Five things every pulmonologist should know about OSA

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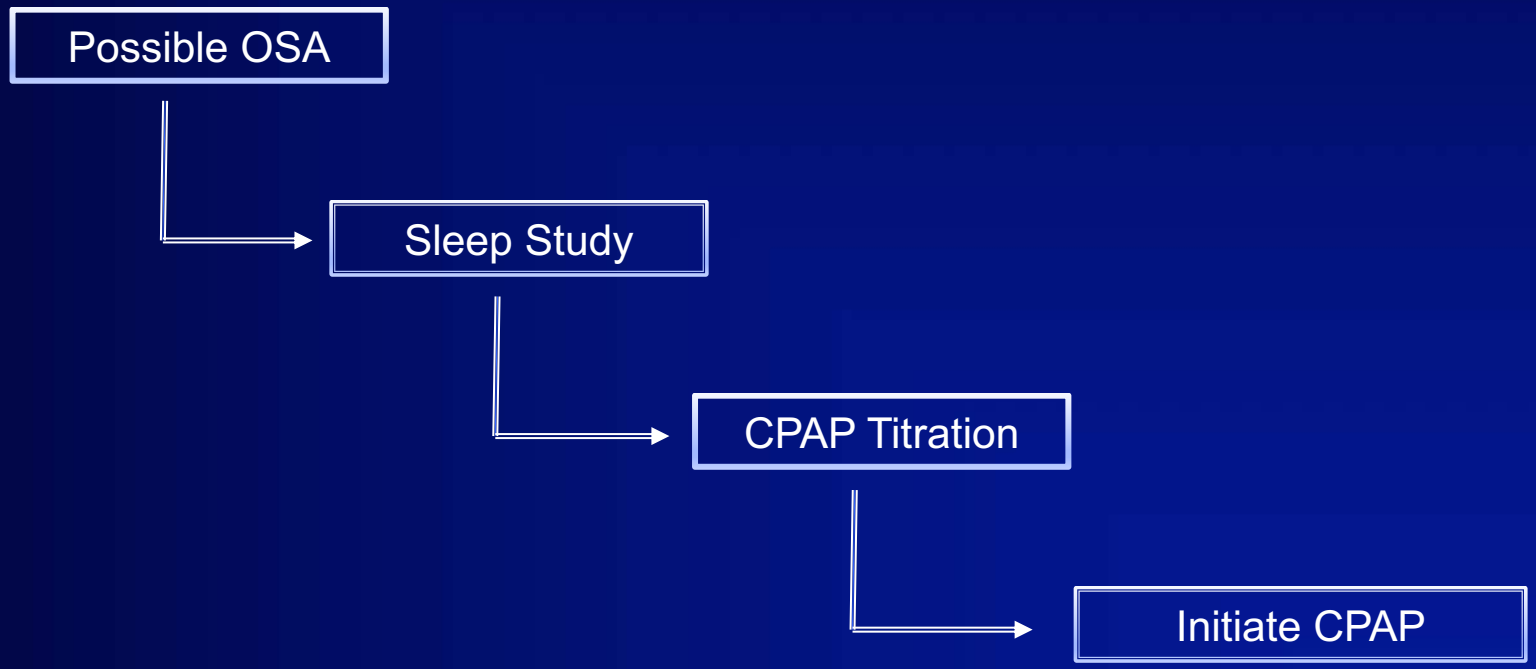
Background

- OSA is extremely common
  - 33% have OSA and 13% have mod to severe OSA[1]
- CPAP is first line therapy
  - CPAP improves sleep quality, daytime functioning, BP and maybe CVD event risk
- In population studies, only ~5% of OSA patients are on treatment[2]
  - Suboptimal diagnosis
  - Suboptimal treatment

[1]Peppard PE et al, Am J Epi 2013; 177:1006-14;
[2]Redline S et al, AJRCCM 2014; 189:335-44.

Traditional OSA Care Delivery Model



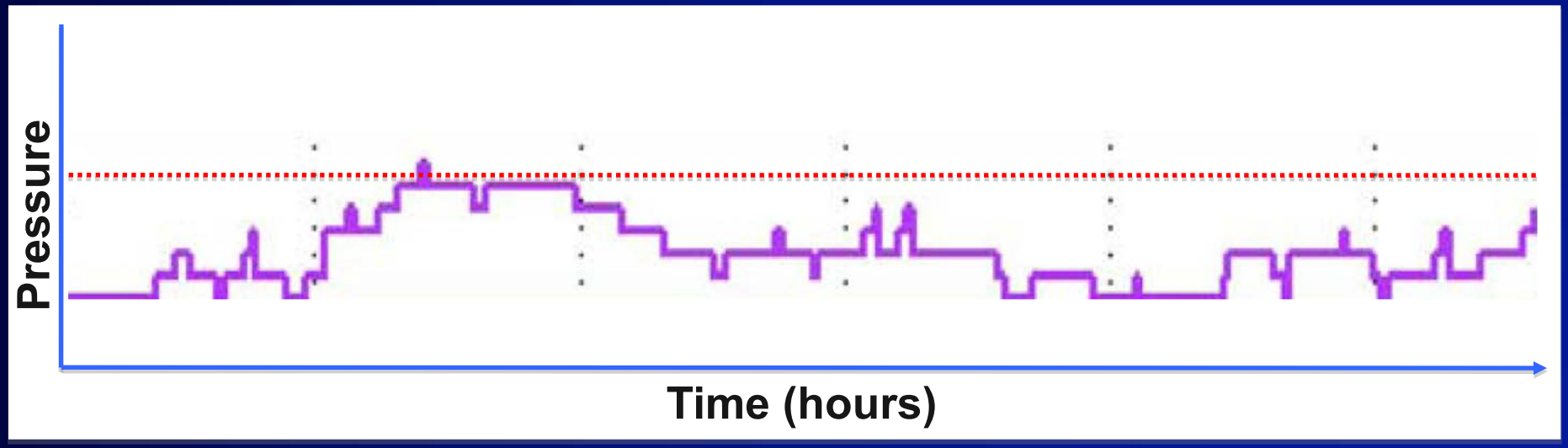
Shortfalls of traditional pathway

- Limited by number of sleep beds and techs.
  - Long waiting times
- Inconvenient to many patients.
  - Those with caregiver responsibilities
  - Those with atypical sleep schedules
  - Rural populations
- Long delays in initiating treatment can reduce uptake of therapy.

