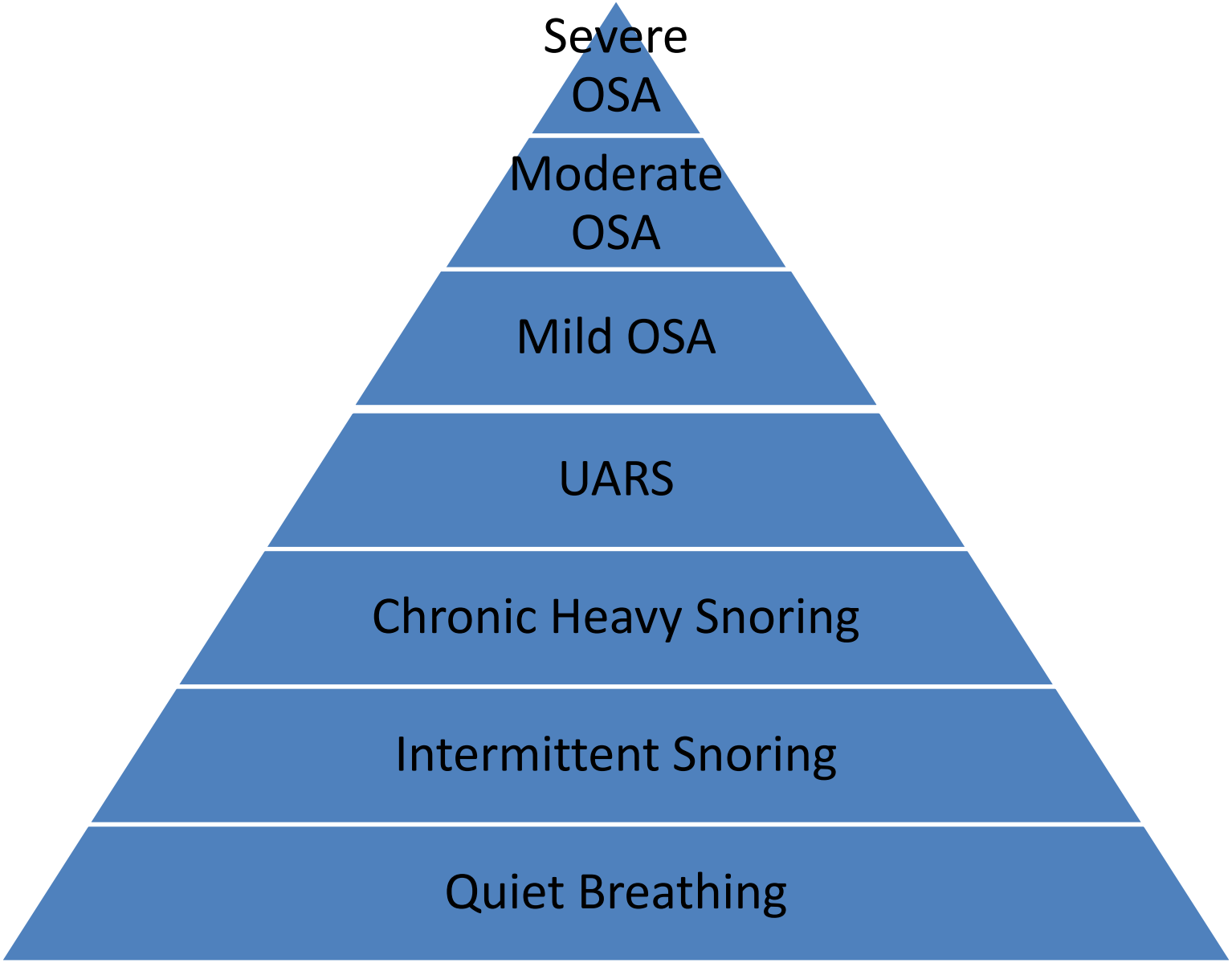
Positive Pressure Ventilation in OSA
Choosing Right Mode & Interface

