, adherence, and quality of life at 1 and 3 months**
- Intervention group had **better CPAP use by 2 hour/d** (Cohen  $d=1.33$ ,  $p<0.001$ ), **4-fold increase in adherence rate,  $p<0.001$** , and greater improvement in ESS compared to control group

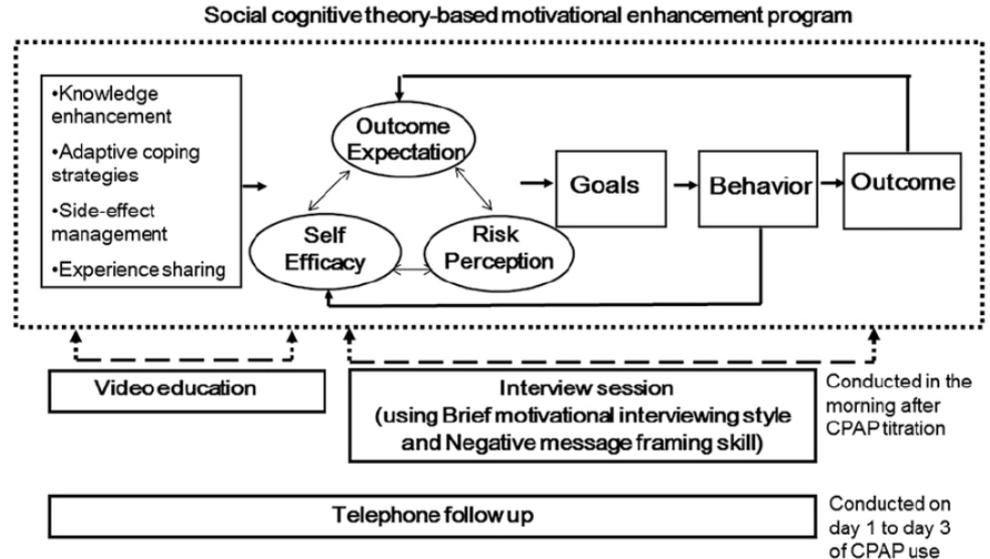
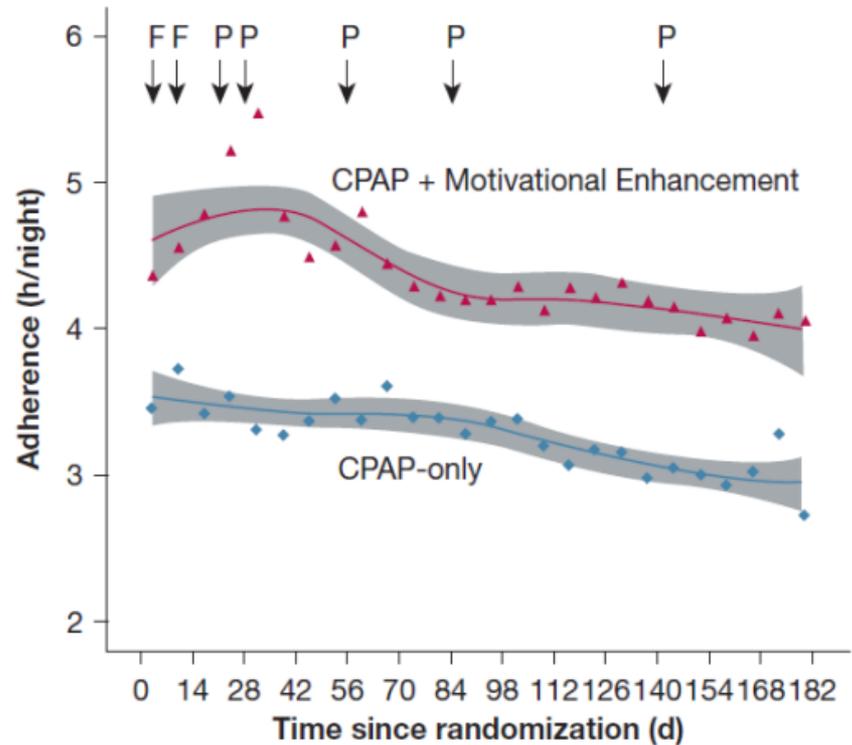


Figure 1 - The conceptual framework and time of conduction of the motivational enhancement education program.