Laboratory vs. Home Sleep Testing

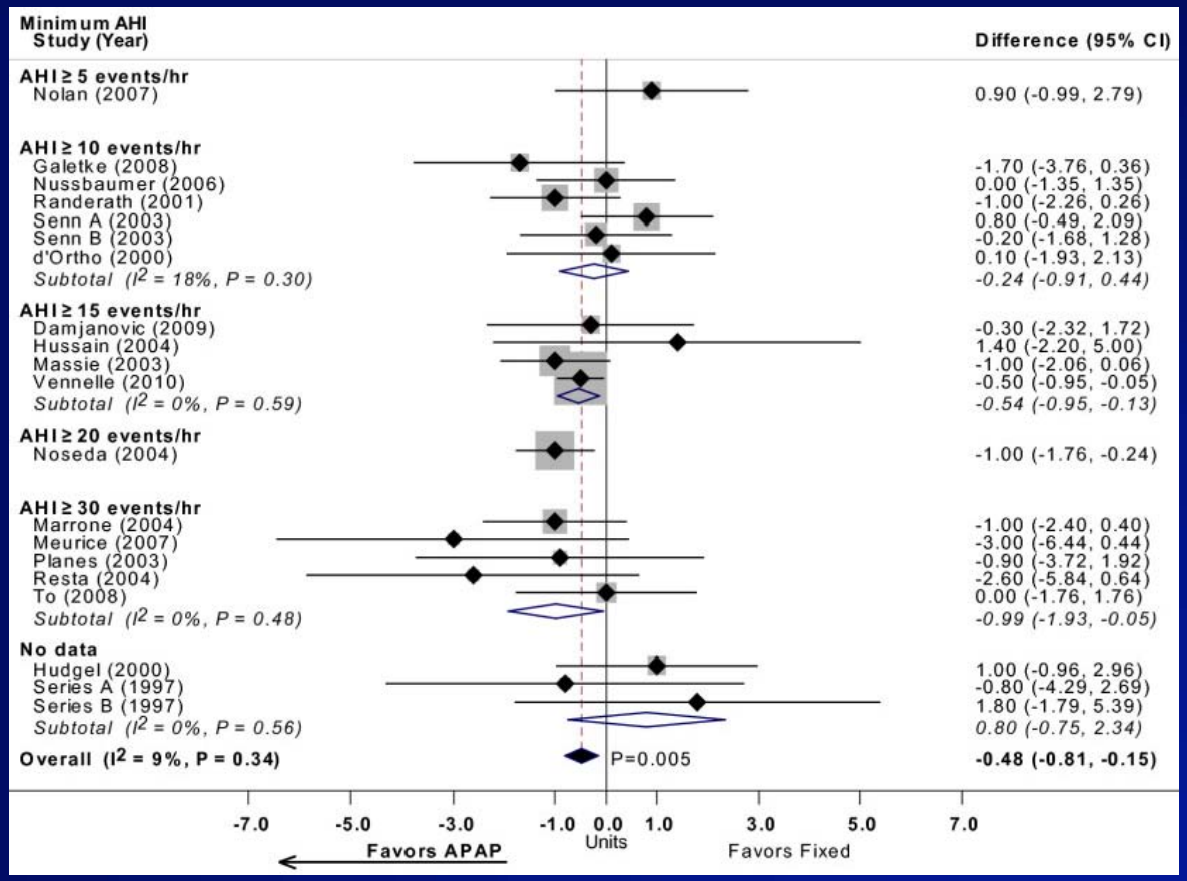
Auto-titrating CPAP (APAP)

- Devices measure flow and/or impedance and adjust pressure up and down to provide the lowest pressure necessary.
- Lowers mean pressure by 2.2 cm H2O.[1]



[1]Ayas NT et al, Sleep 2004; 27:249-53

APAP vs. CPAP

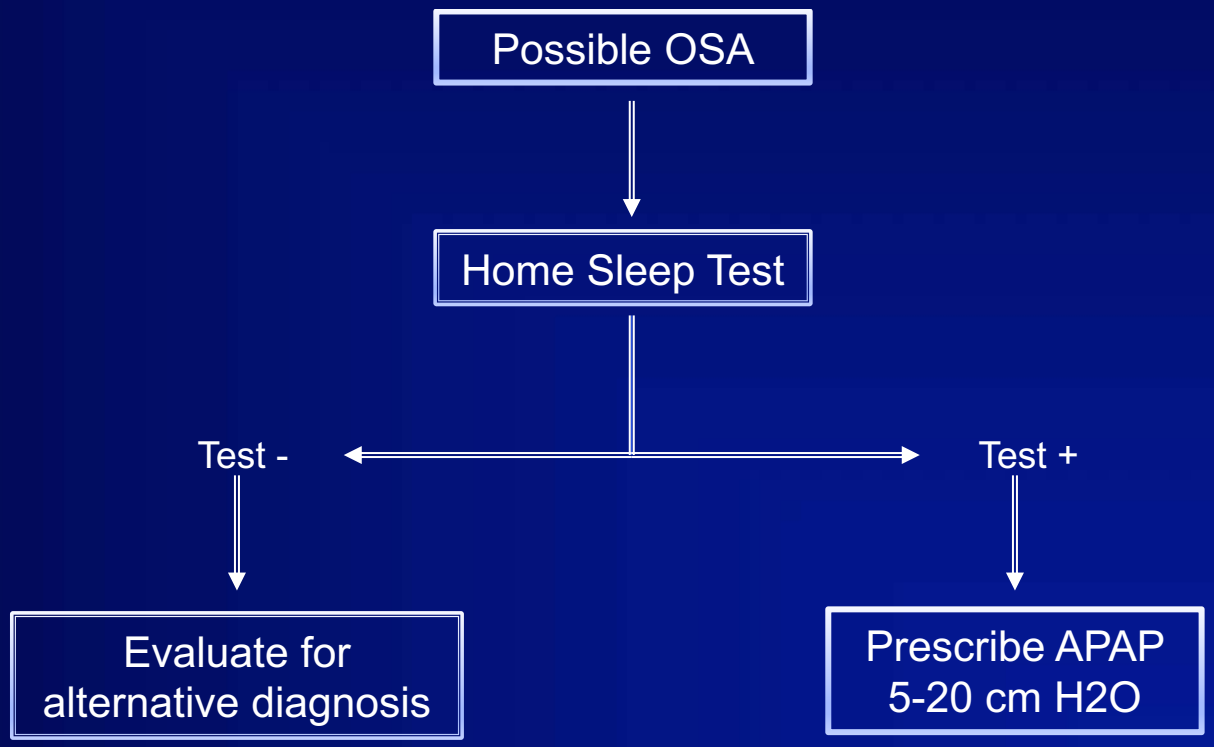


APAP

- increases compliance by 11 min
- reduces ESS by 0.48

Ip S et al, Syst Rev 2012; 1:20

Home Sleep Testing Pathway



- Increases access and reduces burden.
- Makes OSA diagnosis and treatment easier for the non-specialist.

RCTs of Lab versus Home Strategies

Impact at 90 days in high risk OSA patients found to have OSA

Study	N	CPAP Usage		Δ Epworth		Δ Quality of Life		
		Lab	Home	Lab	Home	Lab	Home	Test
Mulgrew	68	5.4 hrs	6.0 hrs	-10.0	-8.0	2.2	1.9	SAQLI
Kuna	296	2.9 hrs	3.5 hrs	-2.9	-2.6	1.8	1.8	FOSQ
Rosen	373	3.7 hrs	4.7 hrs	-7.4	-7.0	0.7	0.9	SAQLI
Hui	172	3.9 hrs	5.0 hrs	-2.2	-3.5	-0.1	0.2	SAQLI

Two shorter term trials also found no benefit of lab versus home-based evaluation and treatment.

Mulgrew AT et al, Ann Intern Med 2007; Berry RB et al, Sleep 2008; Skomro RP et al, Chest 2010; Kuna ST et al, Amer J Respir Crit Care Med 2011; Rosen CL et al, Sleep 2012; Hui DS et al, Sci Rep 2017

Study Limitations

- All studies exclude those at high risk for alternative forms of sleep-disordered breathing (CHF, COPD, opiate use, etc).

- Analyses limited to those with high risk for OSA and found to have moderate to severe OSA
  - How do you manage those at low risk for OSA?
  - How do you manage those with negative HSTs?