Dr Devendra Singh Dadhwal
SR

overview

- OSA
- Treatment
- PAP- mode
- Interface
- Accessory
- Titration

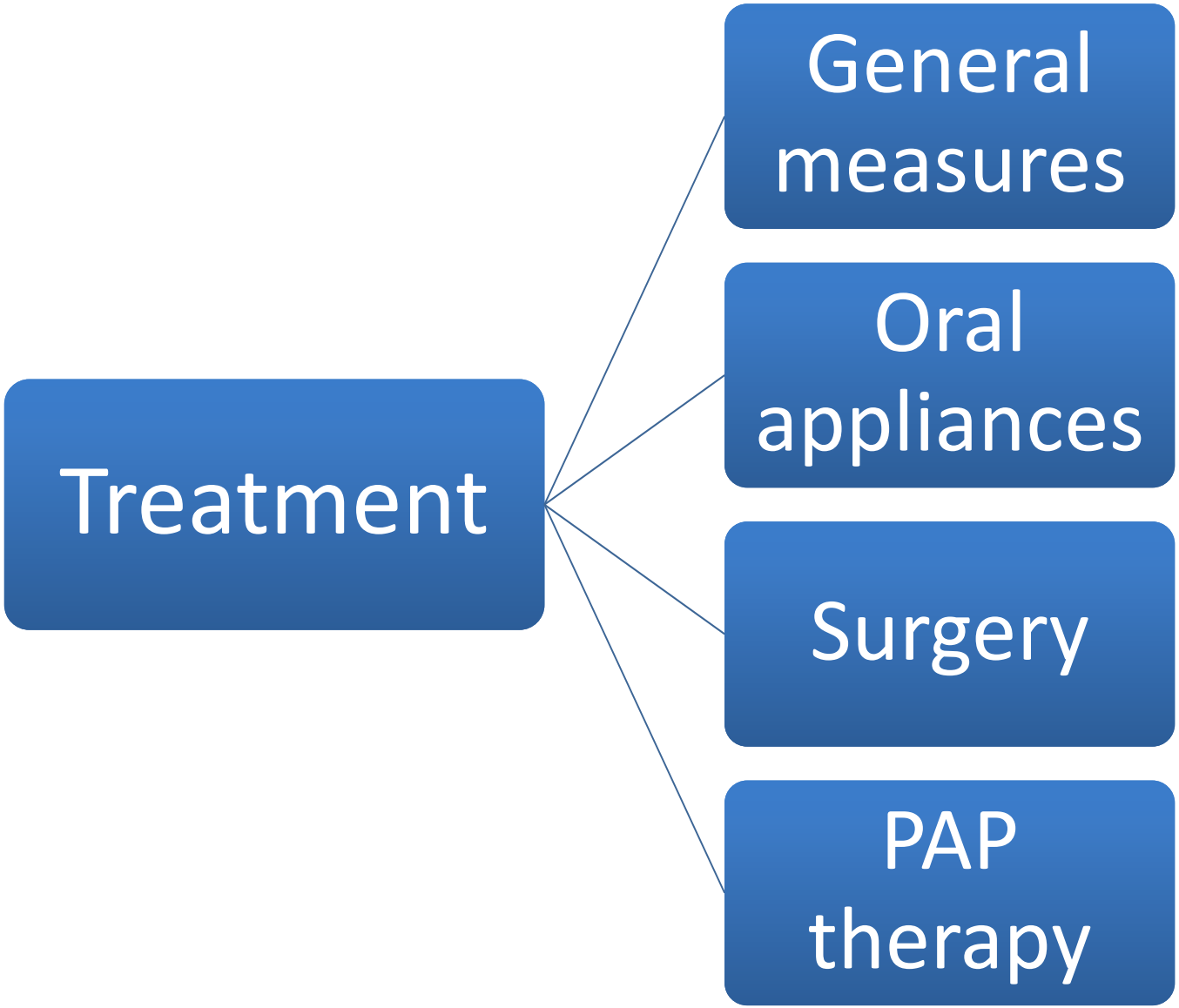
OSA Spectrum



Osa if not treated

- Hypertension (*JAMA* 2000;283:1829-36)
- Cardiovascular diseases including strokes

  (*AJRCCM* 2001;163:19-25)
- Car crashes *(Thorax* 2000;55:224-31)
- Impaired cognitive function *(sleep Med Rev* 2001;5;423-445)
- Impaired quality of life (Sleep 2001;24:96-105)
- Increased health care cost *(Sleep* 1999;22;740-47)
- Worsened glucose tolerance (*AJRCCM* 2002;165:670-676)
- Impotence (*JSMT* 1995;21:239-47)


Treatment
General measures
Oral appliances
Surgery
PAP therapy

General measures

- Weight reduction
- Body position
- Avoidance Alcohol
- Avoidance of sedative
- Smoking cessation
- Treatment of hypothyroidism
- Good sleep hygiene

ORAL APPLIANCES

Mandibular repositioning appliances (MRA)

Tongue retaining devices (TRD)

Oral appliances for obstructive sleep apnoea (Review)

Lim J, Lasserson TJ, Fleetham J, Wright JJ

The Cochrane Library 2009, Issue 3

THE COCHRANE COLLABORATION®

- OA improves subjective sleepiness and SDB compared with control.

- CPAP appears to be more effective in improving SDB than OA.

- It is appropriate to recommend OA therapy to patients with mild symptomatic OSAH, and those patients who are not willing or unable to tolerate CPAP therapy.

SURGICAL MANAGEMENT

- Single level surgery
  - Tracheostomy
  - Maxillomandibular advancement (MMA)
  - Uvulopalatopharyngoplasty (UPPP)
  - Laser assisted uvulopalatoplasty (LAUP)
  - Radiofrequency ablation (RFA)
  - Soft palatal implants

- Multi-level surgery (MLS)
- Phase I
  - Nasal reconstruction
  - Pharynx-UPPP with or without tonsillectomy
  - Hypo pharynx- genioglossus advancement- hyoid myotomy & suspension
  - Possible use of RF techique
  - Reevaluation at 4-6 months
- Phase II
  - Maxillary & mandibular advancement
  - Alternative: surgical or RF tongue reduction

SURGICAL MANAGEMENT

- UPPP
- Maxillomandibular advancement (MMA)

SURGICAL MANAGEMENT

	Quality assessment			Summary of findings			
				No of patients			
Type of Surgery	No. of studies	Study Design	Limitations	Intervention	Control	% reduction in AHI (95% CI)	Quality
MMA	9	Observational	Serious	234	NA	87% (80 to 92)	⊗○○○ Very low
UPPP	15	Observational	Serious	950	NA	33% (23 to 42)	⊗○○○ Very low
LAUP[a]	2	Randomized trial	No serious limitations	34	36	18% (35 to -3)[b]	⊗⊗○○ Low
RFA[c]	8	Observational	Serious	175	NA	34% (19-46)	⊗○○○ Very low
Implants[d]	2	Observational	Serious	69	NA	26% (9-29)	⊗○○○ Very low

Caples S, et al. *SLEEP* 2010;33:1396-1407

PAP THERAPY

- Least invasive & most successful treatment for OSA
- Delivery of low levels of continuous pressure via a nasal or oronasal interface to “splint” open the airway during sleep

Continuous positive airways pressure for obstructive sleep apnoea in adults (Review)

Giles TL, Lasserson TJ, Smith BJ, White J, Wright J, Cates CJ

The Cochrane Library 2006, Issue 2

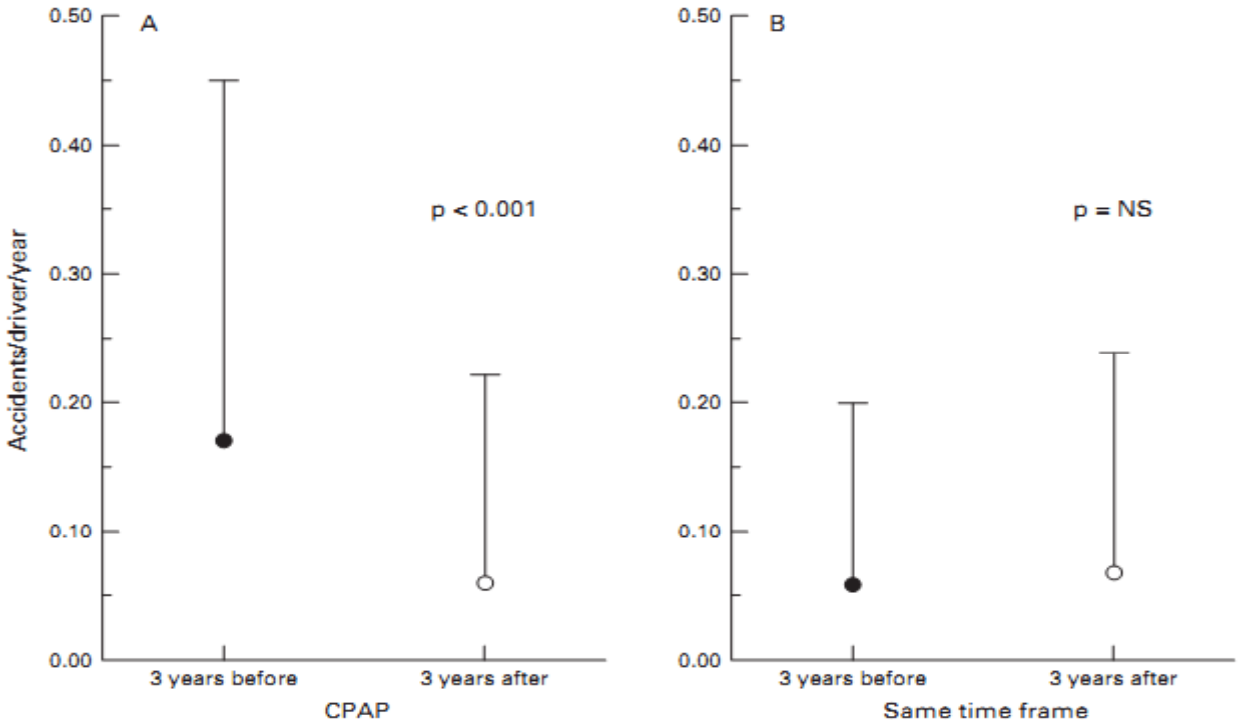
THE COCHRANE COLLABORATION®

- CPAP is effective in reducing symptoms of sleepiness
- Improves quality of life measures in people with moderate and severe OSA.
- It is more effective than oral appliances in reducing respiratory disturbances but subjective outcomes are more equivocal.