# Motivational enhancement for increasing adherence to CPAP: A randomized controlled trial

- A open-label RCT of CPAP +ME (n=41) compared to CPAP alone (standardized CPAP support)(n=42)
- In moderate to severe OSA patients (age 45-75 years) without marked sleepiness and with either CVD or at risk
- ME was delivered by psychologist
  - (2 appointments and 6 phone calls over 32 weeks)
- Intention-to-treat analysis was applied to compare objective CPAP adherence
- In fully adjusted model, **CPAP+ME showed higher average nightly adherence at 6 months (+99.0 min higher, p=0.003) and 97 min higher at 12 months** in subset of patients (n=52)



## Comparison 1. Increased practical support and encouragement during follow-up + CPAP versus usual care + CPAP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Machine usage (hours/night)	13	803	Mean Difference (IV, Random, 95% CI)	0.82 [0.36, 1.27]
2 Machine usage, sensitivity analysis: excluding participants aware of machine usage monitoring	6	378	Mean Difference (IV, Fixed, 95% CI)	1.07 [0.61, 1.52]
3 Machine usage, sensitivity analysis: adherence in control group < four hours/night	8	471	Mean Difference (IV, Fixed, 95% CI)	1.36 [0.96, 1.76]
4 N deemed adherent ( $\geq$ four hours/night)	4	268	Odds Ratio (M-H, Fixed, 95% CI)	2.06 [1.22, 3.47]
5 Epworth Sleepiness Scale scores	8	501	Mean Difference (IV, Random, 95% CI)	-0.60 [-1.81, 0.62]
6 Quality of life: Functional Outcomes of Sleep Questionnaire	2	70	Mean Difference (IV, Fixed, 95% CI)	0.98 [-0.84, 2.79]
7 Quality of life: Sleep Apnoea Quality of Life Index (SAQLI)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8 Mood	3	312	Mean Difference (IV, Fixed, 95% CI)	-0.94 [-1.55, -0.33]
8.1 HAD Scale for Anxiety	1	80	Mean Difference (IV, Fixed, 95% CI)	-1.10 [-2.95, 0.75]
8.2 HAD Scale for Depression	3	232	Mean Difference (IV, Fixed, 95% CI)	-0.93 [-1.57, -0.28]
9 Withdrawals	12	903	Odds Ratio (M-H, Fixed, 95% CI)	0.65 [0.44, 0.97]
10 AHI on treatment	2	115	Mean Difference (IV, Fixed, 95% CI)	-0.07 [-1.62, 1.48]
11 Maintenance of Wakefulness Test (MWT)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

## Educational, supportive and behavioural interventions to improve usage of continuous positive airway pressure machines in adults with obstructive sleep apnoea (Review)

### Comparison 2. Educational interventions + CPAP versus usual care + CPAP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Machine usage (hours/night)	7	508	Mean Difference (IV, Fixed, 95% CI)	0.60 [0.27, 0.93]
2 N deemed adherent ( $\geq$ four hours/night)	3	285	Odds Ratio (M-H, Fixed, 95% CI)	1.80 [1.09, 2.95]
3 Epworth Sleepiness Scale scores	5	336	Mean Difference (IV, Fixed, 95% CI)	-1.17 [-2.07, -0.26]
4 Quality of life: Sleep Apnoea Quality of Life Index (SAQLI)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
5 HAD Scale for Depression	2	152	Mean Difference (IV, Fixed, 95% CI)	-0.52 [-1.25, 0.22]
6 Withdrawal	8	683	Odds Ratio (M-H, Fixed, 95% CI)	0.67 [0.45, 0.98]