Limited studies in routine practice

- Clinical trial of 406 patients being seen in academic sleep centers undergoing full sleep study for possible OSA (both low and high risk)

- Patients randomized to 3 groups:
  - Full data given to physicians
  - Only HST data given to physicians
  - Only overnight oximetry data given to physicians

- Physicians unblinded at 4 months

Chai-Coetzer CL et al, Ann Int Med 2017; 166:332-40

Limited studies in routine practice

Initial Diagnosis	PSG	HST	Oxim
Mild OSA	19%	29%	38%
Mod-sev OSA	50%	50%	46%
Simple snoring	12%	11%	6%
Insomnia	2%	1%	3%
Other	16%	8%	7%

Final Diagnosis	PSG	HST	Oxim
Mild OSA	22%	26%	26%
Mod-sev OSA	50%	50%	47%
Simple snoring	13%	12%	12%
Insomnia	3%	4%	2%
Other	13%	8%	13%

Treatment	PSG	HST	Oxim
CPAP	53%	57%	62%
Oral appliance	4%	3%	5%
Surgery	2%	1%	2%
Positional therapy	4%	7%	2%
Weight loss	19%	21%	18%
Sleep hygiene	5%	3%	5%
Medications	5%	1%	2%
Other	8%	7%	5%

Chai-Coetzer CL et al, Ann Int Med 2017; 166:332-40

Limited studies in routine practice

	Δ Quality of Life			Δ Epworth			CPAP Usage		
	PSG	HST	Oxim	PSG	HST	Oxim	PSG	HST	Oxim
Baseline	16.1	16.1	15.8	10.4	10.4	10.4	---	---	---
4 months	18.0	18.0	17.4	6.2	6.2	7.8	5.3	5.2	4.5
Change	+2.0	+2.0	+1.5	-4.1	-4.1	-2.8			

Chai-Coetzer CL et al, Ann Int Med 2017; 166:332-40

HSTs in routine practice

- Clinical trial of 430 patients referred to 12 academic sleep centers for OSA evaluation.

- Patients randomized to:
  - PSG followed by either APAP or conservative management
  - HST followed by either APAP or conservative management

Corral J et al, Am J Respir Crit Care Med 2017; 196:1181-90

HSTs in routine practice

- No patient randomized to HST crossed over to PSG.
- 68% of PSG patients started on CPAP vs. 53% of HST patients.

Corral J et al, Am J Respir Crit Care Med 2017; 196:1181-90

HSTs in routine practice

	Δ Quality of Life		Δ Epworth		24-hr BP		CPAP Usage	
	PSG	HST	PSG	HST	PSG	HST	PSG	HST
Baseline	93.0	94.0	13.0	13.0	91.0	90.0		
6 months	99.5	100.7	8.1	8.8	91.0	89.8	5.3 hrs	5.1 hrs
Change	+6.5	+6.7	-4.9	-4.2	0.0	-0.2		

No difference in traffic accidents, hospitalizations, or CV events.

Cost per patient: 736€ for PSG vs. 320€ for HST

Corral J et al, Am J Respir Crit Care Med 2017; 196:1181-90

Take home message #1

- You should have a valid reason to not evaluate a patient using a home based strategy.
- Valid reasons:
  - NYHA class IV heart failure, hypercapnic COPD, high opiate usage

CPAP adherence

- ~10% of patients refuse to accept CPAP
- ~10% of patients abandon CPAP after 1 night of treatment
- Up to 50% of patients abandon CPAP by 1 year

Weaver TE et al, PATS 2008; 5: 173-8

How do we make PAP therapy more tolerable?

A. Improve the machine

B. Improve the patient

Improving the Machine

CPAP masks

Nasal Pillows

Nasal Mask

Full Face Mask

Effect of patient mask selection

- 98 consecutive patients with OSA shown 3 types of masks (nasal, oral, oronasal) and allowed to choose one to try at home.
- After 3 weeks, returned for CPAP titration and then followed for 6 months.

	Nasal	Oral	Oronasal
Choice	66%	27%	6%
Pressure (cm H_2O)	7.7 cm	8.0 cm	9.7 cm
Adherence (hrs/night)	4.95 hrs	4.87 hrs	4.50 hrs
6 month failure rate	32%	54%	57%

Beecroft J et al, Chest 2003; 124: 2200-8

RCT of mask type

- 20 patients with newly diagnosed moderate to severe OSA (AHI 34). Each patient treated with 4 weeks of CPAP with nasal mask and with full face mask in random order.

	Face mask	Nasal mask	P-value
Adherence	4.3 hrs	5.3 hrs	0.01
ESS score	9.8	8.2	<0.01

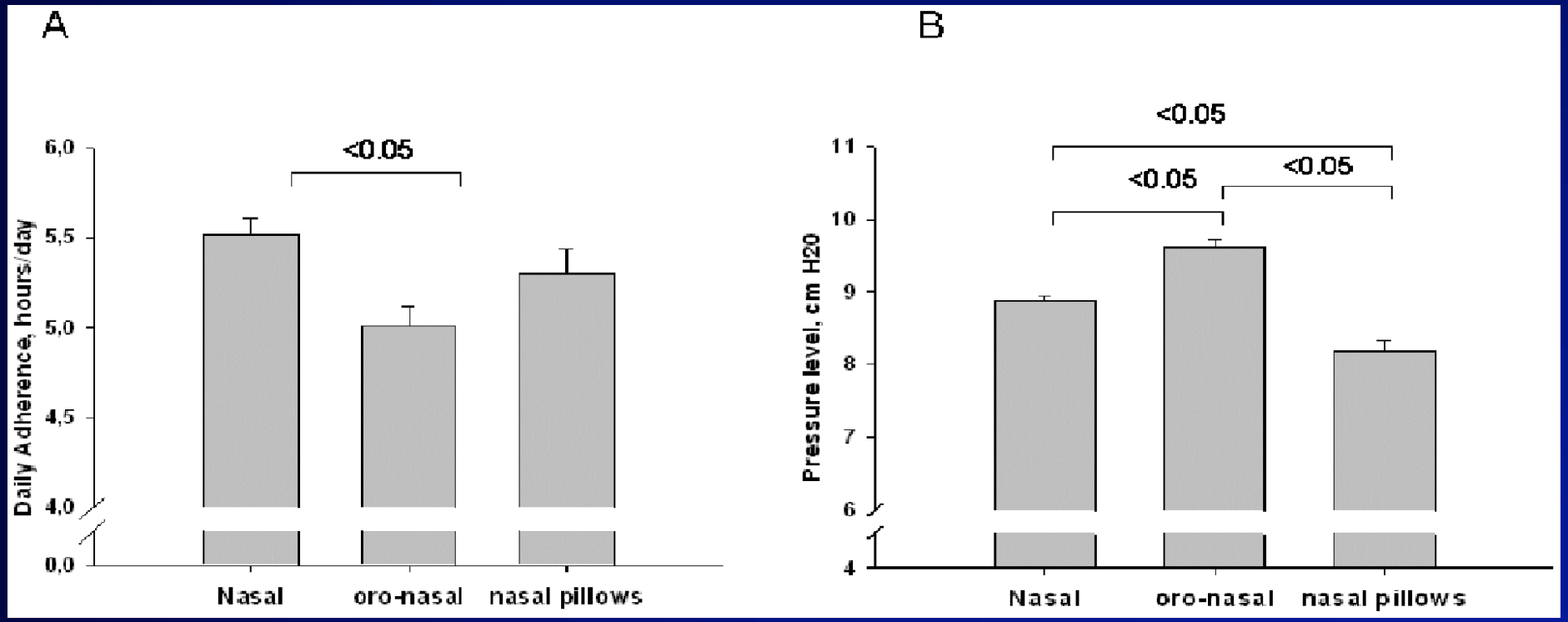
Mask preference: 19 nasal vs. 1 full face