PAP: BENEFITS

- Minimally invasive and reversible
- Reduction and/or reversal of OSA-related signs and symptoms
  - Snoring, excessive daytime sleepiness, unrefreshing or fragmented sleep, cognitive impairment
- Decrease risk of accidents
- Increased productivity
- Decrease long-term complications of OSA
  - Hypertension, heart disease, stroke, death

Reduction in motor vehicle collisions OSA treated with CPAP

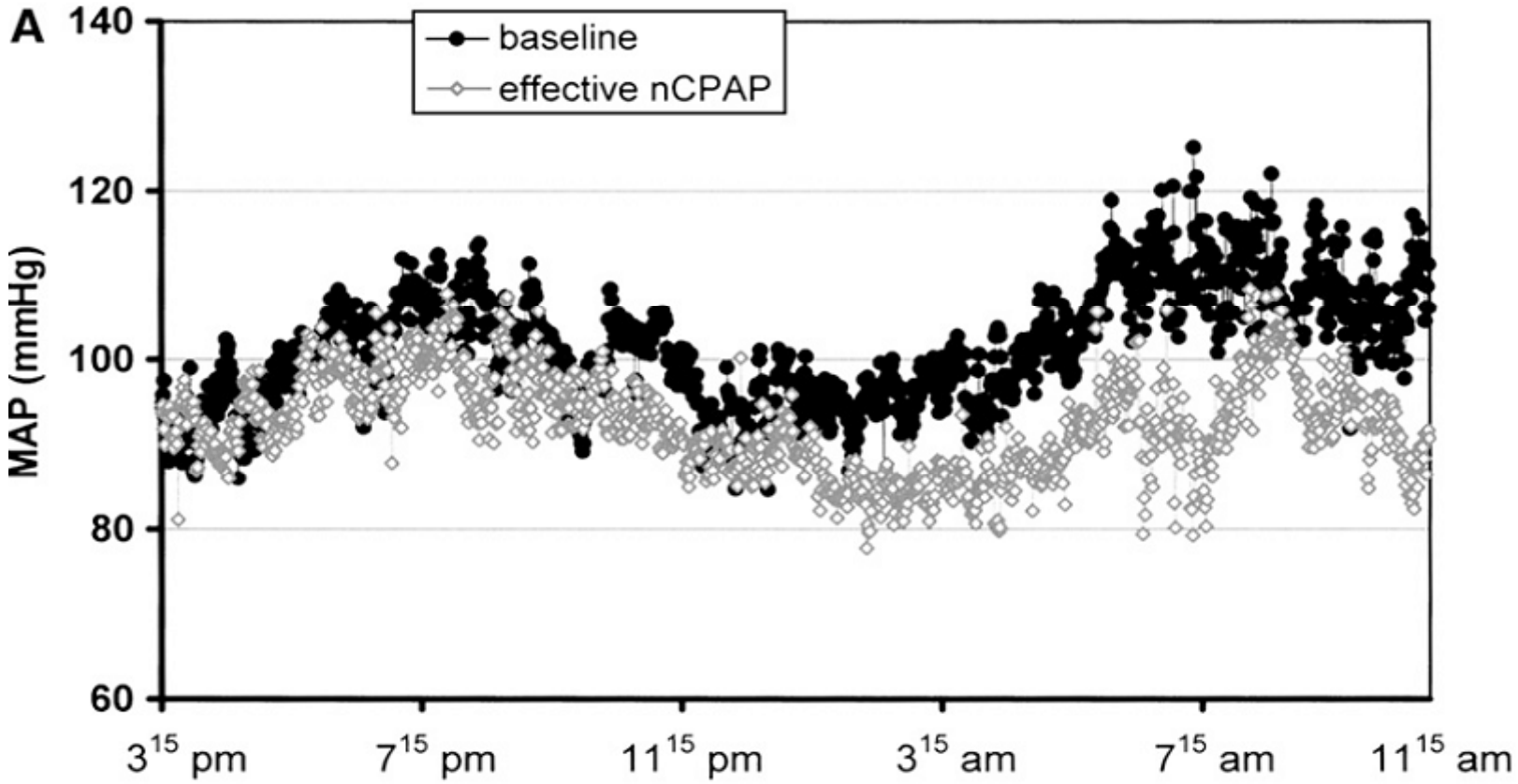


(A) patients with OSA during the 3 years Before and after treatment with CPAP

(B) control subjects during the same time frame.

