

Une perspective (personnelle) sur les origines de la PPC et les modifications contemporaines

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Disclosure of Potential Conflicts of Interest for David M. Rapoport (as of Sept 2010)

Royalties from Patent Licenses/R&D contracts

Fisher & Paykel, Covidian, Biologics

Consultation Agreements

Apnex Medical

Grants (clinical trials)

Ventus Medical, Restore Medical,
Watermark, NHLBI

The Original Invention

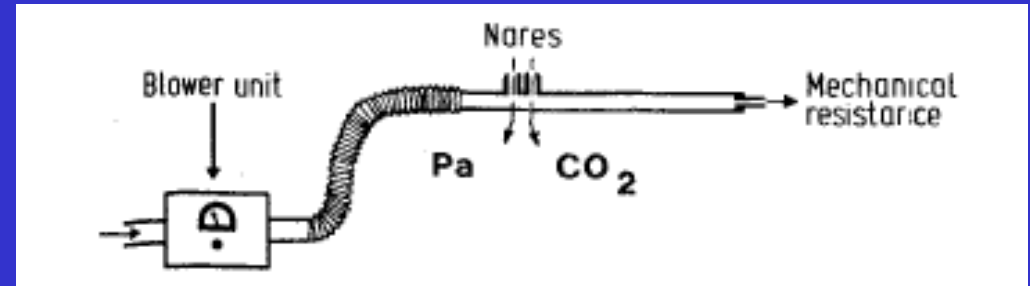
Collin Sullivan 1981

REVERSAL OF OBSTRUCTIVE SLEEP APNOEA BY CONTINUOUS POSITIVE AIRWAY PRESSURE APPLIED THROUGH THE NARES

COLIN E. SULLIVAN
MICHAEL BERTHON-JONES

FAIQ G. ISSA
LORRAINE EVES

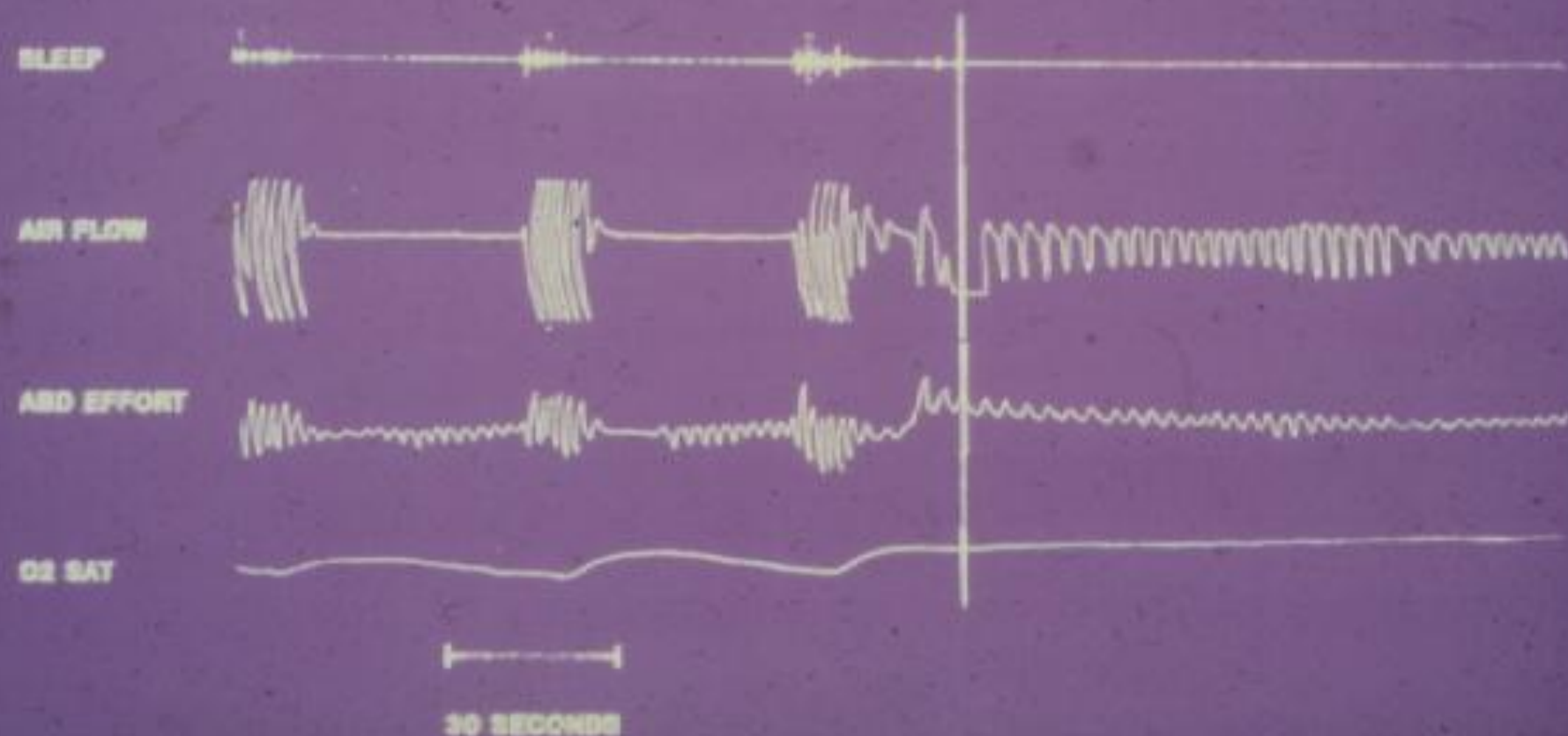
*Department of Medicine, University of Sydney, New South Wales
2006, Australia*



“We actually made the first blowers using a **two-stage vacuum cleaner motor** that we modified for home use. We tried a whole range of head harnesses, but one of the earliest setups that worked was using the **inside of a bicycle helmet to hold the mask in place**. We also **individually molded masks and provided patients with large pots of Silastic paste and catalyst to glue the masks on**. We later accessed the Vortex blower motor, which was designed for dental drills, and these worked really well for home use and were easily accessible. “

The inherent simplicity and safety suggest that home use will be possible.

OBSTRUCTIVE SLEEP APNEA - Nasal CPAP



Effect of CPAP on Obstructive Sleep Disordered Breathing

Physiologically...

- treats breathing disorder (AHI or RDI) when worn
- ~70% compliance with treatment

Clinically...

- Severe SDB

 - improves sleepiness, quality of life, survival, reduces BP, ?other

- Mild SDB

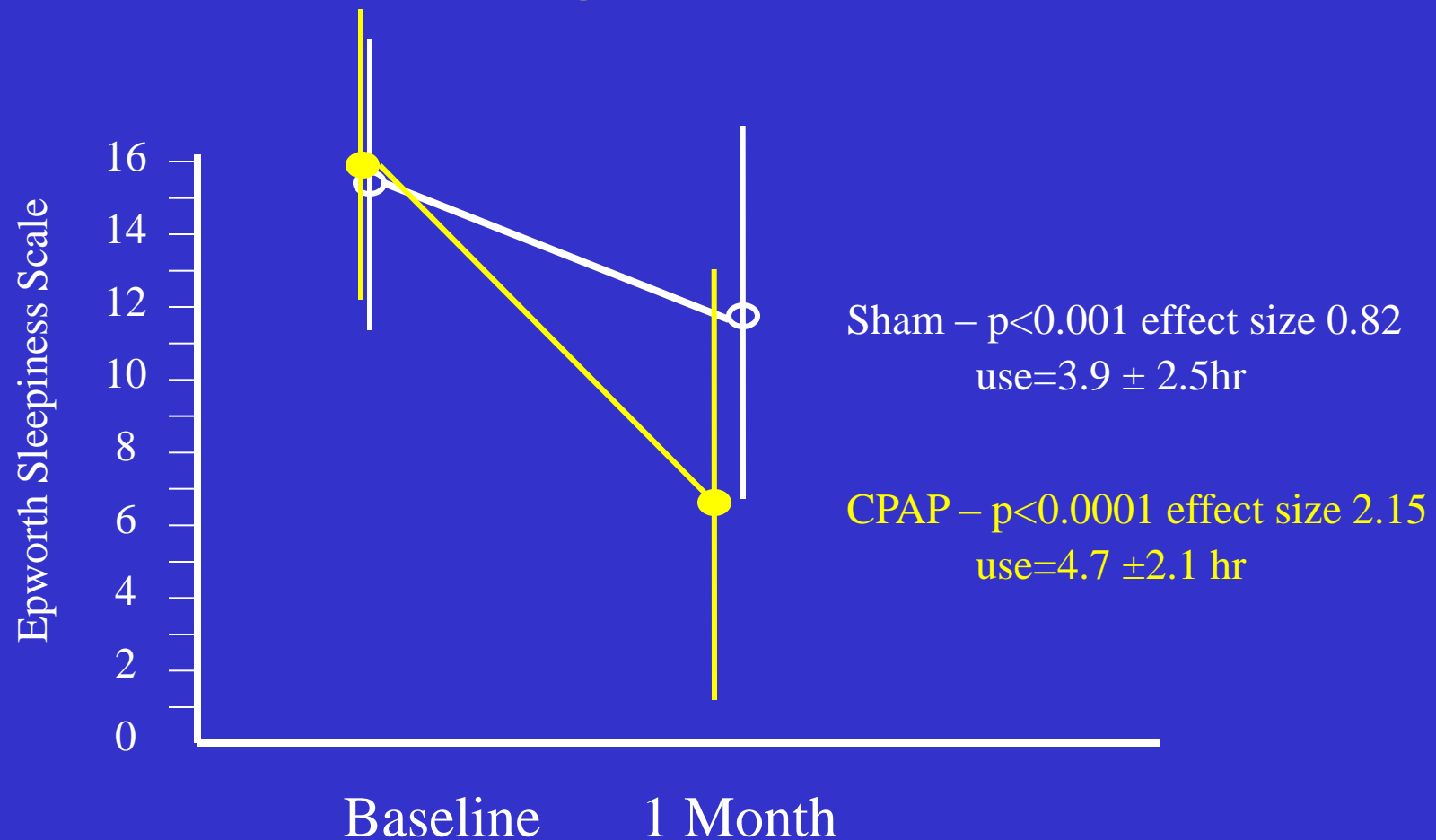
 - ?variable effects shown, studies pending
 - often prescribed, ?compliance/efficacy