## Educational, supportive and behavioural interventions to improve usage of continuous positive airway pressure machines in adults with obstructive sleep apnoea (Review)

### Comparison 3. Behavioural therapy + CPAP versus control + CPAP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Machine usage (hours/night)	6	584	Mean Difference (Random, 95% CI)	1.44 [0.43, 2.45]
2 Sensitivity analysis: excluding participants aware of machine usage monitoring	5		Mean Difference (Fixed, 95% CI)	1.54 [0.99, 2.09]
3 N deemed adherent ( $\geq$ four hours/night)	3	358	Odds Ratio (M-H, Fixed, 95% CI)	2.23 [1.45, 3.45]
4 Epworth Sleepiness Scale score	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
5 Quality of life: Functional Outcomes of Sleep Questionnaire	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
6 Withdrawal	5	609	Odds Ratio (M-H, Fixed, 95% CI)	0.85 [0.57, 1.25]

# Conceptual Framework for CPAP-motivation education class based on the Health belief Model

## ■ Translation into the real-world routine

CPAP clinic



**Conceptual Framework**

**Individual Level**

**STRATEGIES**

**Health Belief Model:**  
perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy

**Stages of change model:** assess each stages: pre-contemplation, contemplation, decision, action, maintenance

- Intensive Education to enhance knowledge and awareness
- Motivation session through HBM
- Negative message framing
- Skill to wear CPAP and troubleshooting technical problems/side effect management
- Adaptive coping strategies

**Interpersonal Level**

**Social cognitive Theory:**  
Reciprocal determinism, Behavioral capability, Expectations, self-efficacy, observational learning, reinforcement

- Self efficacy (provide training and guidance).
- Expectations
- Observational learning
- progressive goal setting
- positive reinforcement
- demonstrate desired behavior

*GOAL SETTING*



*BEHAVIOR*



*OUTCOMES*

*1 sessions of group interventions class and individual hands-on demonstrations; 2 session of return visit (interview session using motivation techniques and discussion of objective and subjective outcomes); brochure*

Predictors of initial acceptance of continuous positive airway pressure (CPAP) in obstructive sleep apnea patients after intensive educational-behavioral program.

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Mean(SD)	Total N=247	CPAP acceptance N=210	CPAP denial N=37	p- value
Age, years (Mean, SD)	55.36±13.0	55.85±12.7	52.6±14.4	.160
Gender, Male (n, %)	155(62%)	136(64.8%)	19(51.4%)	.120
BMI, kg/m <sup>2</sup> (Mean, SD)	28.8±5.9	29.0±5.9	28.2±5.8	.466
ESS (Mean, SD)	11.1±5.1	10.6±4.8	11.2±5.1	.540
AHI, events/hr. (median, IQR)	41.5(46.4)	43.1(46.5)	25.5(42.1)	.01
Minimum Spo <sub>2</sub> (Mean, SD)	79.6±10.9	78.6±11.1	84.8±8.5	<0.001
Severity (n, %)				.009
- Mild	30(12.1%)	21(70.0%)	9(30.0%)	
- Moderate	60(24.3)	48(80.0%)	12(20.0%)	
- Severe	157(63.6%)	141(89.9%)	16(10.2%)	
Coverage (n, %)				<0.001
- Government reimbursement	147(59.5%)	132(89.9%)	15(10.2%)	
- Self-affordable	69(27.9%)	63(91.3%)	6(8.7%)	
- No reimbursement	31(12.6%)	15(48.1%)	16(51.6%)	
No of trials (n, %)				<0.001
- No trial	3(1.2%)			
- 1 trial	102(41.3%)	79(77.5%)	23(22.5%)	
- 2 trials	75(30.0%)	67(89.3%)	8(10.7%)	
- 3 trials	67(27.1%)	64(95.5%)	3(4.5%)	

# Predictors of initial acceptance of continuous positive airway pressure (CPAP) in obstructive sleep apnea patients after intensive educational-behavioral program.