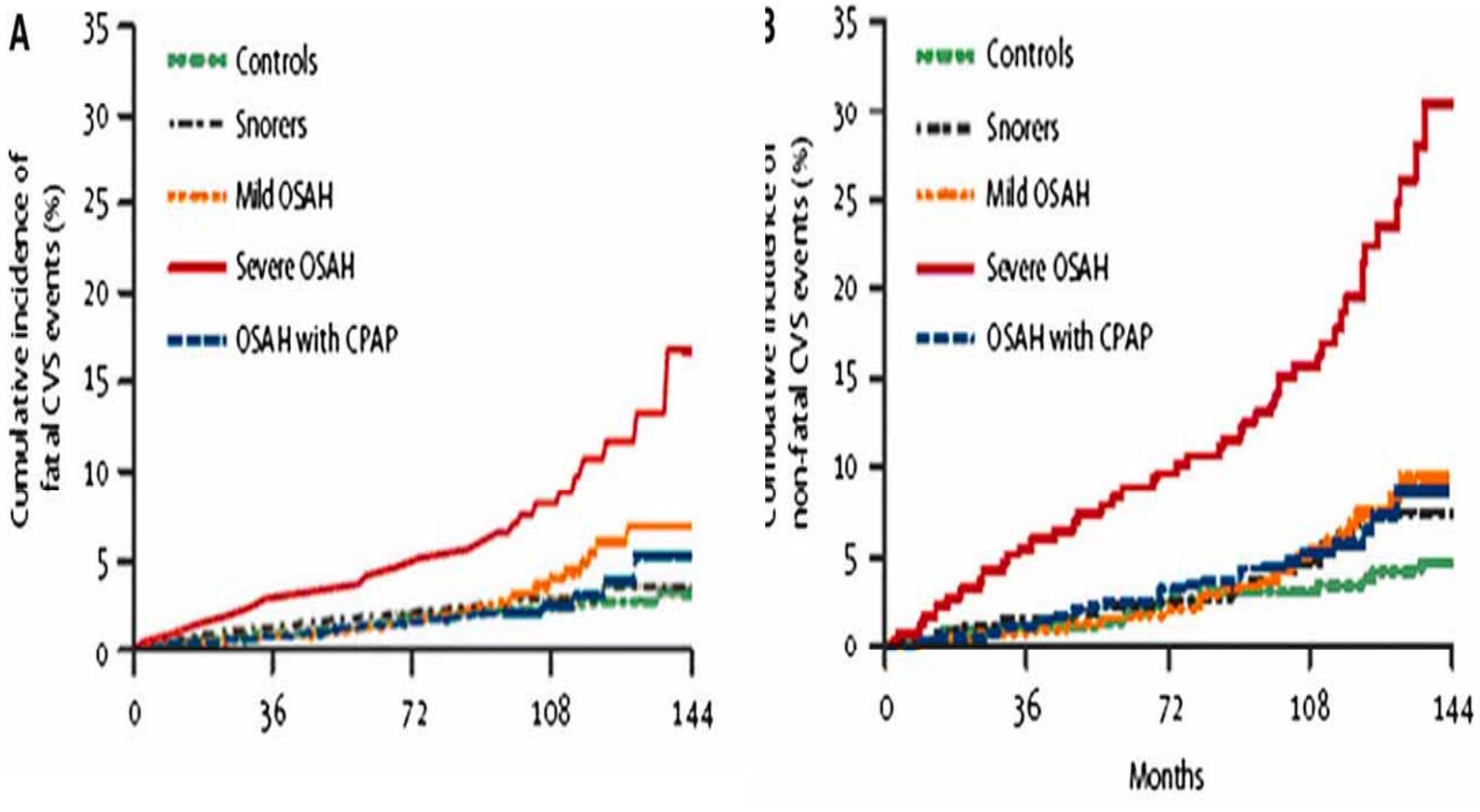
C F P George et al, Thorax 2001;56:508–512

Changes in MAP over 20 hours after treatment with CPAP for 9 wks



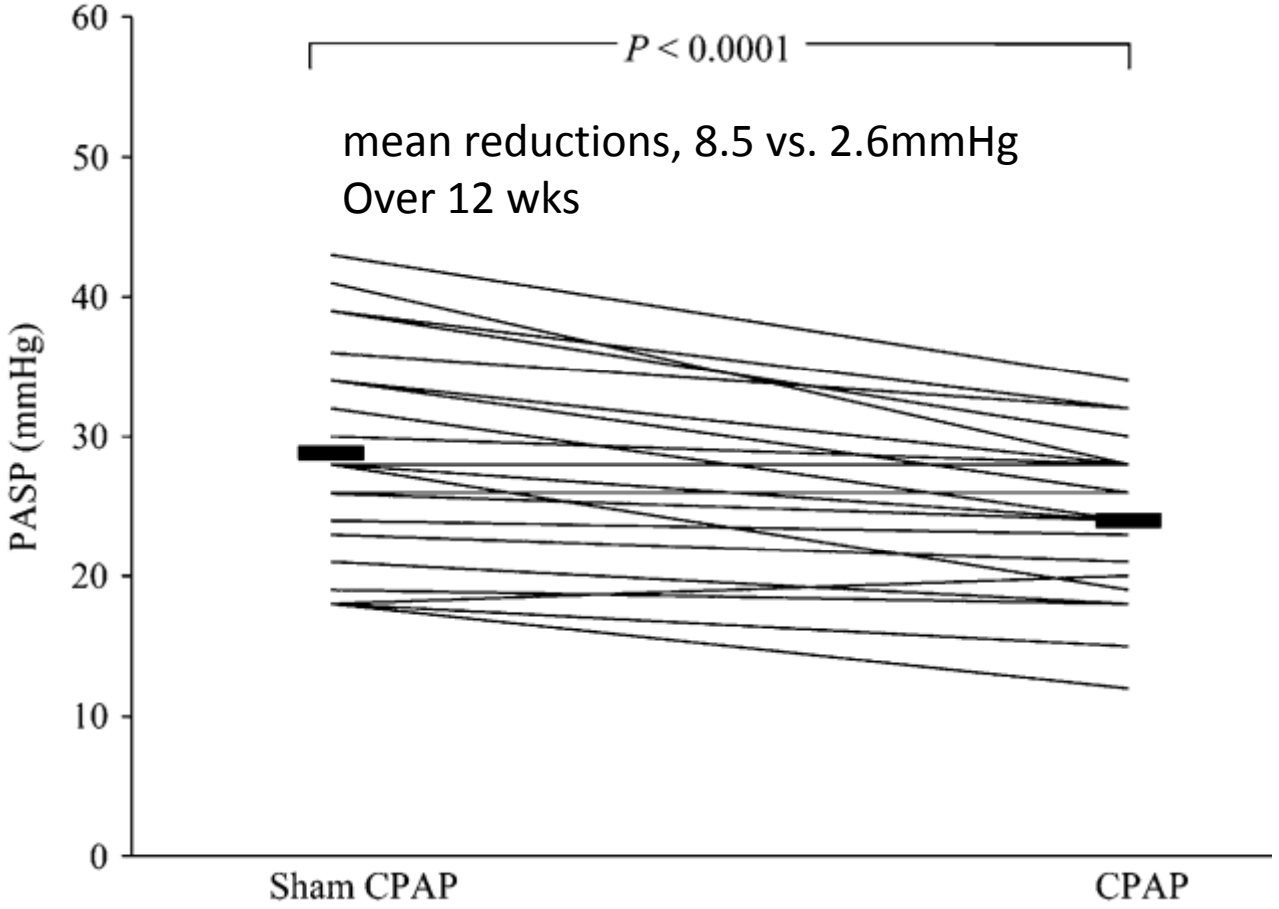
Becker HF et al, Circulation 2003;107:68–73.

OSA & CVA events 10 yrs of follow-up



Marin JM et al,. Lancet 2005;365:1046–1053
an observational study

OSA & Pasp
sham CPAP and CPAP



Arias MA et al, Eur Heart J 2006;27:1106–1113.
a randomized, controlled cross-over study

PAP Therapy

- PAP device- an air pump
- Flexible hose
- Interface – Mask
- Headgear-securing system
- Accessory- Humidifiers

PAP Type

- Continuous PAP (CPAP)
- Bilevel PAP (BPAP)
- Autotitrating PAP (APAP)
- Adaptive Servo-Ventilation (ASV)
- Pressure-Relief
- Pressure ramp

Continuous PAP (CPAP)

- First described by Sullivan in 1981.
- It has remained the treatment of choice for patients with sleep disordered breathing.
- It generate continuous positive airway pressure which provide a pneumatic splint for the airway, thereby prevent collapsing during sleep.