- Snoring

 - Other treatments preferred by most (?efficacy/data)

Effectiveness of CPAP in Moderate/Severe OSAHS

RCT n=102



Mechanism of Action of CPAP

Soft palate uvula tongue base

Awake



CPAP
Asleep



“..3 potential mechanisms of action:

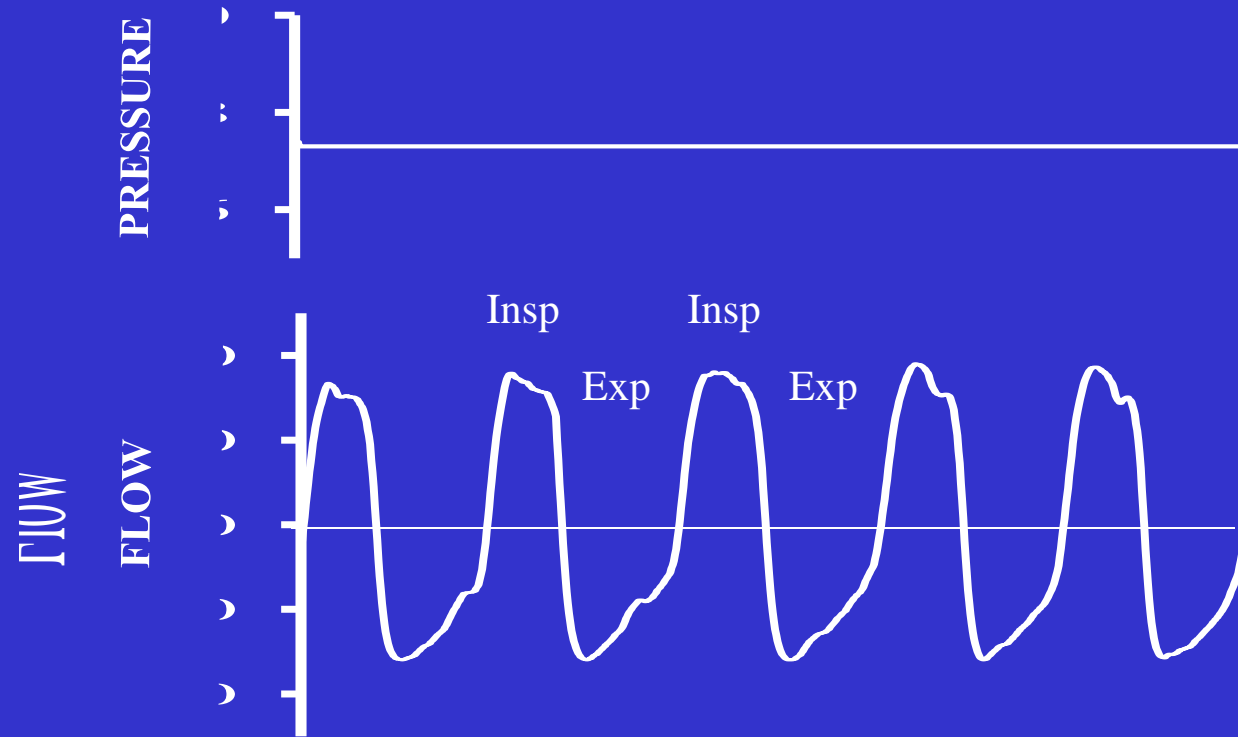
- 1) prevention of sleep-induced collapse
- 2) dilatation of the airway by nasal CPAP
- 3) stimulation of mechanoreceptors”

UNTREATED SDB

Flow

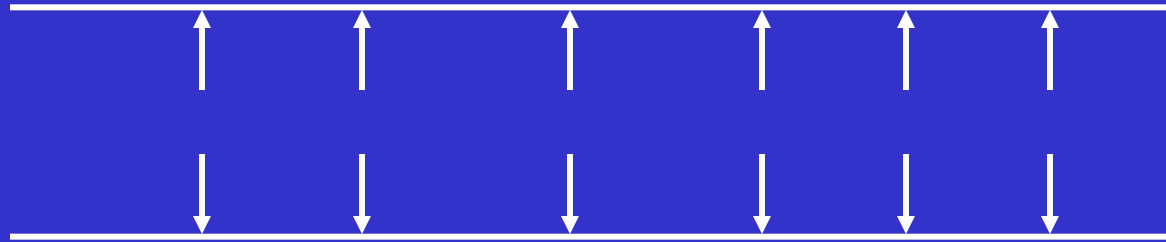


CPAP = CONSTANT Pressure At the Nose



CPAP TREATED SDB

CPAP



Original CPAP System



Why Try To Do “Better” Than CPAP?

~~Give better physiological treatment for SDB~~

Give more comfortable treatment

make initial treatment more “palatable”

make long term treatment less uncomfortable

?is lower pressure more comfortable

metrics of success with “comfort”:

greater adherence to therapy

better sleep architecture on therapy

Variants of CPAP Used for SDB

CPAP

Bilevel Pressure

Compensated Pressure Waveforms

Autoadjusting Pressure

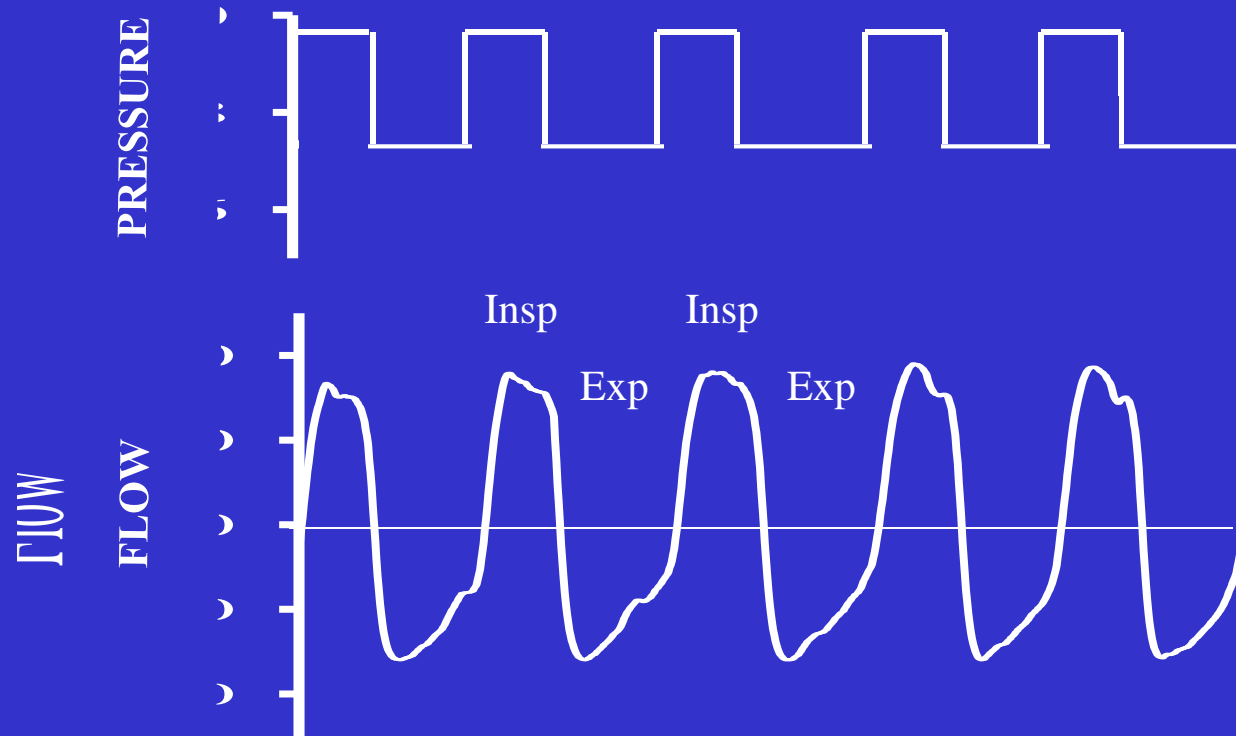
CPAP for Sleep Only

Trans Nasal Insufflation

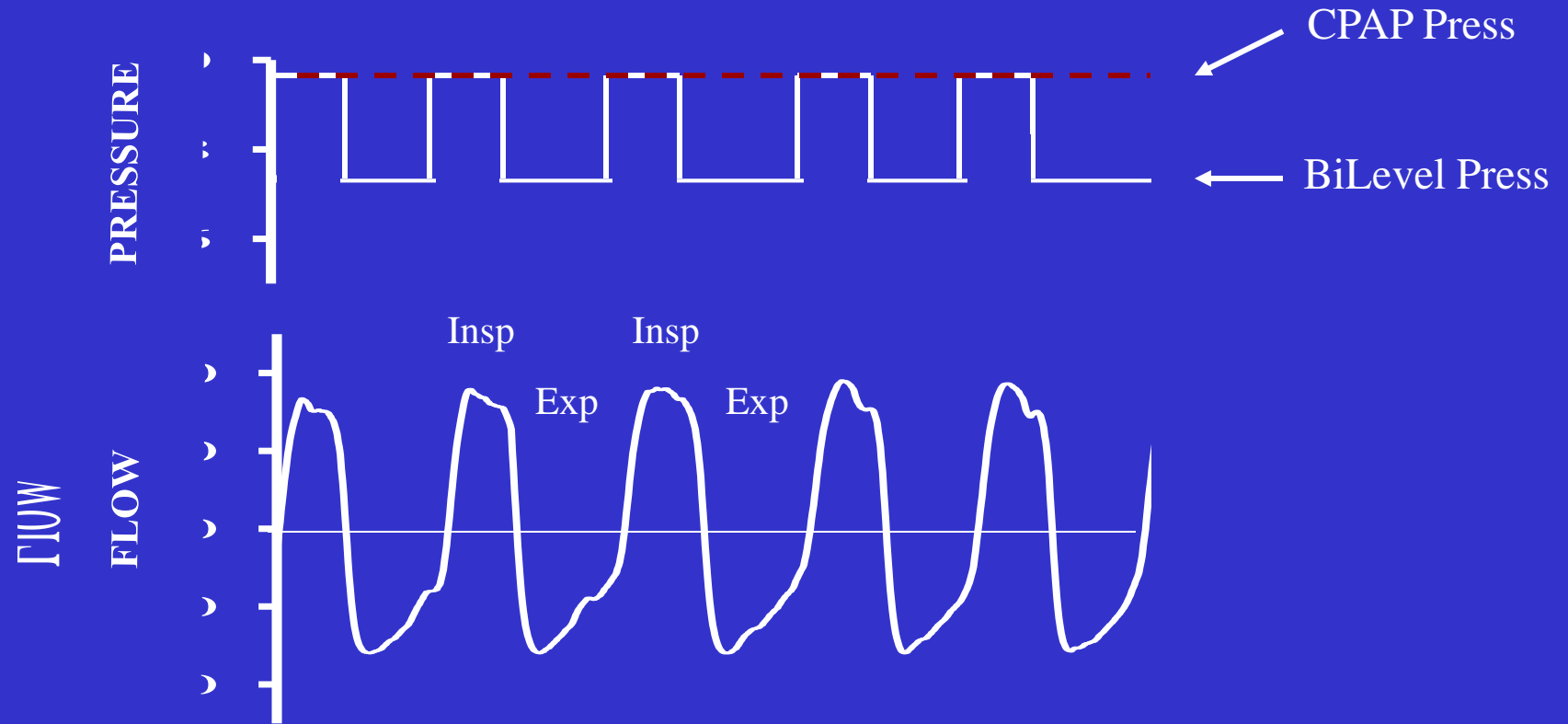
BiPAP®

Mark Sanders (1985): If airway collapses during inspiration, maybe we don't need to treat expiration.

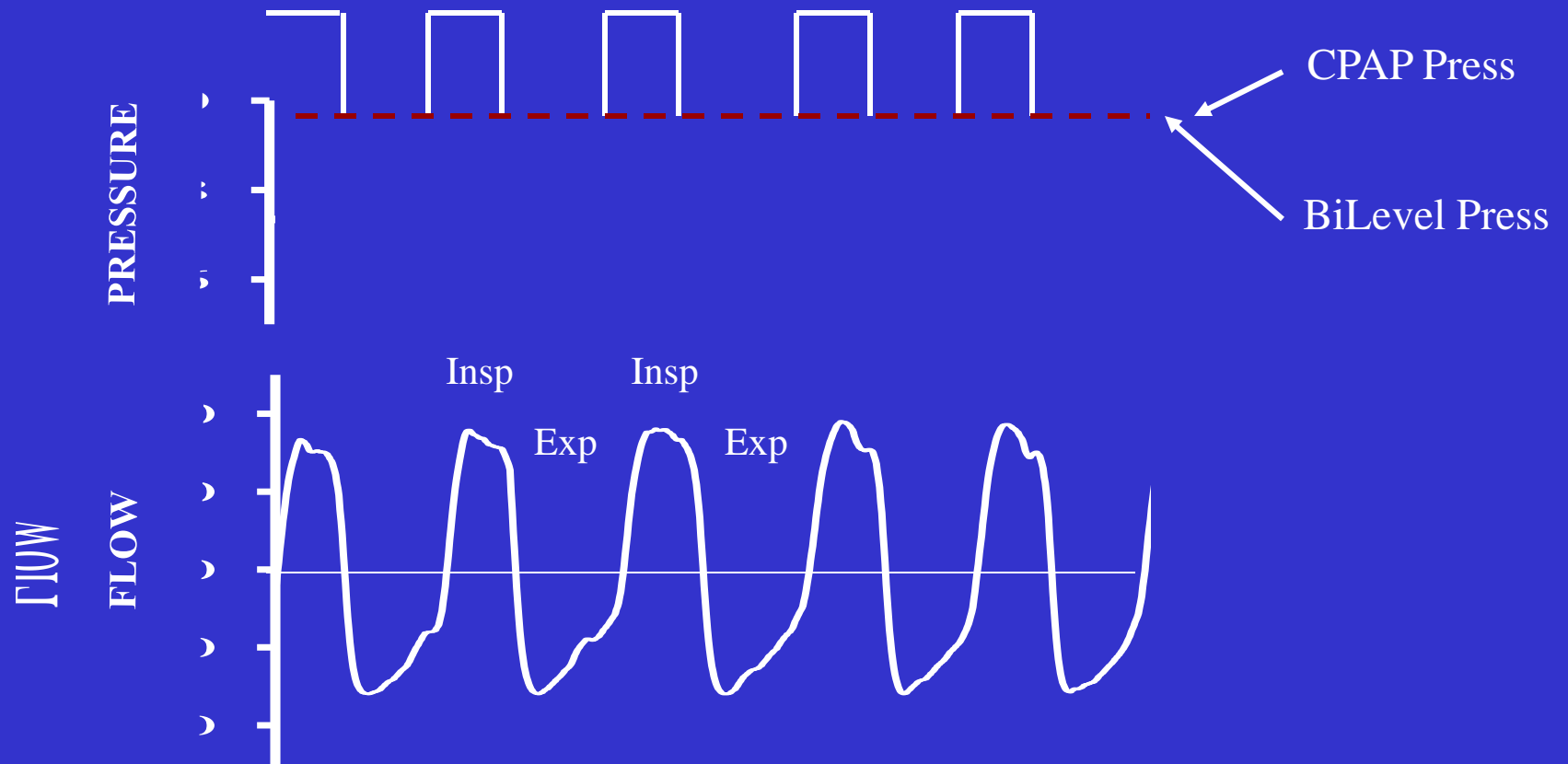
BiLevel = Pressure Support Ventilation



Which Pressure Is Modified in “Bi” Level?



Which Pressure Is Modified in “Bi” Level?

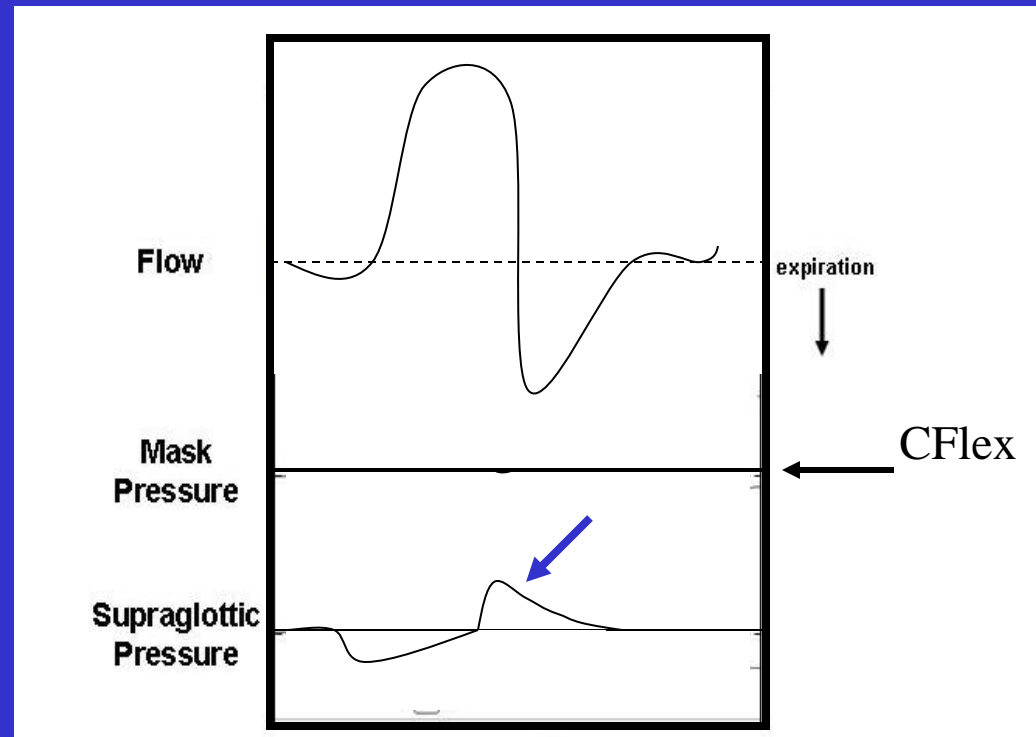


Modifying Within-Breath Pressure

CFlex[®]