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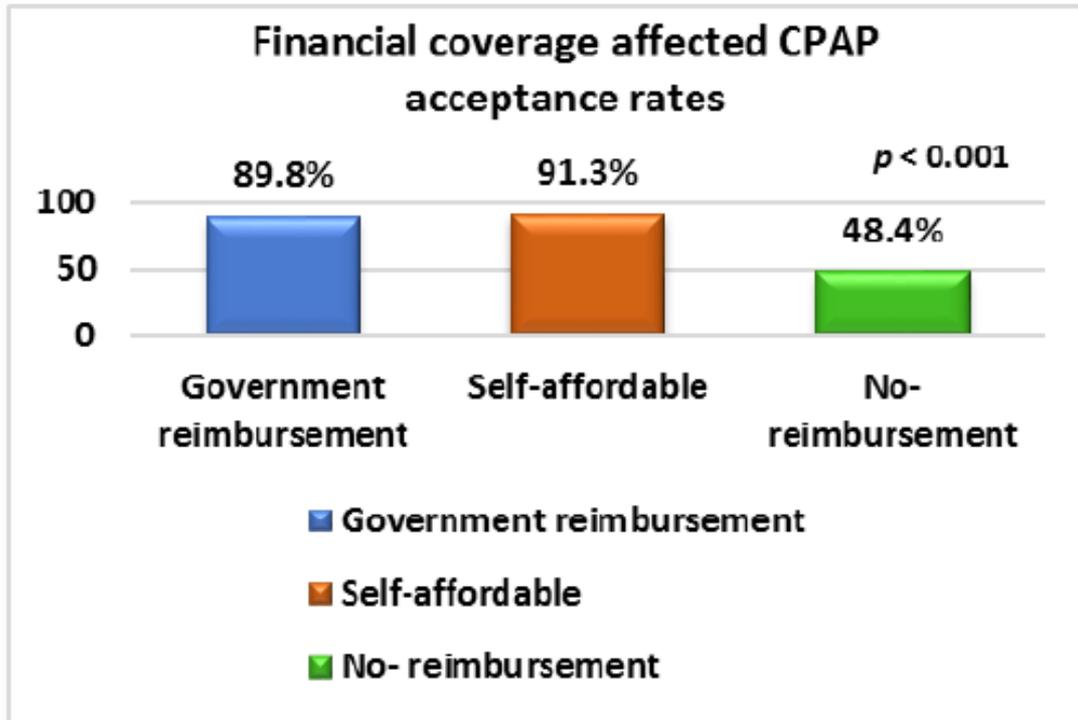
Division of Pulmonary and Critical Care, Medicine Department, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand<sup>2</sup>

Table 3 Multivariate analyses for predictors for CPAP acceptance

<i>Predictors for CPAP acceptance</i>	<b>Odd ratio</b>	<b>95% CI</b>	<b>p-value</b>
<b>OSA severity</b>			
- <i>AHI &lt; 15 events/hour</i>			
- <i>AHI ≥ 15 events/hour</i>	4.1	1.20 – 13.88	0.024
<b>Financial coverage</b>			
- <i>No reimbursement</i>	12.1	3.37 – 43.31	<0.001
- <i>Self-affordable</i>	8.1	2.91 – 22.36	<0.001
- <i>Government reimbursement</i>			
<b>Numbers of trials</b>			
- <i>1 trial</i>	2.8	1.05 – 7.53	0.04
- <i>2 trials</i>	8.6	2.09 – 35.35	0.003
- <i>3 trials</i>			

**Conclusions:** Intensive educational-behavioral program resulted in high initial acceptance rate of CPAP in OSA patients. Multiple trials of CPAP should be offered as more success occurred with increasing numbers of trials. Predictors of CPAP acceptance were severe OSA and no financial shortage. Only half of patients without government reimbursement accepted CPAP, despite medical indications. Alternative OSA treatment should be available for CPAP-denial patients.