Sullivan CE et al, Lancet 1981;1(8225):862–5.
Strohl KP et al, Am Rev Respir Dis 1986;134(3):555–8

Indication for CPAP

- The most common is OSA.
- It may also be effective in treating CSA (CSR and primary CSA) but not be effective in treating CSA caused by opioid use.
- CPAP titration for CSA is reasonable to assess for effectiveness before switching to a different PAP device.

Ruttanaumpawan P et al. Sleep 2009;32(1):91–8.
Javaheri S, et al. J Clin Sleep Med 2008;4(4):305–10

Bilevel PAP (BPAP)

- Independent adjustment of the EPAP and IPAP
  - EPAP
    - To stabilize the upper airway at end expiration so that the airway is sufficiently patent to permit the patient to trigger delivery of IPAP by generating low-level inspiratory volume or flow.
  - IPAP
    - To prevent upper-airway closure and partial obstruction (hypopnea) during the inspiratory phase of breathing.

Resta O et al. Respir Med 1999;93(3):190–5.
Sanders MH et al. Chest 1990;98(2):317–24.

BPAP type

- BPAP-S (spontaneous mode)
  - Patients may breathe with their own requency, with the BPAP supporting both phases of respiration (IPAP and EPAP)
- BPAP-ST(spontaneous-timed mode with backup rate)
  - It guarantees a certain number of breaths per minute , if the patient does not initiate a breath within a specified period.
  - Inspiratory time must be set, which tells the machine the maximum time allowed for inspiration.

Indications for BPAP

- OSA
  - BPAP and CPAP showed no differences in the improvement of AHI, ESS, or sleep quality.
  - No differences in adherence or comfort level among BPAP and CPAP users of OSA pt without coexisting respiratory disorders.

Gay Pc et al. Sleep 2003;26(7):864–9.
Reeves-Hoche MK et al. Am J Respir Crit Care Med 1995;151(2 Pt 1):443–9.

- OSA - prefer BPAP over CPAP
  - Comorbid obesity
  - Daytime hypercapnia

Resta O et al. Respir Med 1998; 92(6):820–7.
Schafer H et al. Respir Med 1998;92(2): 208–15

  - When pt are uncomfortable or unable to tolerate CPAP because of a high pressure requirement
  - When pt have persistent OSA on CPAP even at a CPAP of 20 cm H_2O.

Kushida CA et al. J Clin Sleep Med 2008;4(2):157–71

- Central Sleep Apenea
  - Primary CSA
  - CSA caused by
    - Cheyne-Stokes breathing pattern
    - High-altitude periodic breathing
    - Drugs or substances such as opioids.
  - Complex CSA
- BPAP in the ST mode is useful to treat patients with CSA syndromes

Autotitrating PAP

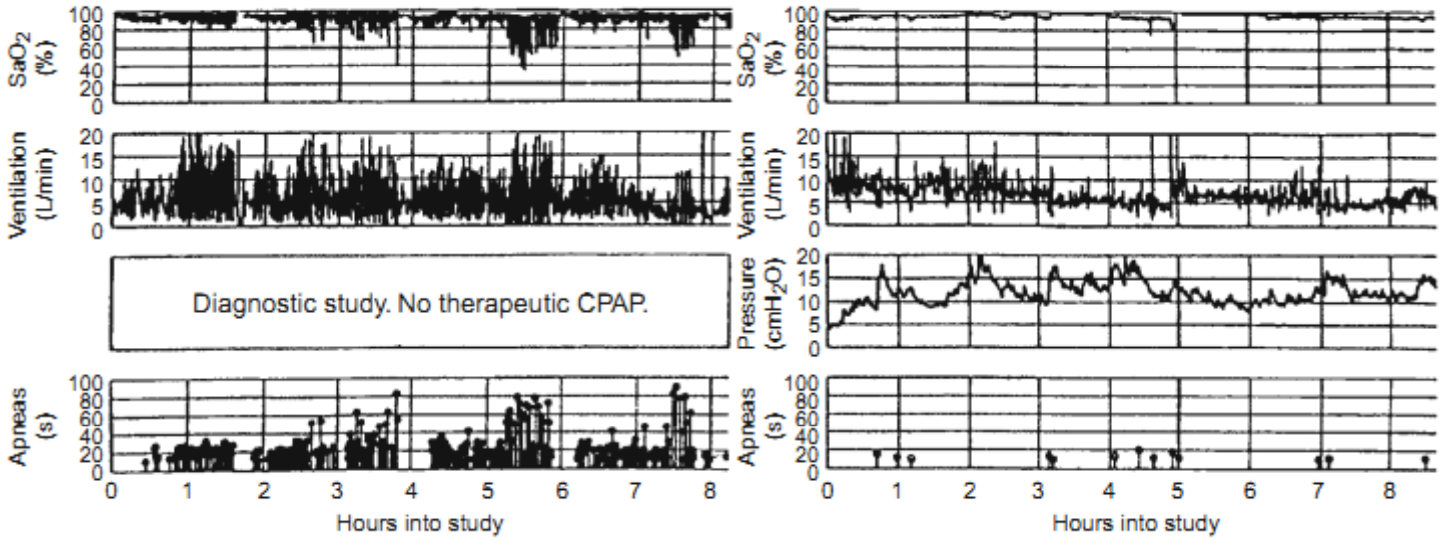
- Autotitrating PAP (CPAP & BPAP)
  - Use proprietary algorithms to detect impending collapse
  - Adjust the amount of pressure that is delivered in order to maintain airway patency.

- Following a period of upper airway stability
  - the pressure gradually decreases until impending collapse or instability is again detected then increased per the algorithm.

- The optimal therapeutic PAP may vary across the night (e.g., various body positions and stages of sleep).
- The pressure “floats” throughout the night with the intention of meeting the patient’s requirements in real time

Diagnostic study

Autotitrating CPAP



Autotitrating CPAP with pressure levels that vary across the recording

Polo O et al, Lancet 1994;344:656

- Although APAP in compared to standard CPAP, is associated with a reduction in mean applied pressure across the night by 2.2 cm water.

- But APAP and standard CPAP were similar in
  - Adherence
  - Eliminate respiratory events
  - Improvement in subjective sleepiness
- APAP is more costly than standard CPAP

Ayas NT et al, Sleep. 2004 Mar 15;27(2):249-53.