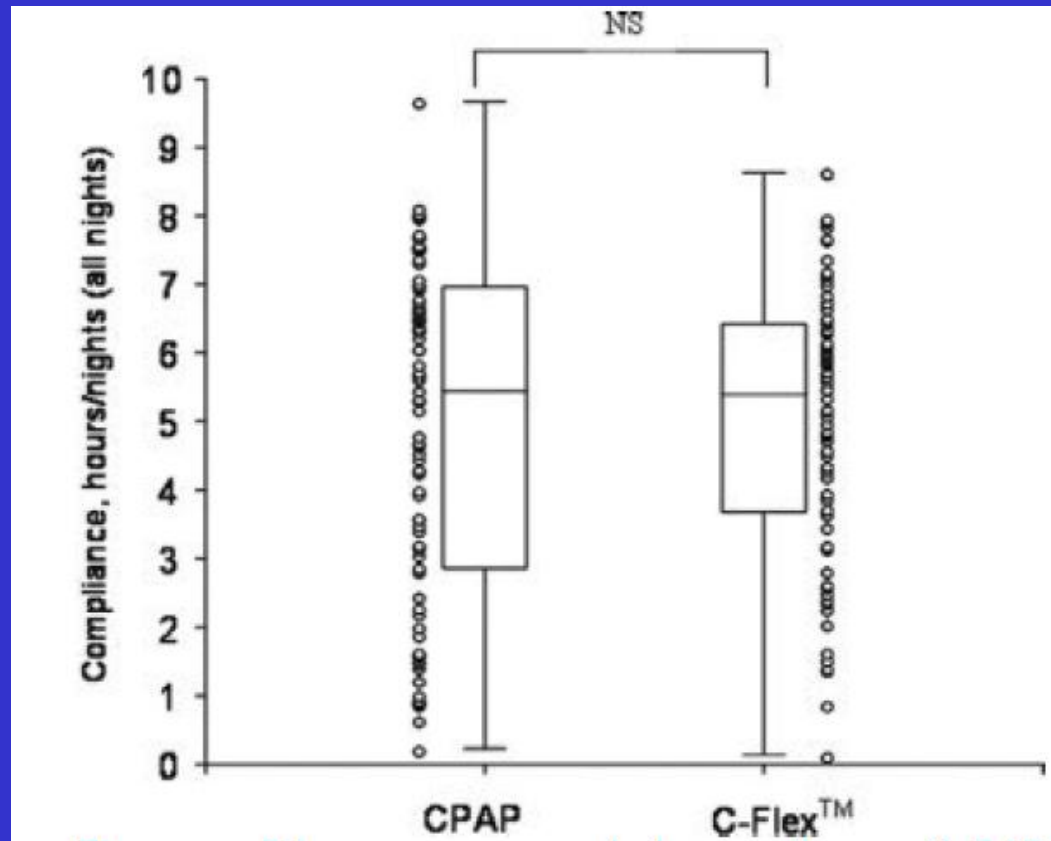
**Patient expiration causes a rise in pressure because of tubing and machine resistance,
so machine can give less pressure during expiration.**

Expiratory pressure profile in CFlex



Compliance CFlex[®] vs CPAP

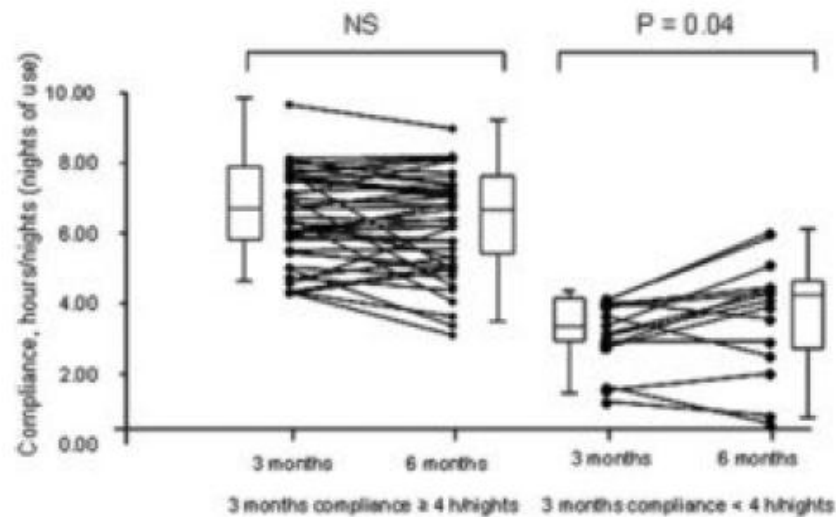
218 patients at 3 months (blinded)



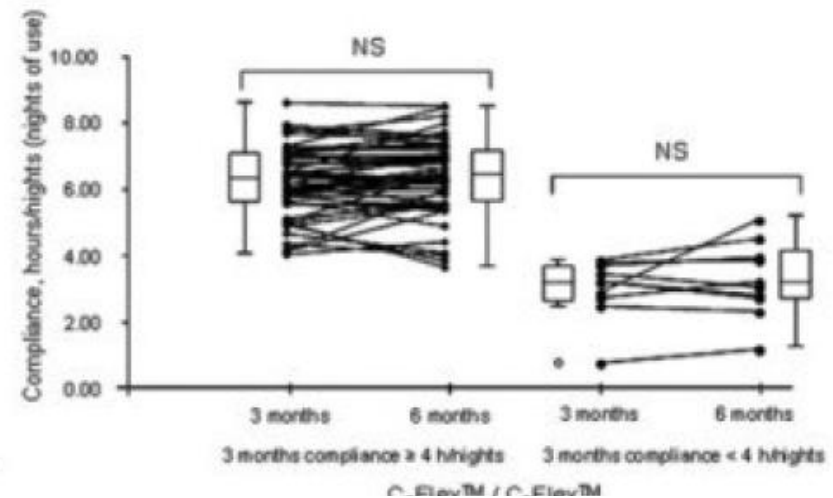
Pepin JL, Chest 2008; 136:

Crossover from CFlex[®] vs CPAP

218 patients at 6 months unblinded

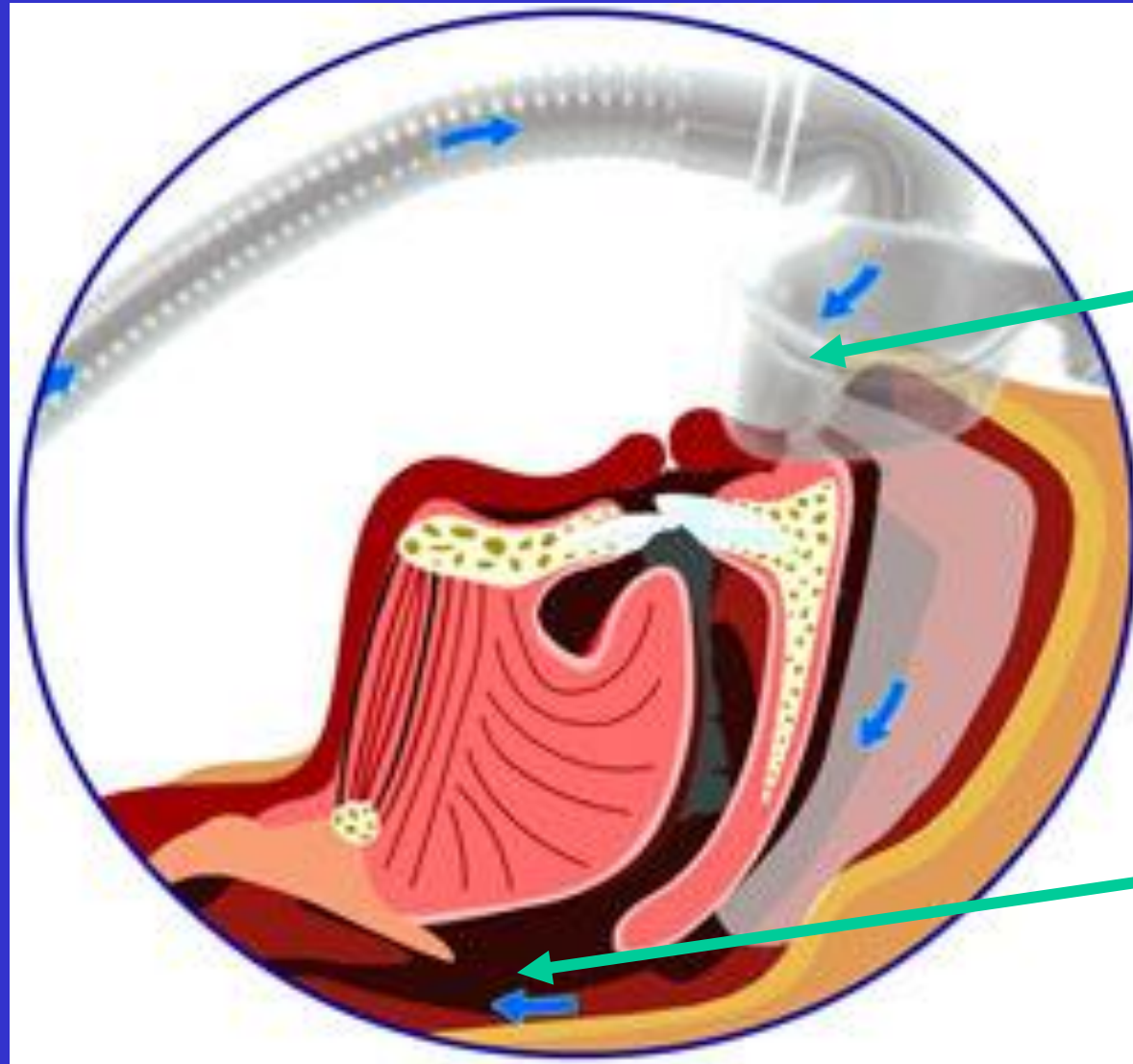


CPAP to CFlex



CFlex to CFlex

Methods

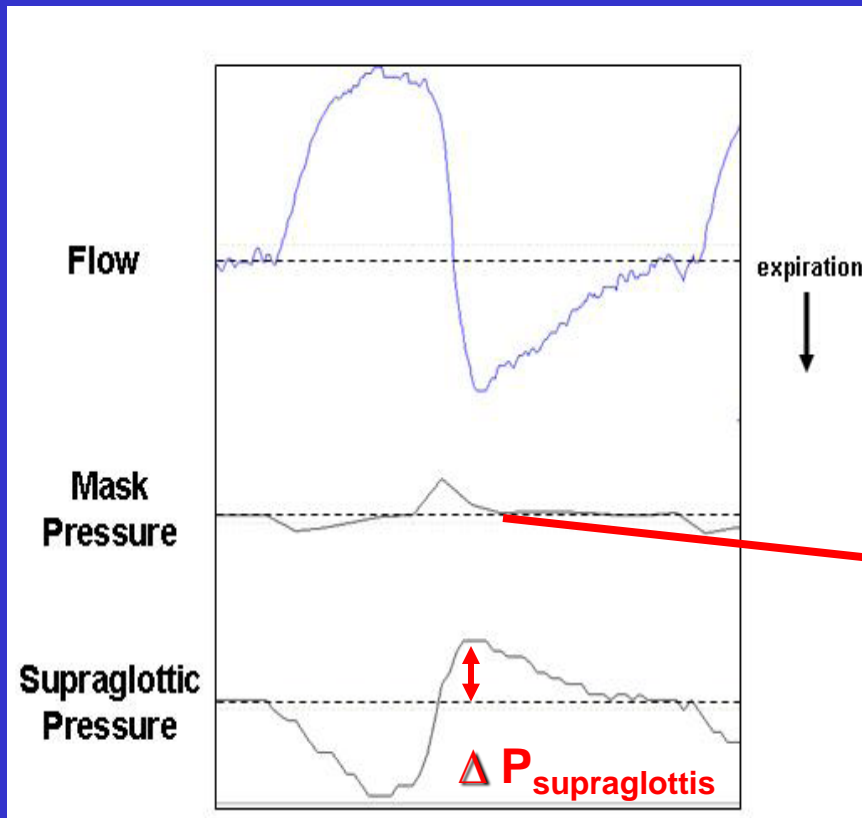


P_{mask}

$P_{\text{supraglottis}}$

Data collected

CPAP

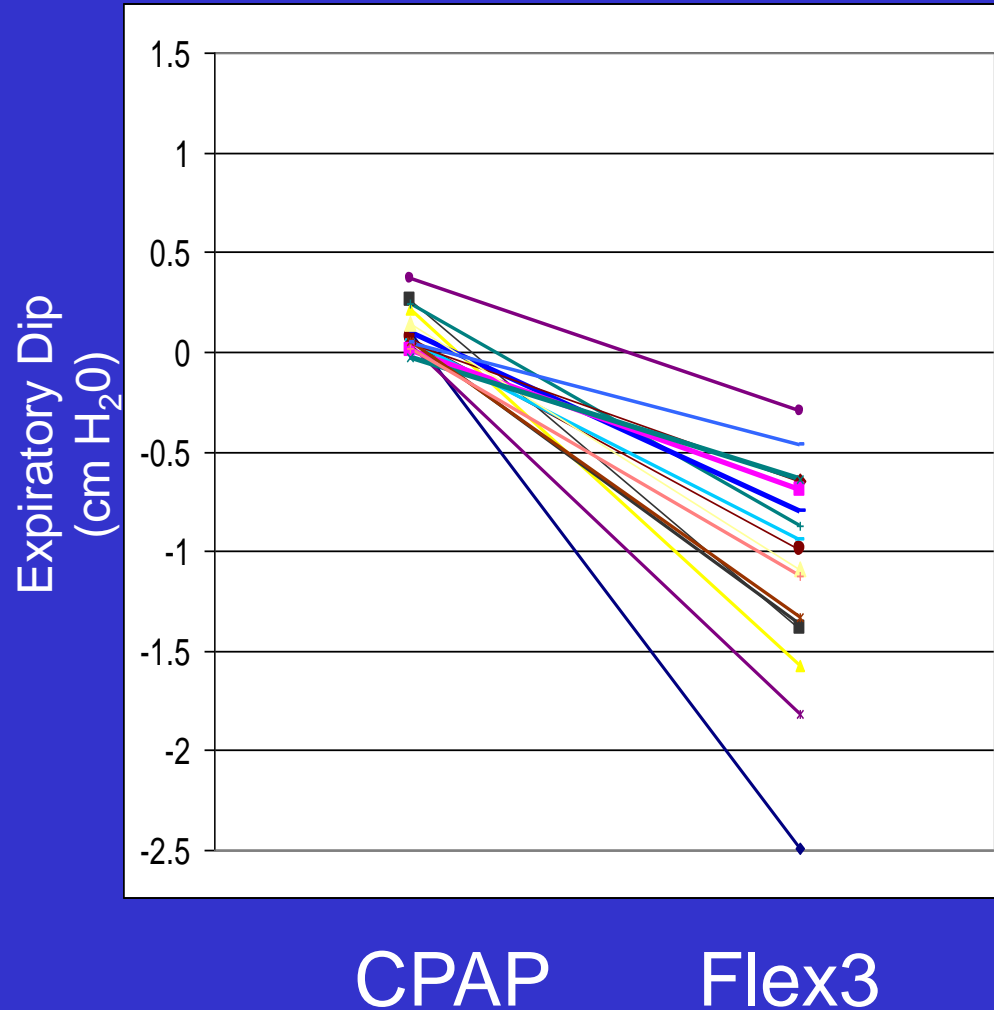


CPAP: $\Delta P_{\text{mask}}=0$

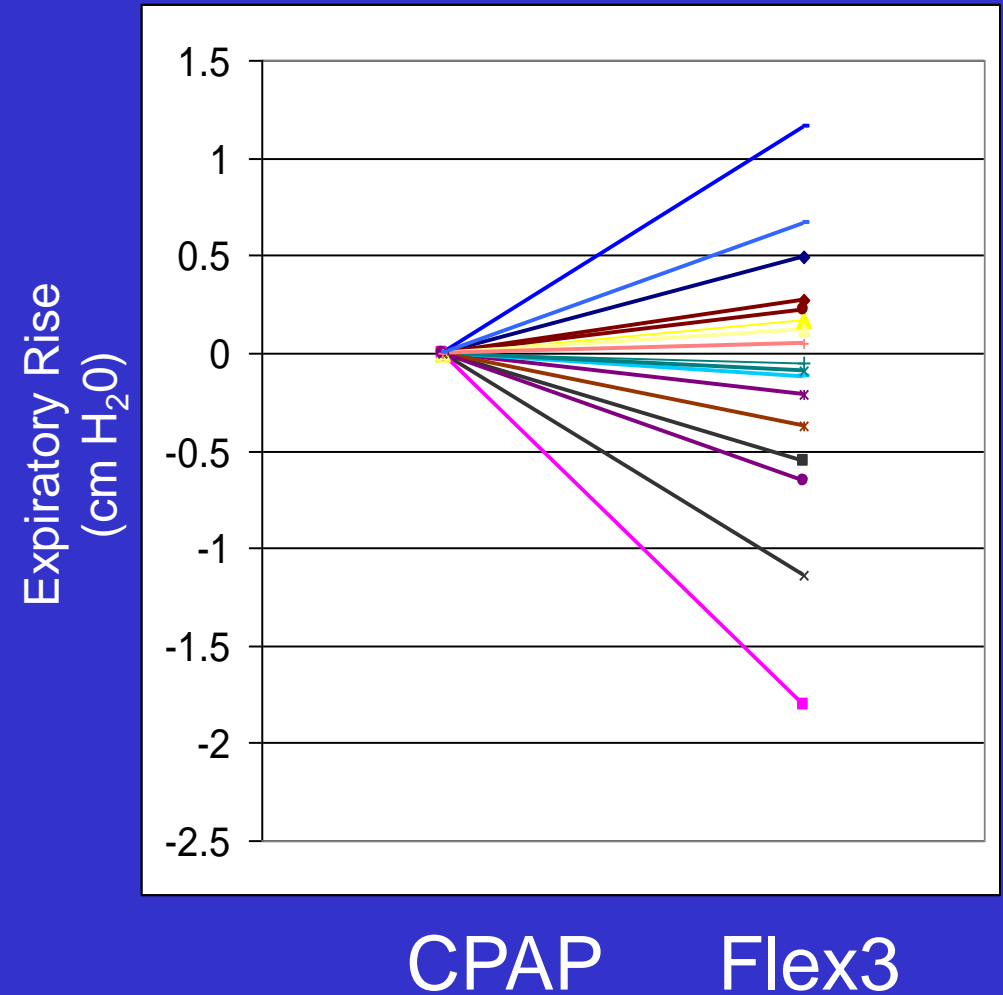
C-FLEX™: $\Delta P_{\text{mask}}>0$

Change in Peak Expiratory Pressure with C-Flex™

Mask



Supraglottis



Conclusions

As intended, application of C-Flex™ results in some reduction of expiratory pressure at the mask in all patients.