Mortimore IL et al, Thorax 1998; 53: 290-2

Real world experience in France

Observational study of 2311 patients in France:

- 62.4% nasal, 26.2% full face, 11.4% nasal pillows



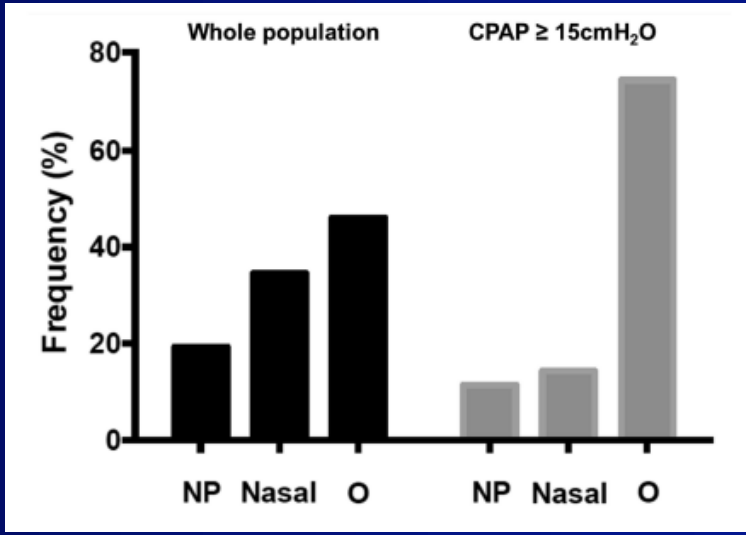
Adjusted OR for nonadherence = 2.0 for full face mask

Borel JC et al, PLoS One 2013

Real world experience in Australia

- All OSA patients started on CPAP for 1 year in an Australian sleep lab (n=358).

	Nasal	Pillows	Oronasal
Tech Choice	35%	19%	46%
Pressure (cm H2O)	10 cm	11 cm	12 cm
Residual AHI	6.4	6.7	11.3



Deshpande S et al, J Clin Sleep Med 2016; 13: 1263-8

Comparing full face to nasal masks

Table 1—Summary of four cases.

Case	Sex	Age, y	BMI, kg/m²	Baseline AHI, events/h [15]	Prescribed CPAP with Oronasal Mask, cmH_2O	Residual AHI with Oronasal Mask, events/h [15,16]	Prescribed CPAP with Nasal Mask, cmH_2O	Residual AHI with Nasal Nask, events/h [15,16]
1	Male	38	28.5	49.9	17.5	55.8	12.0	3.8
2	Male	65	26.9	25.0	17.9	22.7	7.8	2.0
3	Female	56	29.4	35.0	5.0	45.2	5.0	4.8
4	Male	77	37.0	121.0	19.0	48.3	18.0	1.7

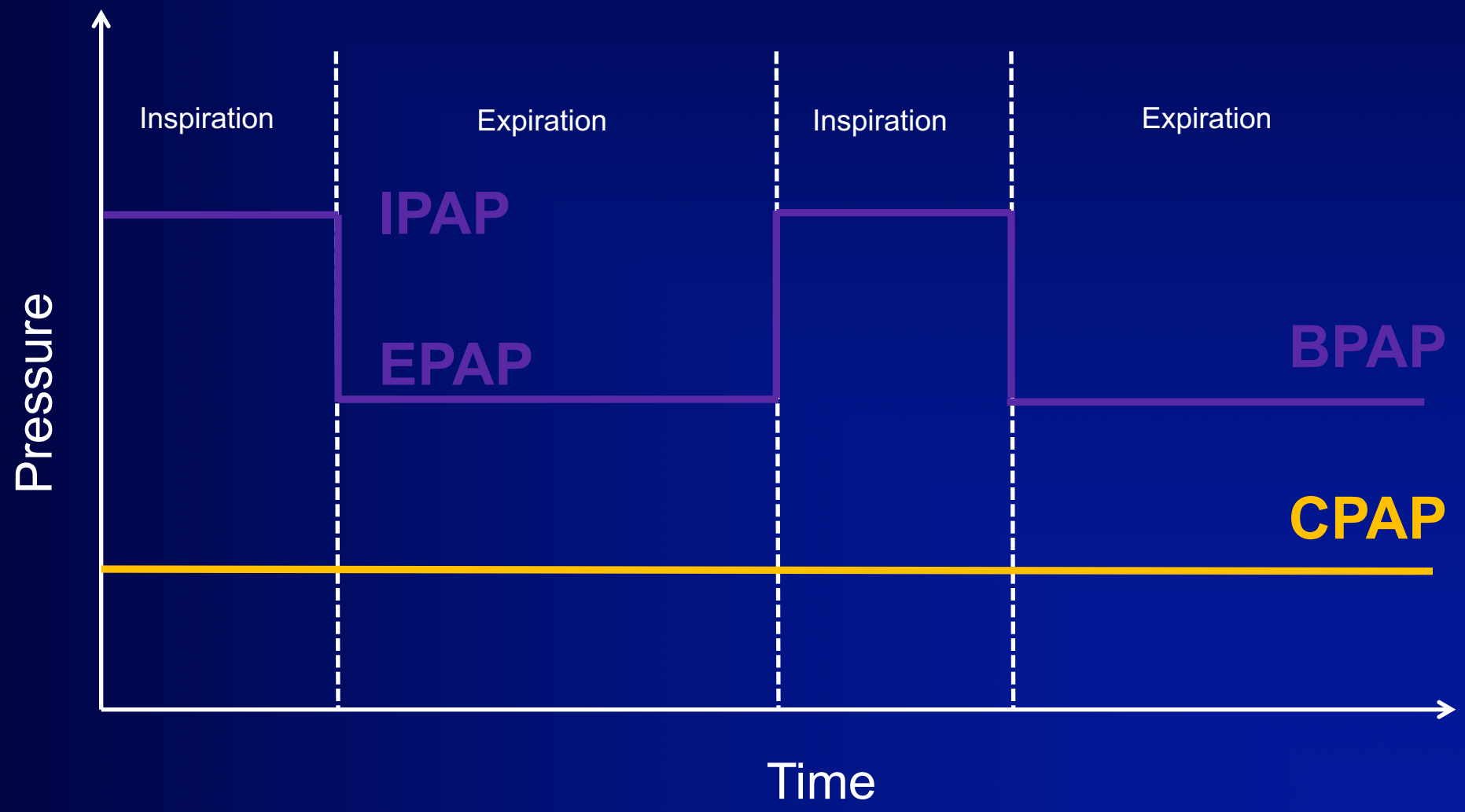
- By pushing on mandible, full face masks may obstruct flow at the level of the oropharynx.