Adaptive Servo-Ventilation

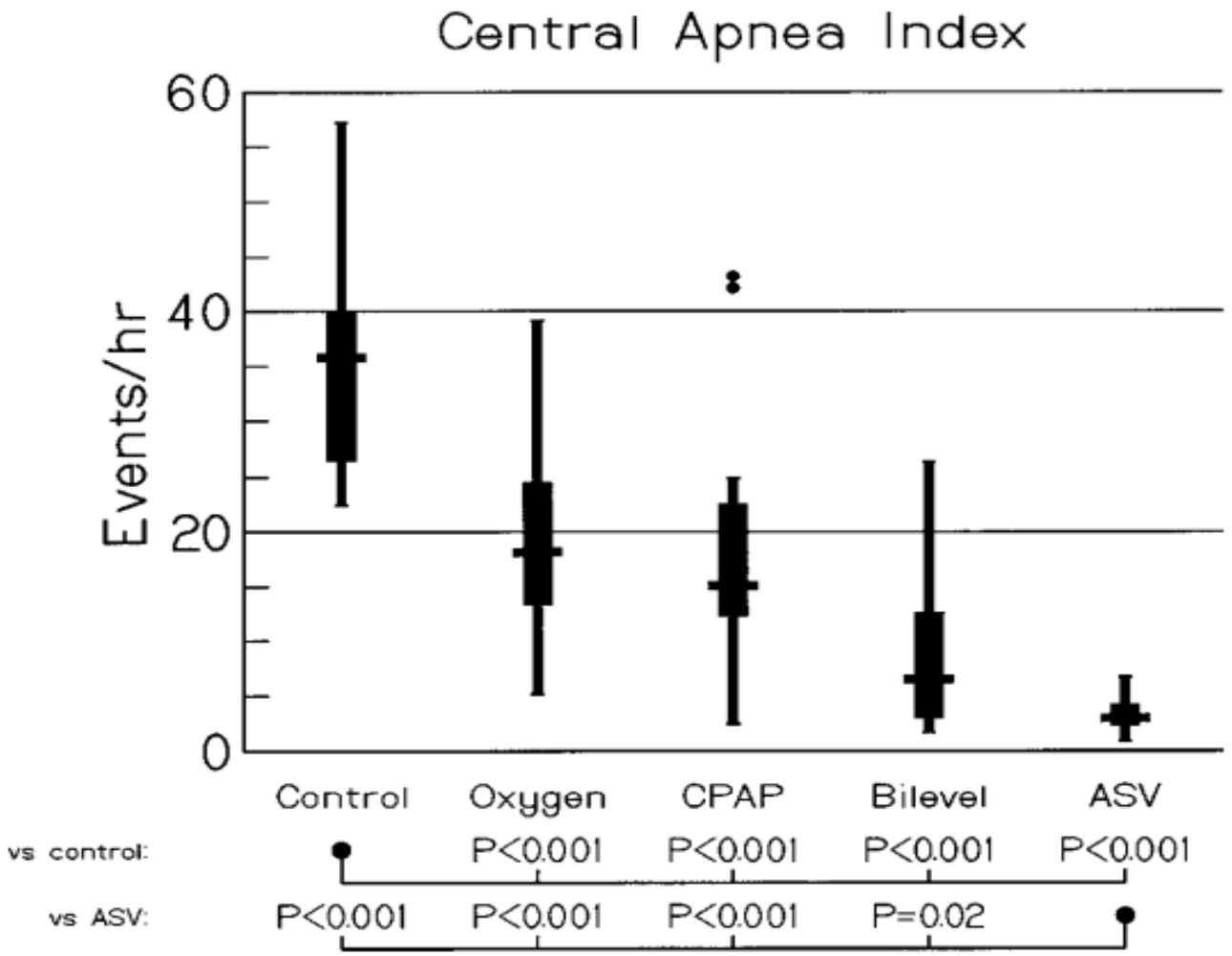
- The ASV is a highly evolved bilevel device
- The IPAP is variable and responds rapidly within 2 or 3 breaths to significant changes in patient V_T

- These variable degree of IPAP support stabilizes the patient's ventilation over time.
  - When V_T increases, the device IPAP decreases.
  - When V_T decreases, the device IPAP increases.

- All or most of the central events are automatically treated by fluctuations in the 'adaptive' IPAP.

Teschler H et al, Am J Respir Crit Care Med 2001;164:614-619.

- After a 3-minute initial collection period, the ASV sets a MV target that is 90% of the previous MV.
- There is a weak downward force on total MV
  - That decreasing or eliminating the frequent CO_2 dips below the apnea threshold which drives the central events
- If the subject suddenly ceases all central respiratory effort
  - Machine support will increase (min of 4 cm H_2O up to Max 10 cm H_2O) whatever is required to maintain ventilation at 90% of the long term average
  - Reached in 12 s, with ASV default backup rate of 15 b/min
- If the subject then resumes normal spontaneous effort, support will fall back to the min of 4 cm H2O over a similar time period.



Box: effect of treatment on CSA index. Horizontal bar: median; Thick vertical line: interquartile range; Circles: outliers; Thin bar: range excluding outliers.

Teschler H et al, Am J Respir Crit Care Med 2001;164:614-619.

- Indications
  - CSB with heart failure or idiopathic
  - Complex CSA(Treatment-Emergent CSA)
    - Common risk factors for this stroke or other CNS injury, atrial fibrillation, heart failure, very high BMI and chronic use of long-acting opioid medications for pain management
- Contraindications
  - Because of it's 90% target, the device should not be used in patients who have a condition that might result in hypoventilation

    eg- severe COPD, neuromuscular disorders etc

“Pressure-Relief” PAP

- This provide expiratory pressure relief at the beginning of exhalation
- The pressure increases to the prescribed EPAP level at end expiration
- The level of pressure relief varies based on the patient’s expiratory flow
- The pressure-relief bilevel PAP, device also provides relief of pressure at end inspiration, in addition to expiratory pressure relief.
- Patients on pressure relief use their therapy on average >4 h/night at both 30 and 90 days compared with an average of< 4 h/night when using traditional CPAP

Aloia, M.S., et al., Chest 2005; 127:2085-2093

C-Flex (Philips Respironics)

- Pressure relief at the beginning of exhalation and returning to therapeutic pressure just before inhalation
- Pressure relief
  - Proportional to flow (more exhalation effort equals more relief)
  - C-Flex setting (1 provides the least amount of relief, 3 the most relief)

C-Flex+

- It softens the pressure transition from inhalation to exhalation with pressure relief at the beginning of exhalation

A-Flex

- It work with auto CPAP algorithm
- It provides flow-based pressure relief at the beginning of exhalation and softens the pressure transition from inhalation to exhalation.

Bi-Flex

- It work with BiPAP algorithm
- It provides flow-based pressure relief
  - At the end inhalation
  - At early exhalation

Pressure Ramping

- For some patients, positive pressure is unpleasant and cause difficulty with initiating sleep.
- Pressure ramping of CPAP allows adjustment of the rate of rise in delivered pressure over time
  - From a clinician-specified level to the target therapeutic pressure.
- “ramp abuse” patient repeatedly awoke to reactivate the ramp and ramping may allow
  - Apnea, hypopnea, and oxyhemoglobin desaturation to occur for a variable period of time, until the pressure reaches the therapeutic value.