Despite this reduction of expiratory pressure during C-Flex™, we did not demonstrate the expected fall in supraglottic pressures in most patients.

Thus, if C-Flex™ improves comfort, it is unlikely to do so by the mechanism of reducing the supraglottic expiratory pressure, at least during sleep.

The possibility remains that while awake, supraglottic pressure behaves differently.

Expiratory Pressure Relief (EPR)

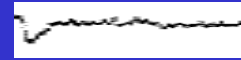
Fundamentally different from Cflex (pressure drops for ALL of expiration).

Essentially a form of Bi Level.

If prescribed with a titrated CPAP, may cause undertreatment and recurrence of obstruction.

CPAP 6 with EPR 2

Cflex



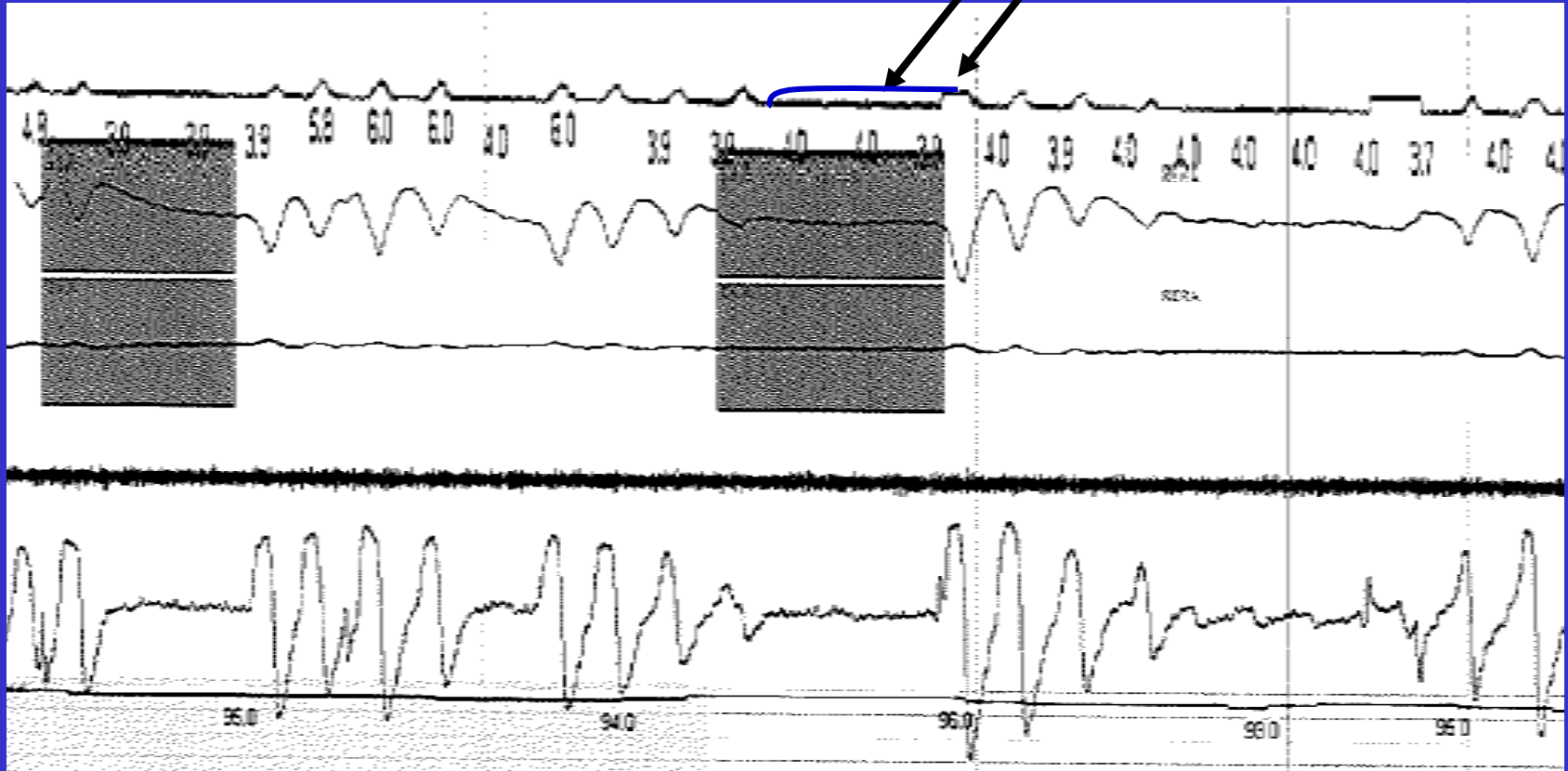
Expiratory Pressure = 4 →

Inspiratory pressure = 6

CPAP

Abd

Rib



Flow

SpO2

CPAP 6 with EPR 2

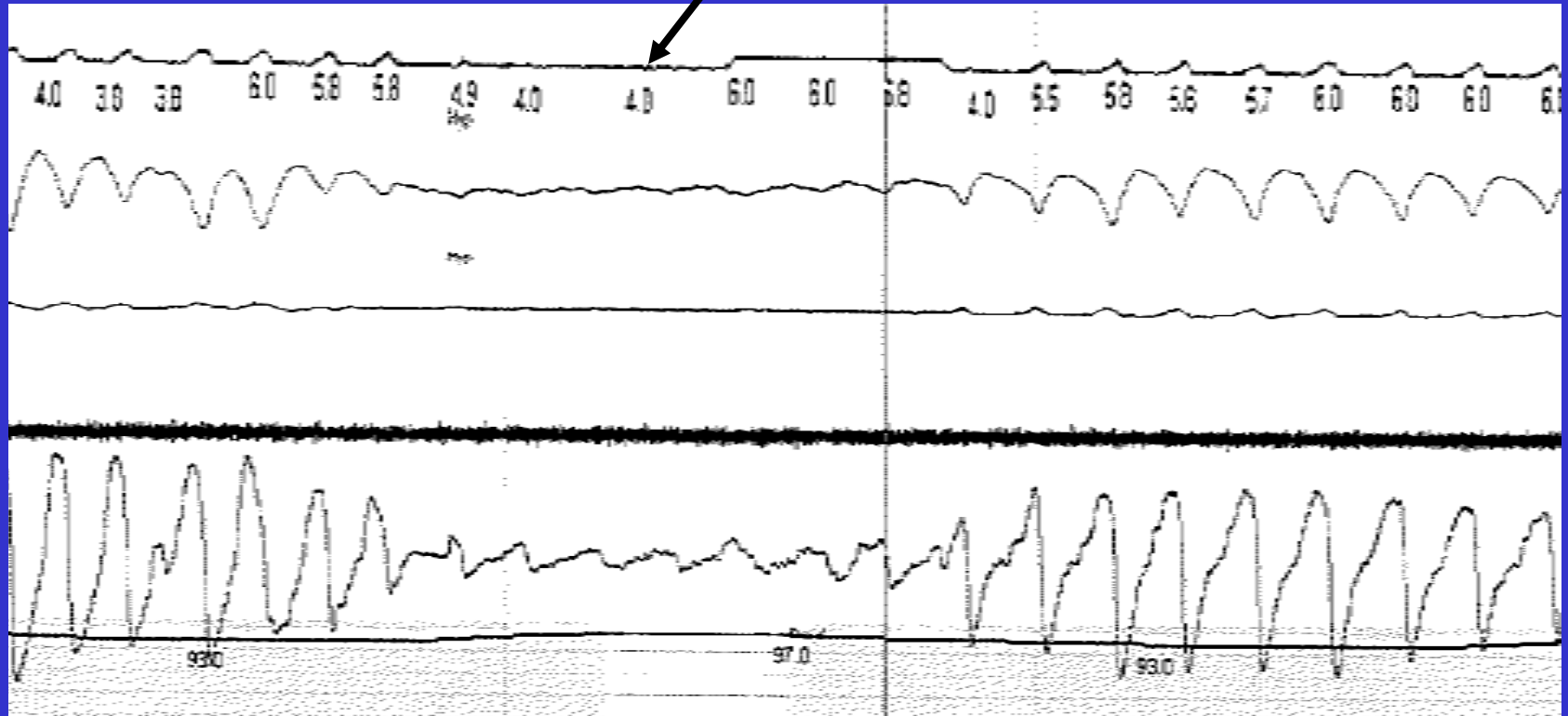
CPAP

Abd

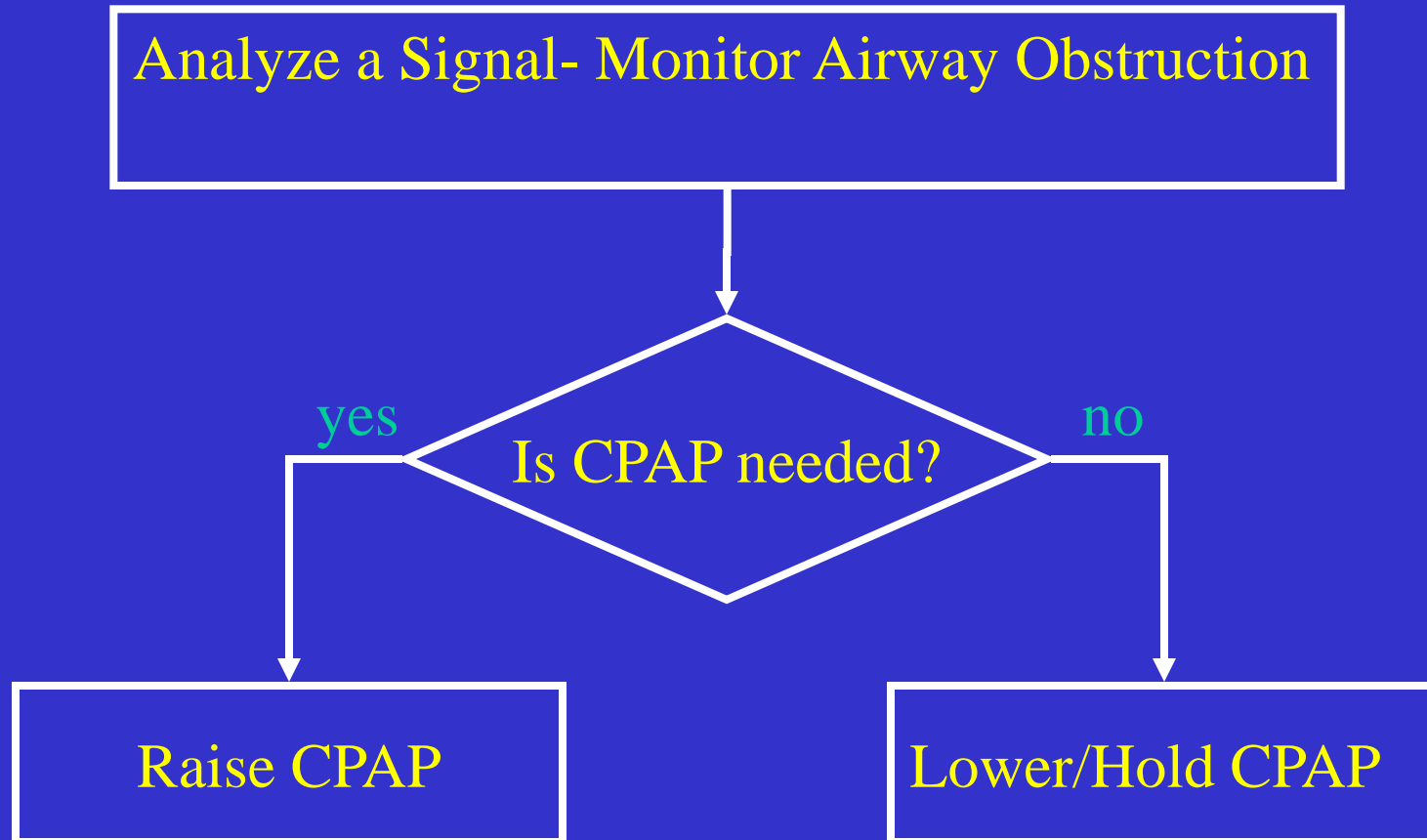
Rib

Flow

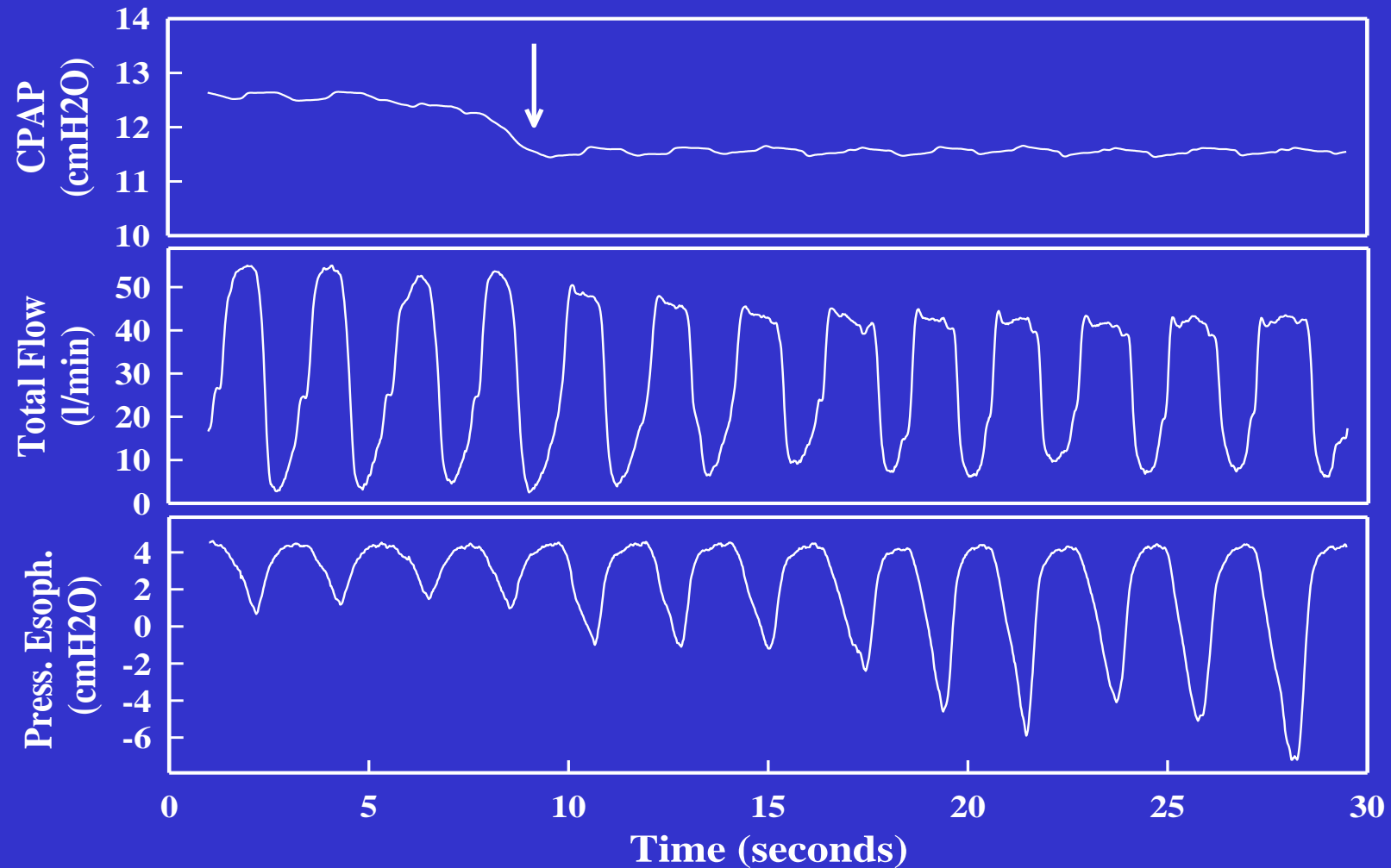
SpO2