Ng JR et al, J Clin Sleep Med 2016; 12: 1227-32

Take home message #2

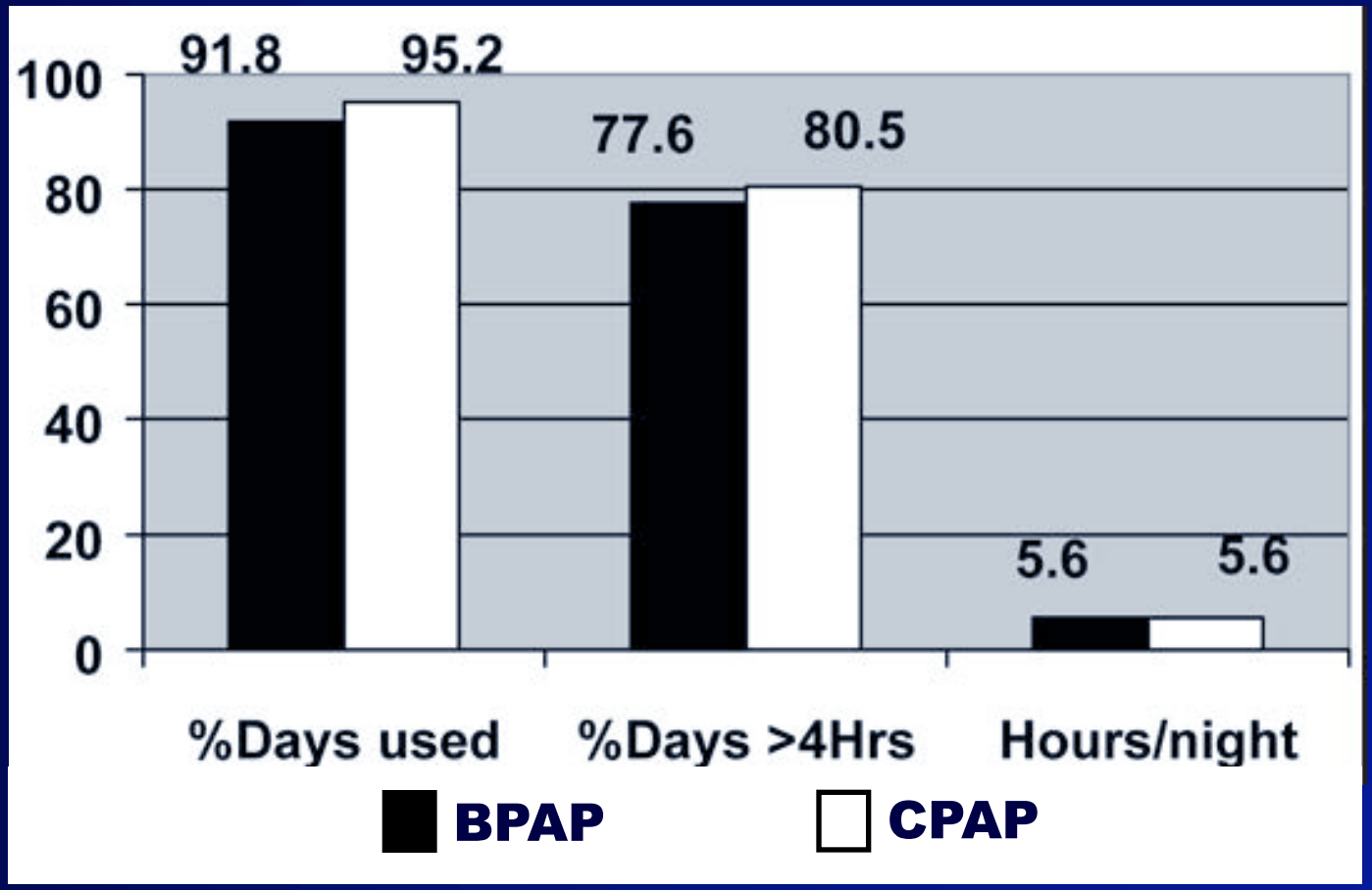
- Don’t use full face masks (unless absolutely necessary).

Bilevel PAP (BPAP)



BPAP vs. CPAP in PAP naïve

RCT over 30 days (N=27)



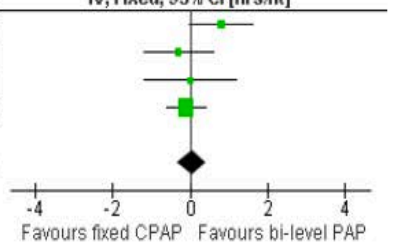
Gay PC et al, Sleep 2003; 26: 864-9

Meta-analysis of BPAP vs. CPAP

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

Study or Subgroup	Bi-level PAP Mean [hrs/nt]	Bi-level PAP SD [hrs/nt]	Bi-level PAP Total	Fixed CPAP Mean [hrs/nt]	Fixed CPAP SD [hrs/nt]	Fixed CPAP Total	Weight	Mean Difference IV, Fixed, 95% CI [hrs/nt]
Ballard 2007	3.7	2	51	2.9	2.3	53	20.0%	0.80 [-0.03, 1.63]
Blau 2007	5.3	1.5	15	5.6	1	17	17.1%	-0.30 [-1.20, 0.60]
Gay 2003	5.6	1.7	12	5.6	1.4	15	9.6%	0.00 [-1.19, 1.19]
Reeves-Hoché 1995	4.9	1.17	26	5	0.72	36	53.3%	-0.10 [-0.61, 0.41]
Total (95% CI)			**104**			**121**	**100.0%**	**0.06 [-0.31, 0.43]**

Heterogeneity: $Chi^2 = 4.08$, df = 3 (P = 0.25); $I^2 = 27\%$
Test for overall effect: Z = 0.29 (P = 0.77)

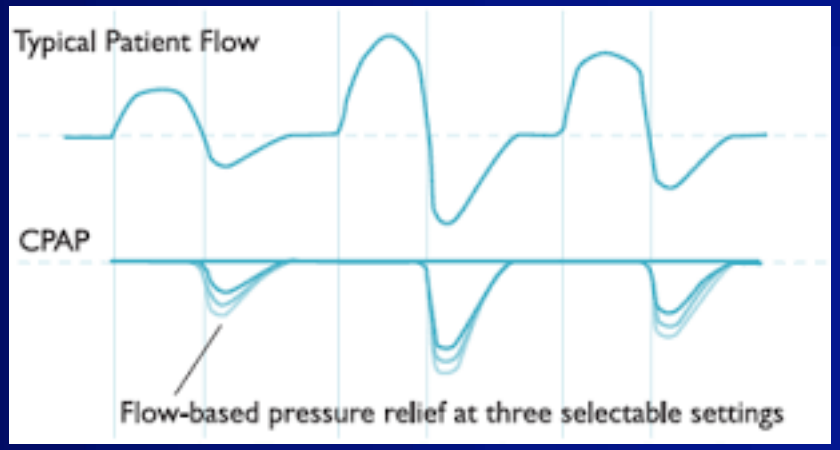


- In total, 4 trials and 225 patients.
- An additional cross-over study in patients with low CPAP compliance found patient preference:
  - CPAP 40%, BPAP 40%, Neither 20%

Smith I et al, Cochr Data Syst Rev 2009

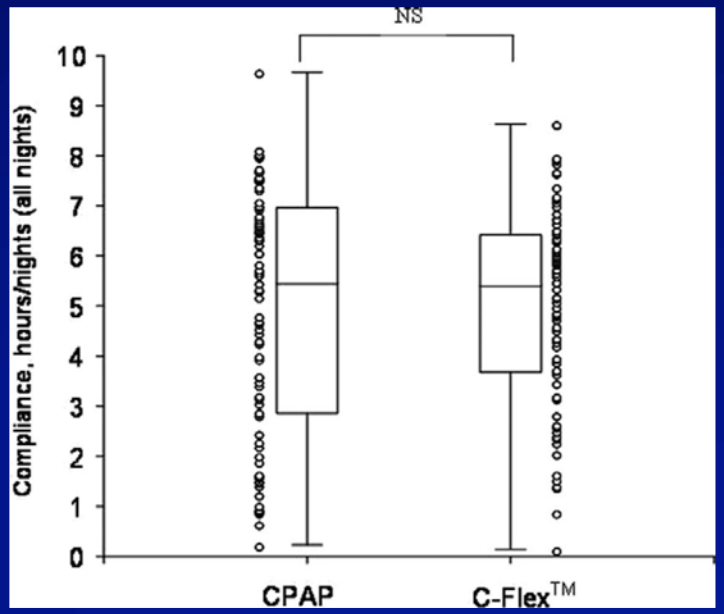
Expiratory pressure relief

- Drops CPAP pressure early in exhalation when expiratory flow is the greatest but then allowing it to rise back to CPAP by the end of exhalation when flow is minimal.