Interface

- PAP Therapy
  - Major determinant of success or failure is choice of interface which strongly affects patient's comfort.

Mehta S et al, Am J Respir Crit Care Med 2001;163(2):540-577.

  - Only about 50% of the patients classified their interface fit as "good" or "very good."

Meslier N et al, Eur Respir J 1998;12(1):185-192

Ideal interface

- Leak-free
- Good stability
- Nontraumatic
- Light-weight
- Long-lasting
- Nondeformable
- Nonallergenic material
- Low resistance to airflow
- Minimal dead space
- Low cost
- Easy to manufacture (for the molded interfaces)
- Available in various sizes

Ideal securing system

- Stable (to avoid interface movements or dislocation)
- Easy to put on or remove
- Nontraumatic
- Light and soft
- Breathable material
- Available in various sizes
- Works with various interfaces
- Washable (for home care)
- Disposable (for hospital use)

Interfaces- type

- Ready-to-use :
  - Standard commercially available models in various sizes (pediatric and adult -small, medium, and large)
- Custom-fabricated:
  - Molded directly on the patient or on previously obtained molded cast of the patient

The classes of interface

- Oral Interfaces
- Nasal mask
- Nasal pillows
- Oronasal
- Full-face
- Helmet

Oral Interfaces

- Mouthpiece is placed between the patient's teeth and lips and held in place by lip-seal
  - Types:

    1.Standard narrow mouthpieces with various degrees of flexion

    2. custom-molded bite-plates.
  - Use
    - For long-term ventilation, who required several hours of ventilatory support,
    - For the sequential use- mouthpiece during the daytime and a nasal mask overnight.

- Complication
  - Mouthpieces may elicit gag reflex, salivation, vomiting, vomit aspiration and orthodontic deformities(Long-term use).

Nasal mask & pillows

- Nasal mask:
  - covers the nose but not the mouth
- Nasal pillows:
  - plugs inserted into the nostrils

  - Limitations
    - It has limited effectiveness when nasal resistance exceeds 5 cm H_2O.

      Ohi M et al, Am J Respir Crit Care Med 1994;149:A643.

    - The presence of expiratory air leak makes V_T monitoring unreliable.

- Advantages
  - Less interference with speech and eating
  - Allows cough
  - Less danger with vomiting
  - Allow the patient to wear glasses & Claustrophobia uncommon
  - No risk of asphyxia in case of ventilator malfunction
  - Less likely to cause gastric distension
- Contraindications
  - Relative
    - Edentulism
    - Mouth open during sleep
  - Absolute
    - Unable to breath through the nose
    - Severe acute respiratory failure (Oronasal breathing)
    - Surgery of the soft palate

Oronasal Mask

- Oronasal mask
  - Covers the nose and mouth
- They should have
  - Quick-release straps
  - Anti-asphyxia valves : to prevent rebreathing in the event of ventilator malfunction

- Type
  - Non-vented mask
    - For ventilators which have an integral safety valve (active exhaust system).
  - Vented mask
    - For ventilators with continuous positive airway pressure without active exhalation system
    - It includes an exhalation port to provide adequate flow to wash out exhaled CO_2

- Advantages Compared to Nasal Mask
  - Fewer air leaks with more stable mean airway pressure, especially during sleep
  - Less patient cooperation required

- Contraindications
  - Relative
    - Tetraparetic patients with severe impairment in arm movement
  - Absolute
    - Vomiting
    - Claustrophobia

Full-face mask

- It covers the mouth, nose, and eyes
- It has a soft cuff that seals around the perimeter of the face, so there is no pressure on that areas where an oronasal/nasal masks have.

Helmet

- It covers the whole head and all or part of the neck; no contact with the face or head
- It is secured to the patient by armpit straps
- It has
  - A transparent hood
  - Soft collar that contacts the body at the neck and/or shoulders
  - Two ports: one for gas entrance, and another from which gas exits
  - Anti-asphyxia valves

- Advantages Compared to Oronasal Mask
  - Less resistance to flow
  - Can be applied regardless of the facial contour, facial trauma, or edentulism
  - Allows coughing
  - Less need for patient cooperation
  - Better comfort
  - Less interference with speech
  - Securing system has lower risk of causing skin damage
- Contraindications
  - Relative
    - Need for monitoring of volumes
    - Difficult humidification
  - Absolute
    - Claustrophobia
    - Tetraplegia

Accessories

- Humidification
  - Unidirectional inspiratory nasal airflow, can dry the nasal mucosa(worsened by mouth air-leak)
  - The mucosa progressively dries and releases inflammation mediators with increased vascularity

    Hayes M et al, Thorax 1995;50(11):1179-1182
  - The gas delivered from the ventilator have lower humidity than the ambient air

    (worsened as the pressure support increases)

    Holland AE et al, Respir Care 2007;52(1):38-44

Humidifier- types

- Heated Humidifier
  - Uses heat to produce moisture.
  - The heat is adjustable
  - The chamber is much smaller than a passover humidifier
- Cool Passover Humidifier
  - The air picks up moisture as it "passes over" the water in the chamber
  - There is no way to increase the amount of moisture
  - Cold climates, reduce the amount of moisture in the air
- Heat-and-Moisture Exchanger (HME)
  - Captures heat and moisture on expiration and returns it to the patient in inspiration.

- Heated Humidifier
  - Stand Alone Humidifiers
    - It will work with any CPAP and does not attach directly to the CPAP

- Integrated Humidifiers
  - It is a component to a specific CPAP that fits directly to the CPAP
  - It will function only with the CPAP for which they were designed

- Built In Humidifiers
  - It is part of the CPAP machine and cannot be removed or separated from the CPAP machine

- To minimizing the incidence of rainout
  - Snuggle Hose is a tube of very soft fleece material which insulates the hose
  - Heated hoses with copper coils to conduct heat

- Cool Passover Humidifier
  - All heated humidifier will work as passover humidifier when not heated but less effectivily

Heat-and-Moisture Exchanger (HME)

- HMEs are
  - Easy to use
  - But can add an important amount of dead-space as usually placed between the Y-piece and the interface
- In compared to heated humidifier,
  - HME was associated with significantly higher $PaCO_2$

    Jaber S et al, Intensive Care Med 2002;28(11):1590-1594
  - Alveolar ventilation was maintained only at the expense of a greater work of breathing with HME

    Lellouche F et al, Intensive Care Med 2002; 28(11):1582-1589.