Table 2 Financial coverage and CPAP acceptance rate.



# Telemedicine

- **In a multicenter-RCTs of 139 subjects with cost-effective analysis,** telemedicine for CPAP monitoring of OSA patients compared to hospital based care **resulted in comparable compliance rate at 6 months, but more cost-saving on transport and less lost productivity.**
- **A RCT for telehealth program for CPAP adherence reduces labor and yield similar adherence and efficacy** compared to standard of care (**adherence rate 83% vs 73% and CPAP use  $5.1 \pm 1.9$  vs  $4.7 \pm 2.1$  hours**) at 30 days.
- =Digital patient engagement tool to enhance CPAP adherence

# Short-term CPAP adherence in obstructive sleep apnea: a big data analysis using real world data

- De-identified data from large cloud database of PAP user during 2014-2017 in the US were analyzed
- Device usage information were **transmitted remotely by Air10 platform** devices in encrypted form
- **Patients engagement tool**, My Air were also available on 2014, and iOS app on 2016

**Table 1**

Adherence data from the first 90 days of therapy.

Adherence measures	Values (n = 2,621,182) Median (IQR) <sup>a</sup>
CMS compliance in first 90 days, n (%)	1,955,961 (74.6)
Time to achieve CMS compliance, days	23.00 (21.00, 27.00)
Device usage, h/session	6.18 (4.79, 7.35)
Daily usage (all days), h/night	5.54 (3.42, 7.04)
Proportion of days with non-zero usage, %	93.3 (72.2, 98.9)
Proportion of days compliant (usage $\geq$ 4 h/night), %	80.0 (46.7, 95.6)

CMS, Center for Medicare and Medicaid Services; IQR, interquartile range; SD, standard deviation. CMS Compliance definition:  $\geq$ 4 hours' PAP use on 70% of nights in a consecutive 30-day period in the first 90 days of therapy.

# Effect of Telemedicine Education and Telemonitoring on Continuous Positive Airway Pressure Adherence

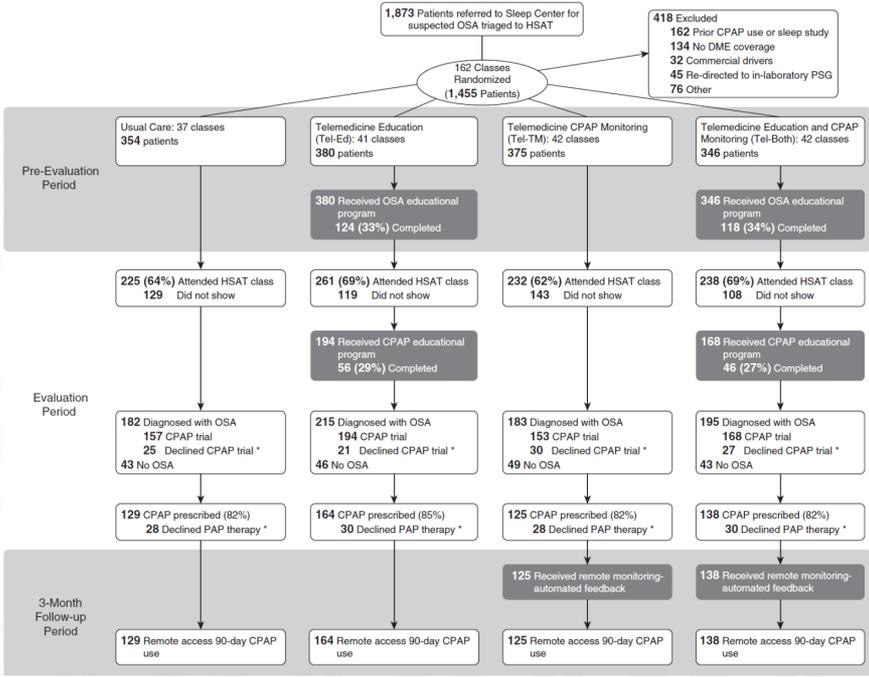
- A four-arm, randomized, factorial design clinical trial of 556