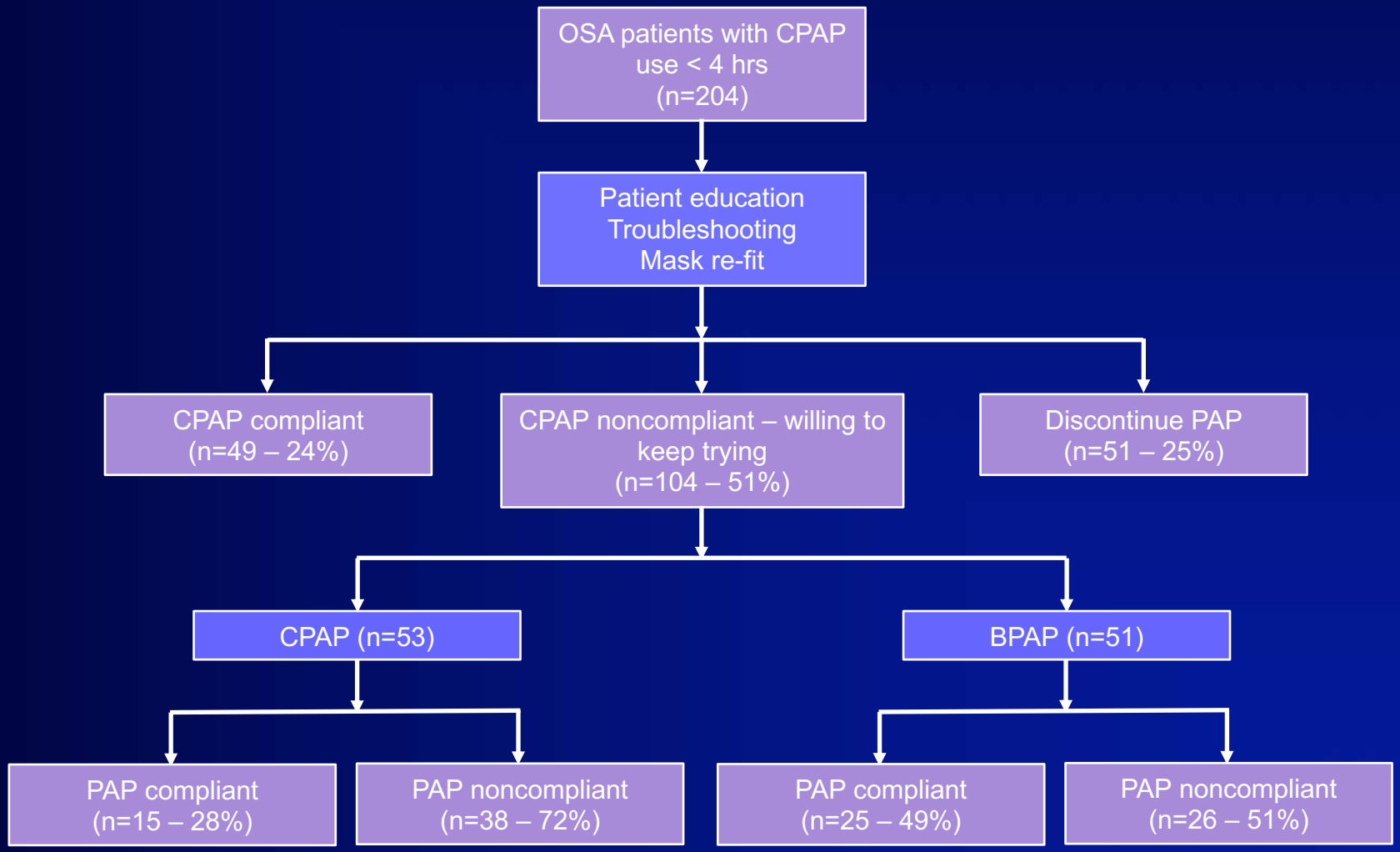
Effect of EPR on OSA treatment

- Randomized trial of CPAP vs. CPAP + EPR for 3 months in 218 patients with mod-sev OSA (mean AHI 43, ESS 11.1, CPAP 10.6)
- Mean adherence 4.91 vs. 4.98 hrs
- Mean ESS 8.0 vs. 7.8
- No difference in improvement in symptoms, side effects, comfort



Pepin J et al, Chest 2009

BPAP as rescue



Ballard R et al, J Clin Sleep Med 2007; 3: 706-12

Take home message #3

- No reason for routine use of BPAP.

- If pressure intolerance is a problem:
  - EPR is a lot quicker and cheaper than BPAP.

Improving the Patient

Patient education

- Goal is for patient to understand:
  - What is OSA, why is it bad for you?
  - What is CPAP, how does it treat OSA, what benefits will you get from it?

- In one study from Israel, 65 newly diagnosed OSA patients interviewed.
  - 1/3 had doubts/skepticism of their diagnosis
  - Did not think their symptoms/signs were as bad as other people they knew
  - Did not trust in-lab studies to reflect what happened at home.

Zarhin D et al, Sociol Health Illn 2015; 37: 715-30

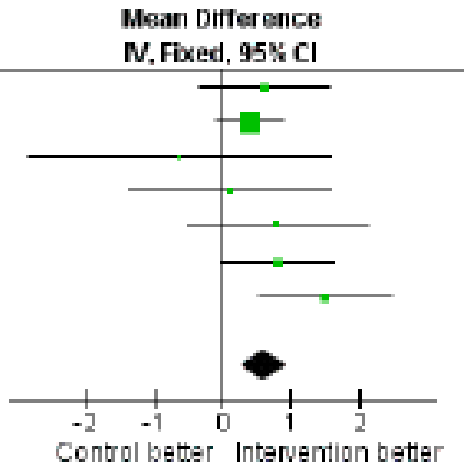
Educational interventions

- Typically one time session.

Figure 6. Forest plot of comparison: 2 Educational interventions + CPAP versus usual care + CPAP, outcome: 2.1 Machine usage (hours/night).