- HME Precautions
  - Difficult to wean patients may require removal of HME.
  - It should not be used on PICU patients.
  - It must be removed during aerosol therapy.
  - It should be replaced every 24 hours.
  -
- HME Contraindications
  - Patients with copious or frothy secretions or suspicion of retained secretions.
  - Patients with a large air leak distal to the HME (such as a large BPF).
  - Patients with a minute volume > 10 L/min.

Patient Education

- All potential PAP titration candidates should get
  - Adequate PAP education
    - Causes and mechanisms of OSA
    - PAP therapy (and treatment alternatives)
    - Consequences of untreated OSA
    - side effects
    - hands-on demonstration
  - Careful mask fitting
    - With the goals of maximizing comfort, compensating for significant nasal obstruction, and minimizing leak
  - Acclimatization prior to titration
    - Wearing the interface with the pressure on prior to “lights off.”

Silva RS et al, Sleep Breath 2008;12:85-9

PAP Titration

- GOALS OF PAP TITRATION
  - To identify
    - The optimal pressure that eliminates SDB events (apneas, hypopneas, RERAs, oxygen desaturation, and snoring), during all stages & positions of sleep without side effects
  - To attain
    - RDI of less than 5 per hour
    - No oxygen desaturation below 88% and
    - With minimal leak around the mask interface.

- The optimal pressure
  - Predictive Formulas to Estimate CPAP Pressure
  - The gold standard
    - Manually titration during attended overnight lab PSG
  - Auto titration
    - Autotitrating PAP (APAP)

Predictive Formulas to Estimate CPAP Pressure

- Based on pt's BMI,NC & AHI
  - CPAP min = - 5:12 + (0.13xBMI) + (0.16xNC in cm) + (0.04xAHI)
- Based on pt's BMI
  - BMI <30 8cmH2O
  - BMI 30-35 10 cm H2O
  - BMI >35 12 cm H2O
- The formulaic prescription strategy could be used when there would be an untoward delay in initiating CPAP treatment
- However, studies have failed to confirm their accuracy

Gokcebay N et al, Sleep 1996;19(7):600–1.

Rowley JA et al, Sleep Breath 2005;9(1):26–32.

Respiratory rules for adults

Technical considerations

- For Apnea:
  - oronasal thermal sensor
- For Hypo apnea:
  - nasal air pressure transducer with or without square root transformation
- For Respiratory efforts:
  - esophageal manometer, or inductance plethysmography
- For blood oxygen saturation:
  - pulse oxymetry

(AASM Manual for scoring of sleep & associated events 2007)

- For Snoring:
  - Sawtooth Patterns in the Unfiltered Airflow or Mask Pressure Tracings and/or Detection of Vibration by Piezoelectric Transducers or Microphones Applied to the Neck

(Clinical guidelines for the manual titration of PAP in patients with OSA. *JCSM 2008;4(2)*

Manual Titration of PAP in OSA

- An optimal titration
  - Reduces RDI <5 for at least a 15 min duration
  - Should include supine REM sleep at the selected pressure that is not continually interrupted by spontaneous arousals or awakenings

- A good titration
  - Reduces RDI ≤10 or by 50% if the baseline RDI <15
  - Should include supine REM sleep that is not continually interrupted by spontaneous arousals or awakenings at the selected pressure

Manual Titration of PAP in OSA

- An adequate titration
  - does not reduce the RDI ≤10 but reduces the RDI by 75% from baseline (especially in severe OSA patients), or
  - Criteria for optimal or good are met with the exception of supine REM sleep.

- An unacceptable titration
  - does not meet any one of the above grades.

- A repeat PAP titration study
  - If the initial titration does not achieve a grade of optimal or good and,
  - If it is a split-night PSG study, it fails to meet AASM criteria (i.e., titration duration should be >3 hr).

Split-night study

Criteria

- An AHI of > 40 is documented during a min. of 2 hrs of diagnostic PSG
- AHI 20 to 40/h with severe de-saturation or other indications for an immediate titration, and
- 3 h required for the PAP titration

Potential disadvantages

- Underestimation of the severity of sleep apnea
- Inadequate time for PAP titration

Kushida CA et al. Sleep 2005; 28:499–516

Titration method for CPAP in ≥12 years of age

- Start: 4 cm of H_2O
- Increased by at least 1 cm H2O with interval no shorter than 5 min if
  - ≥ 2 apnea
  - ≥ 3 hypopnea
  - ≥ 5 RERA
  - ≥ 3 min of loud or unambiguous snoring
- Goal: eliminating all obst. respiratory events
- Max: 20 cm of H_2O
- If there are continued obst. respiratory events at 15 cm H_2O of CPAP , the patient may be switched to BPAP

Kushida CA et al,AASM Clinical guidelines for the manual titration of PAP in OSA. J Clin Sleep Med 2008;4(2):157-171.

Titration method for BPAP in ≥12 years of age

- Start: 8/4 cm of H_2O
- increased by at least 1 cm H_2O of IPAP & EPAP with interval no shorter than 5 min if
  - ≥ 2 apnea
- Increased by 1 cm of IPAP only if no apnea but
  - ≥ 3 hypopnea
  - ≥ 5 RERA
  - ≥ 3 min of loud or unambiguous snoring
- Goal: eliminating all obst. respiratory events
- IPAP-EPAP differential: min 4 & max 10 cm of H_2O
- Max IPAP: 30 cm of H_2O

Kushida CA et al,AASM Clinical guidelines for the manual titration of PAP in OSA. J Clin Sleep Med 2008;4(2):157-171.

Manual Titration of PAP in OSA

- Supplemental O_2 should be added if
  - Patient's awake supine RA spo_2 ≤88%.
  - Spo2 is ≤88% for ≥5 minutes in the absence of obstructive respiratory events.
  - Should be introduced at 1 l/min and titrated with ↑ 1 l/min no shorter than 15 minutes to achieve a target spo2 between 88% and 94%
  - O2 should be introduced into the **tubing near the PAP device** rather than directly into the mask for more constant O2 delivery to patients
- Adaptive Servo Ventilation may be considered if the patient is observed to have Cheyne-Stokes Respiration or if treatment emergent central sleep apnea appears.

PAP: ADVERSE EFFECTS

Most of the side effects are related to **pressure or airflow or interface**

Mask marks on face	48%
Nasal bridge discomfort or breakdown	33%
Nasal congestion	26%
Dry nose/dry or red eyes	21-22%
Machine noise	17%
Ear pain	8%
Rhinitis	7%
Facial acne under mask	6%
Difficulty exhaling	6%

Strollo PJ et al. Clin Chest Med 1998;19: 55

OTHER PROBLEMS

- Nose bleeds
- Air-swallowing
- Pneumothorax or pneumomediastinum
- Pneumoencephalus
- Tube condensation
- Claustrophobia/anxiety
- “Temporary” treatment
- Difficulty initiating and/or maintaining sleep
- Day-to-day inconvenience
- Difficulty traveling/poor portability
- Spousal intolerance