OSA patients

- 2 telemedicine intervention were implemented (**web-based OSA education; Tel-Ed**) and **CPAP telemonitoring with automated patient feedback (Tel-TM)**

- Randomization include

- Usual care
- Tel-Ed added
- Tel-TM added
- Tel-Ed and Tel-TM (Tel-both)



**Table 3.** CPAP Use and Subjective Outcomes 90 Days after CPAP Dispensation

	Usual Care	Tel-Ed	Tel-TM	Tel-Both	Tel-Ed Effect (95% CI), P Value	Tel-TM Effect (95% CI), P Value	Tel-Both Effect (95% CI), P Value
	<i>n</i> = 129	<i>n</i> = 163	<i>n</i> = 125	<i>n</i> = 138			
Days used, %	64.8 ± 34.2	68.6 ± 31.3	76.6 ± 28.3	78.3 ± 28.3	2.8 (−2.3 to 7.9), 0.28	10.6 (5.5 to 15.7), <0.0001	13.4 (6.1 to 20.8), 0.0004
Average usage on all days, h	3.8 ± 2.5	4.0 ± 2.4	4.4 ± 2.2	4.8 ± 2.3	0.3 (−0.1 to 0.7), 0.10	0.8 (0.4 to 1.15), 0.0002	1.1 (0.5 to 1.7), 0.0002
Average usage on days used, h	5.2 ± 1.8	5.2 ± 1.8	5.3 ± 1.7	5.8 ± 1.6	0.2 (−0.1 to 0.5), 0.13	0.4 (0.1 to 0.7), 0.006	0.6 (0.2 to 1.0), 0.003
Medicare adherence, <i>n</i> (%)	69 (53.5)	100 (61.0)	82 (65.6)	101 (73.2)	1.4* (1.0 to 2.0), 0.07	1.7* (1.2 to 2.4), 0.003	2.4* (1.4 to 3.9), 0.001
	<i>n</i> = 83	<i>n</i> = 113	<i>n</i> = 90	<i>n</i> = 93			
Change in ESS score <sup>†</sup>	−3.7 ± 4.7	−2.8 ± 6.4	−3.7 ± 5.2	−3.0 ± 3.7	0.8 (−0.2 to 1.9), 0.13	−0.14 (−1.2 to 0.9), 0.80	0.7 (−0.9 to 2.3), 0.38
Change in FOSQ-10 score <sup>†</sup>	−14.2 ± 10.3	−9.9 ± 12.9	−10.9 ± 11.2	−11.3 ± 12.8	1.9 (−0.8 to 4.5), 0.16	0.6 (−2.0 to 3.3), 0.64	2.5 (−1.3 to 6.4), 0.20

*Definition of abbreviations:* CI = confidence interval; CPAP = continuous positive airway pressure; ESS = Epworth Sleepiness Scale; FOSQ = Functional Outcomes of Sleep Questionnaire; Tel-both = telemedicine-based education and telemonitoring; Tel-Ed = telemedicine-based education; Tel-TM = telemedicine-based telemonitoring.

Values represent means ± SD or number of patients (%).

\*Reported effect is an odds ratio.

<sup>†</sup>Although CPAP usage data were available for all patients, ESS and FOSQ-10 were available only for those who kept their 3-month follow-up appointment.

## Summary

- **Current status of CPAP use:** remained low and problematic, despite CPAP being the gold standard for OSA
- **Determining the adherence definition:** there is no clear-cut evidence for the threshold for CPAP use required to improve clinical outcomes. “The longer, the better”
- **Predictors of adherer vs non-adherer** depends on patients and disease characteristics, device-related issue, side effects, and psychological issue
- **Interventions to improve PAP adherence**
  - Equipment and technology
  - Behavioral and psychological aspects
  - Adherence maybe improved with current telemedicine practice