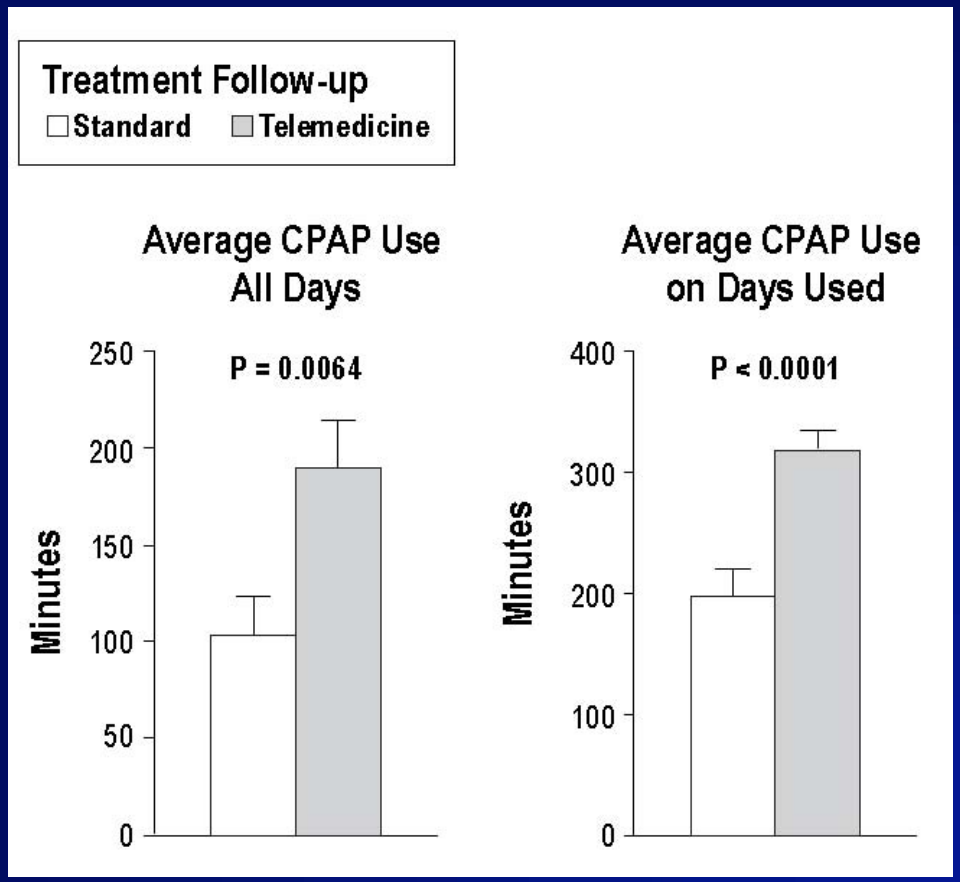
Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Aloia 2012a	4.34	2.45	53	3.73	2.5	48	11.8%	0.61 [-0.35, 1.57]
Basoglu 2011	5.5	1.2	88	5.1	1.6	87	47.5%	0.40 [-0.08, 0.88]
Epstein 2000	3.68	3.15	17	4.31	3.01	13	2.2%	-0.63 [-2.85, 1.59]
Meurice 2007c	5.8	2.8	23	5.7	2.2	21	5.0%	0.10 [-1.38, 1.58]
Meurice 2007d	6.3	2.2	22	5.5	2.4	25	6.3%	0.80 [-0.52, 2.12]
Wang 2011a	3.4	2.1	38	2.6	1.6	38	15.5%	0.80 [-0.04, 1.64]
Wang 2011d	5.2	2	38	3.7	2.3	38	11.7%	1.50 [0.53, 2.47]
Total (95% CI)			**257**			**251**	**100.0%**	**0.60 [0.27, 0.93]**

Heterogeneity: Chi² = 5.91, df = 6 (P = 0.43); I² = 0%
Test for overall effect: Z = 3.57 (P = 0.0004)



Wozniak D et al, Cochr Data Syst Rev 2014

Adherence monitoring



- Daily adherence tracking and response can increase CPAP usage by 87 min/day.

Fox N et al, Sleep 2012; 35:477-81

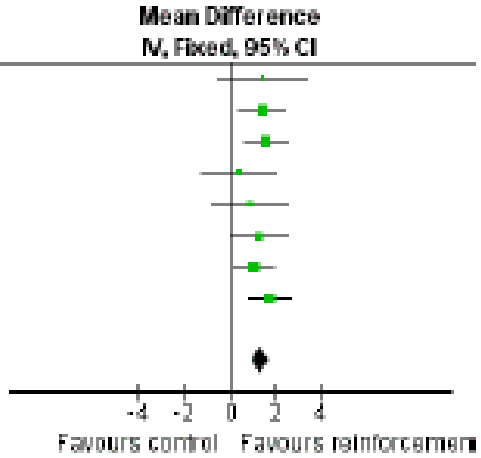
Support with troubleshooting

- Contacting patient regularly to identify problems and help solve them.

Figure 4. Forest plot of comparison: 1 Increased practical support and encouragement during follow-up + CPAP versus usual care + CPAP, outcome: 1.3 Machine usage, sensitivity analysis: adherence in control group =< four hours/night.

Study or Subgroup	intervention Mean	SD	Total	control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
DeMolles 2004	4.4	3	15	2.9	2.4	15	4.3%	1.50 [-0.44, 3.44]
Fox 2012	3.18	2.45	39	1.75	1.97	36	16.2%	1.43 [0.43, 2.43]
Hoy 1999	5.4	1.9	40	3.8	3.5	40	17.2%	1.60 [0.63, 2.57]
Lewis 2006	3.8	2.9	30	3.4	3.2	25	6.1%	0.40 [-1.23, 2.03]
Parthasarathy 2012	4.35	2.6	22	3.4	2.6	17	6.0%	0.95 [-0.70, 2.60]
Stepnowsky 2007	4.1	1.8	20	2.8	2.2	20	10.5%	1.30 [0.05, 2.55]
Wang 2011b	3.7	2.3	38	2.6	1.6	38	20.5%	1.10 [0.21, 1.99]
Wang 2011c	5.2	2	38	3.4	2.1	38	18.1%	1.80 [0.88, 2.72]
Total (95% CI)			**242**			**229**	**100.0%**	**1.36 [0.96, 1.76]**

Heterogeneity: Chi² = 3.06, df = 7 (P = 0.88); I² = 0%
Test for overall effect: Z = 6.60 (P < 0.00001)



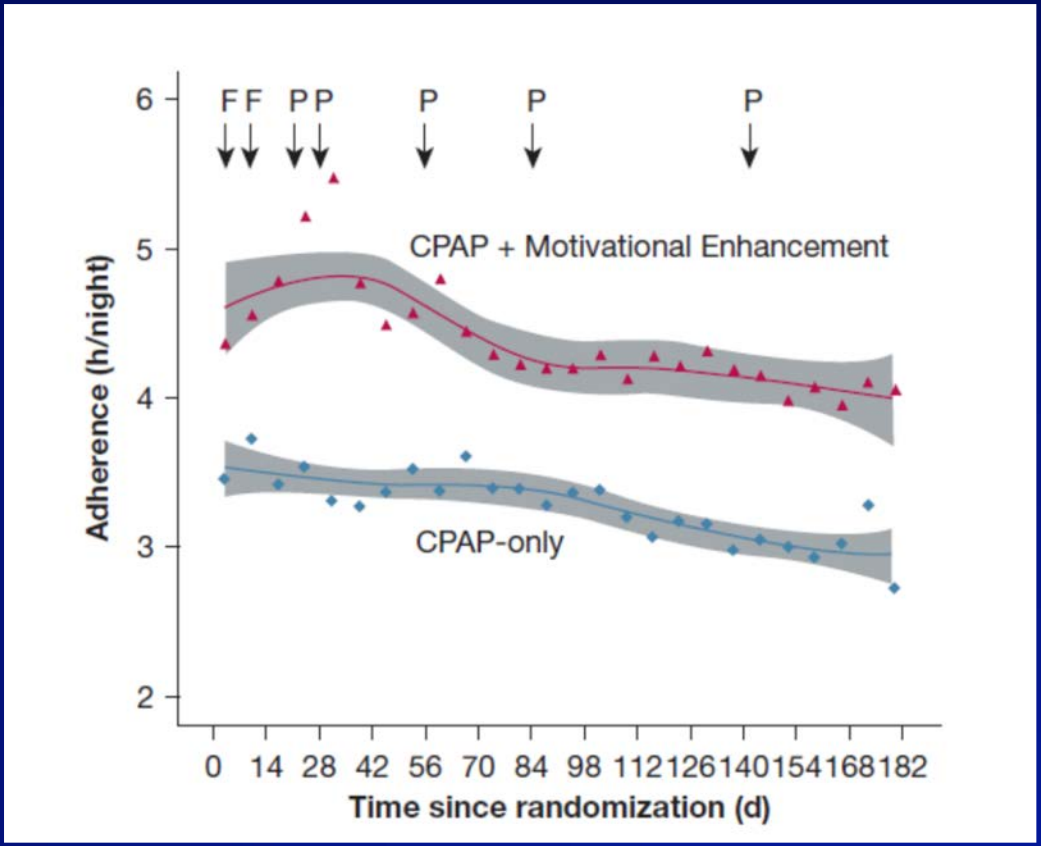
Wozniak D et al, Cochr Data Syst Rev 2014

Behavior change

- Change is difficult and there is always some level of ambivalence
  - Patients need to want to change
  - Patients need to believe that they can change
- Goals are to:
  - Resolve ambivalence and make patients want to change
  - Increase self-efficacy (belief they can make change)

Motivational enhancement RCT

- 83 new OSA patients at high cardiac risk randomized to usual care or ME from a psychologist.
- ME included 2 in-person visits and 5 phone calls over 6 months.



- Adherence: 3.3 hrs vs. 4.4 hrs over 6 months.
- Difference persisted at 1 year.

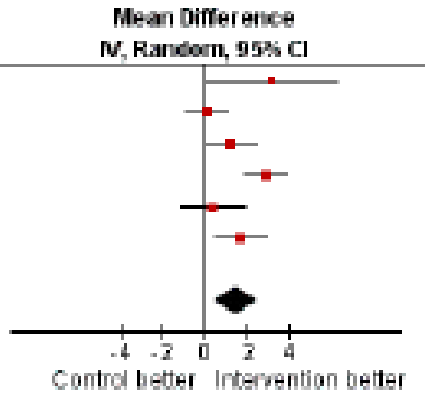
Bakker JP et al, Chest 2016; 150: 337-45

Behavioral modification

Figure 7. Forest plot of comparison: 4 Behavioural therapy + CPAP versus control + CPAP, outcome: 4.1 Machine usage.

Study or Subgroup	Mean Difference	SE	Intervention Total	Control Total	Weight	Mean Difference IV, Random, 95% CI
Aloia 2001	3.2	1.5765	6	6	7.5%	3.20 [0.11, 6.29]
Aloia 2012b	0.13	0.523	47	49	20.1%	0.13 [-0.90, 1.16]
Olsen 2012	1.21	0.64	50	50	18.2%	1.21 [-0.04, 2.46]
Richards 2007	2.87	0.528	49	49	20.1%	2.87 [1.84, 3.90]
Roecklein 2010	0.38	0.82	14	16	15.5%	0.38 [-1.23, 1.98]
Sparrow 2010 (1)	1.71	0.62	124	126	18.6%	1.71 [0.49, 2.93]
Total (95% CI)			**289**	**295**	**100.0%**	**1.44 [0.43, 2.45]**

Heterogeneity: Tau² = 1.05; Chi² = 16.89, df = 5 (P = 0.005); I² = 70%
Test for overall effect: Z = 2.79 (P = 0.005)



Wozniak D et al, Cochr Data Syst Rev 2014

Summary of patient-centered interventions

Intervention	Increase in mean usage per night	Number needed to treat to get 1 additional patient adherent (>4h)
Education	35 min (0.60 hr)	7.7
Troubleshooting	50 min (0.82 hr)	6.3
Behavioral modification	86 min (1.44 hr)	5.3

Wozniak D et al, Cochr Data Syst Rev 2014

Take home message #4

- Spending time with the patient works.

Self-monitoring

- 138 newly diagnosed OSA patients starting PAP randomized to:
  - Usual care
  - Usual care with web access to PAP use
  - Usual care with web access and financial incentive

Nightly hours of PAP Use

	Usual Care	Web Access	Web Access + $$
Week 1	4.7 ± 3.3	6.3 ± 2.5*	5.9 ± 2.5*
3 Months	3.8 ± 3.3	5.0 ± 3.2*	4.8 ± 3.0*

* $p<0.05$ compared to usual care

Kuna ST et al, Sleep 2015; 38: 1229-36

Using CPAP mobile app

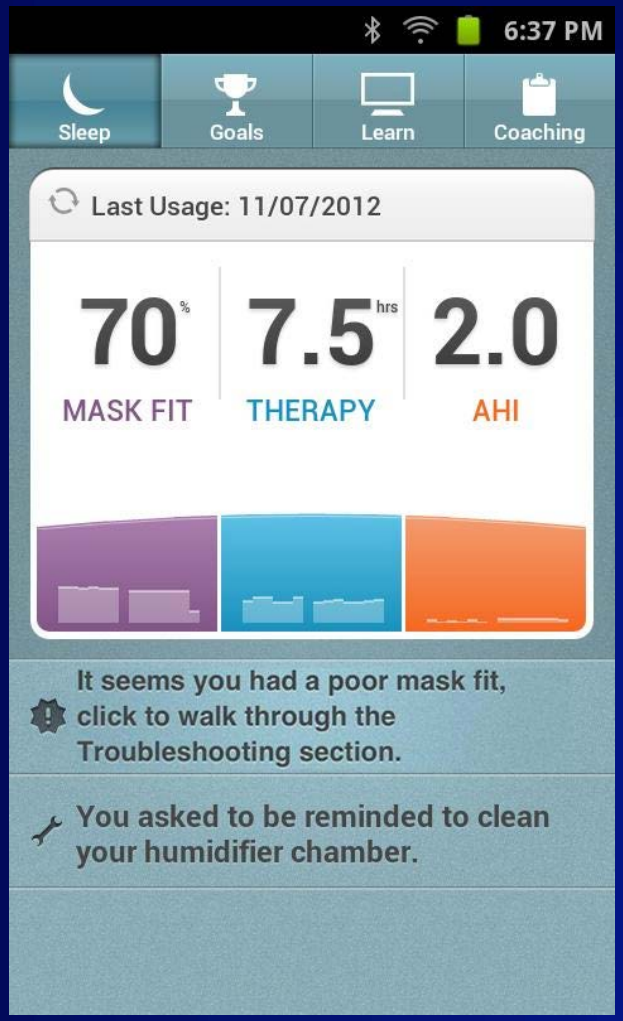
Retrospective analyses from two CPAP manufacturers.

Company 1	Number of patients	Usage per night (over 90 days)	% Adherent (Medicare)
No App	7,601	3.1 hrs	56%
App	7,641	4.5 hrs	78%

Company 2	Number of patients	Usage per night (over 90 days)	% Adherent (Medicare)
No App	85,358	4.9 hrs	70%
App	42,679	5.9 hrs	87%

Malhotra A et al, Chest 2018; 153: 843-50

CPAP mobile apps



Take home message #5

- Self-monitoring increases adherence and is free.

Summary

- 1. Home sleep test/APAP strategy is just as good and quicker than in lab sleep study/CPAP titration.
- 2. Don’t use full face masks unless you have to.
- 3. BPAP is rarely the answer.
- 4. Enabling patients is more effective than tweaking the machine.
- 5. Every patient should be tracking their own usage.