AutoCPAP - Concept

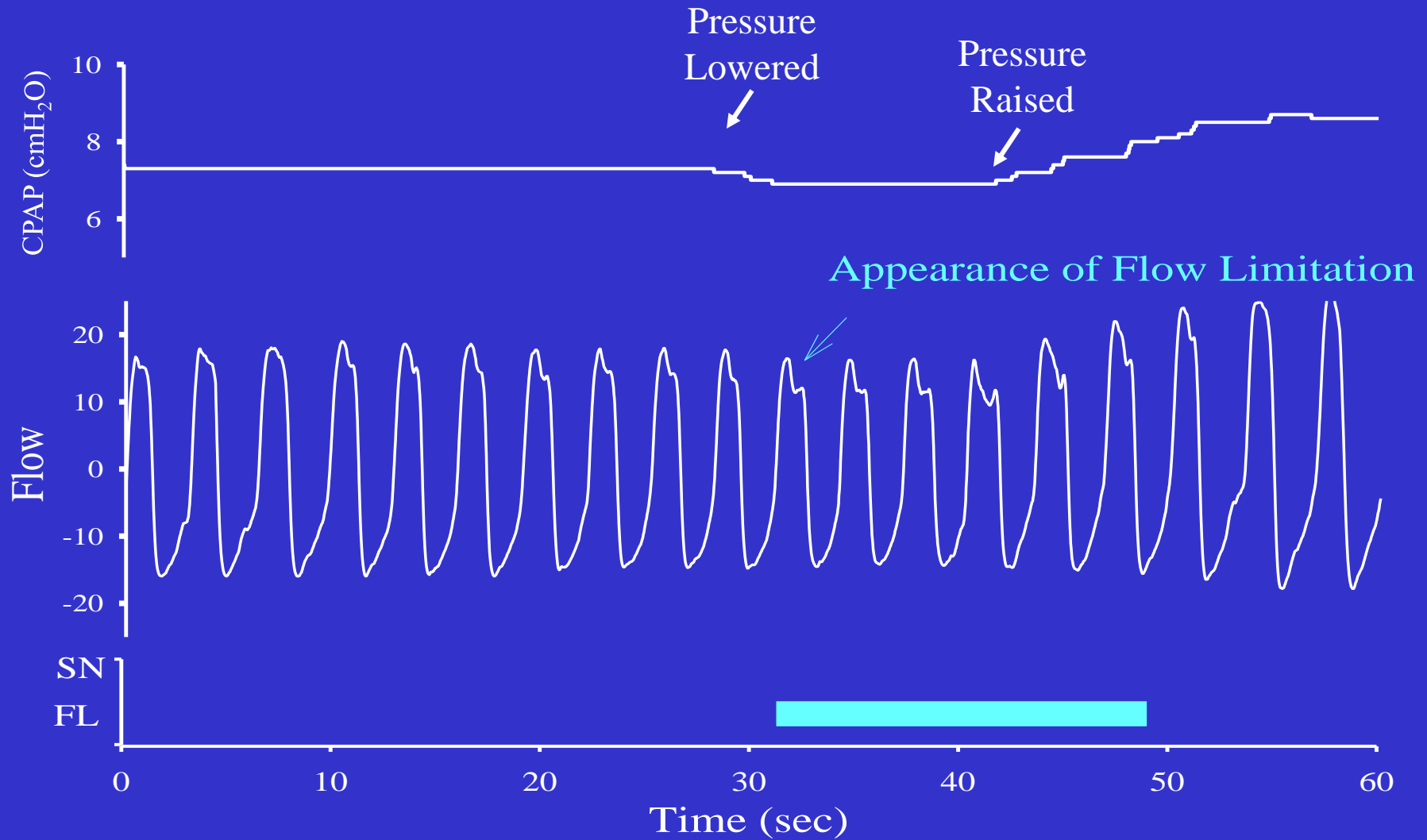


Effect of CPAP on Airway Resistance

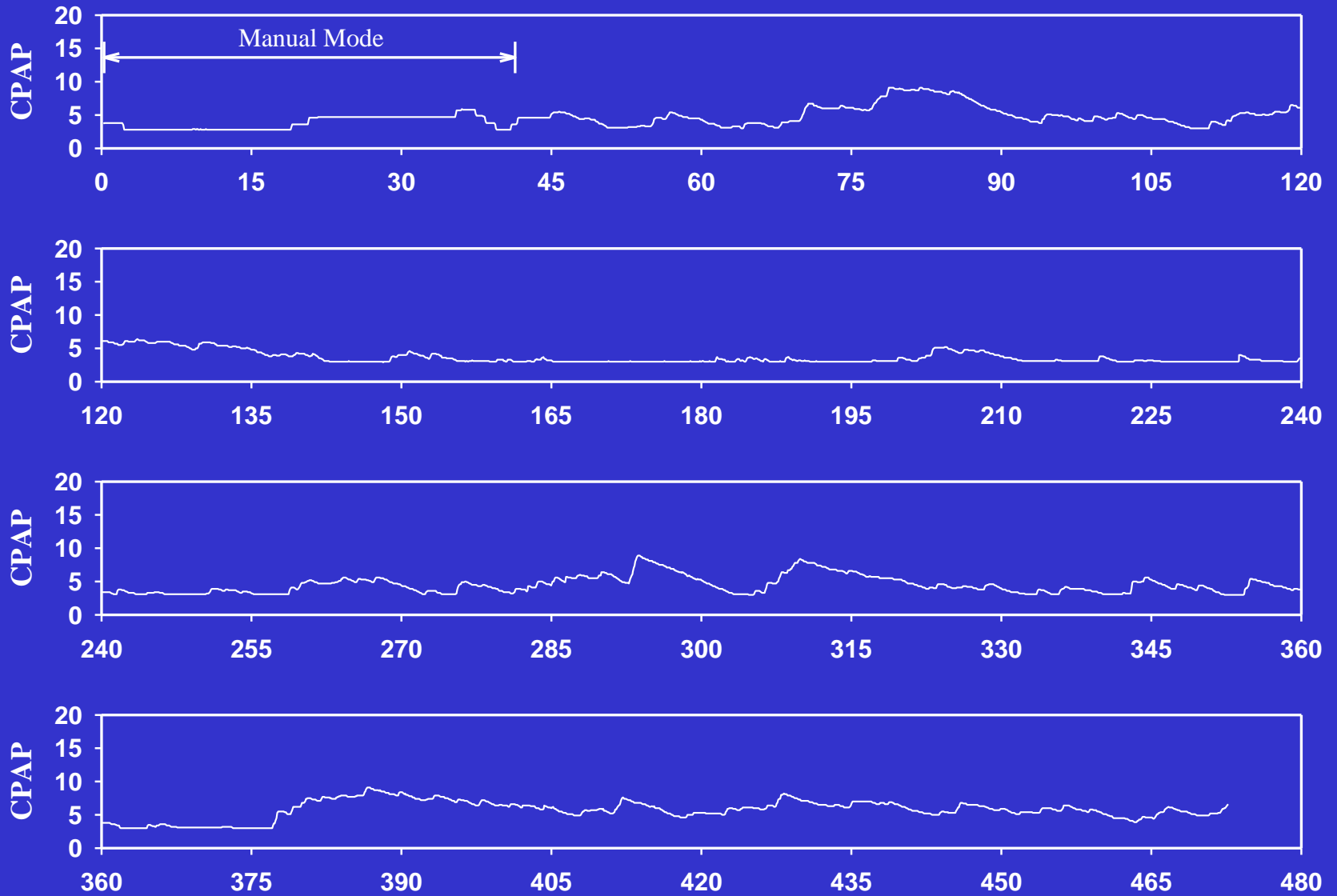


Condos et al. J Respir Crit Care Med 1994. 150:475

AUTOCPAP - Response to Flow Limitation



AutoCPAP – Pressure Varies



Modifying Pressure for Sleep State

SenseAwake™

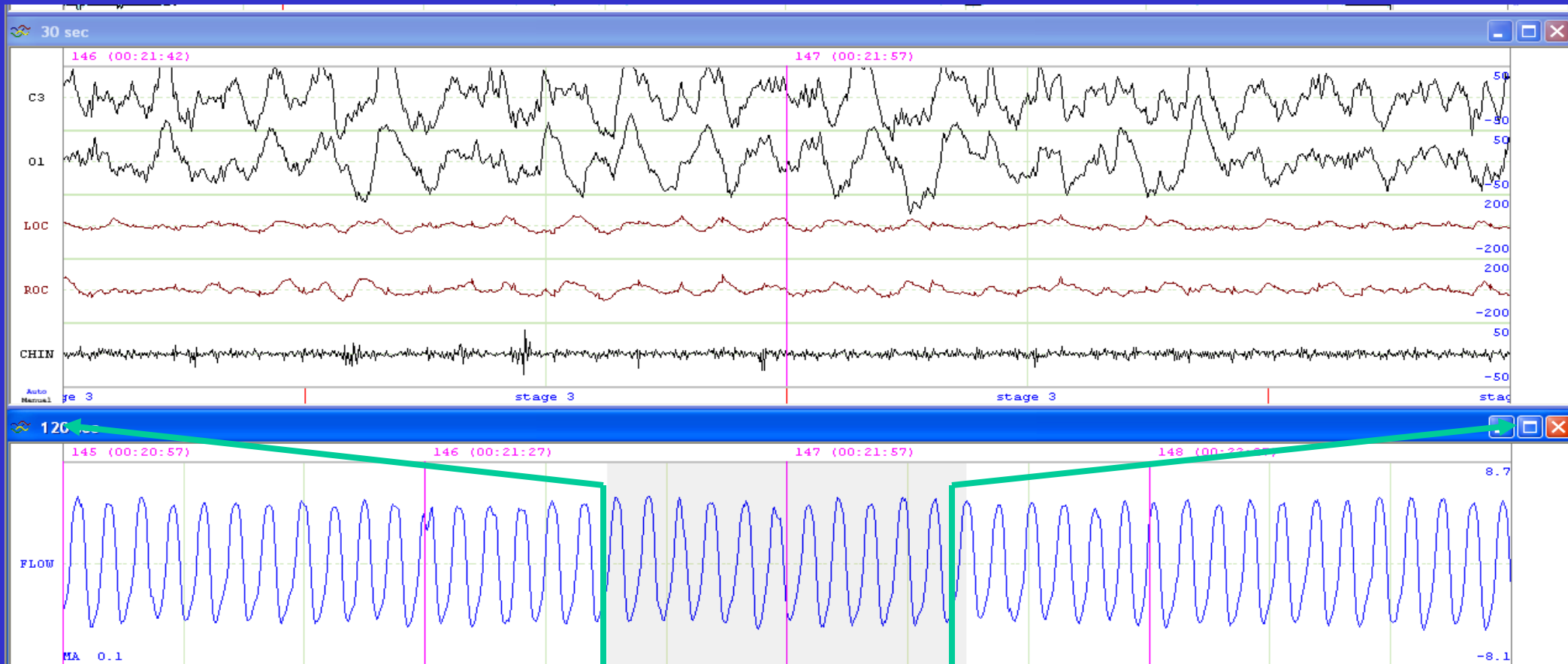
Patient needs CPAP while asleep, but not while awake,

so when wakefulness is detected remove the pressure.

~~-AutoCPAP-~~ SenseAwake™

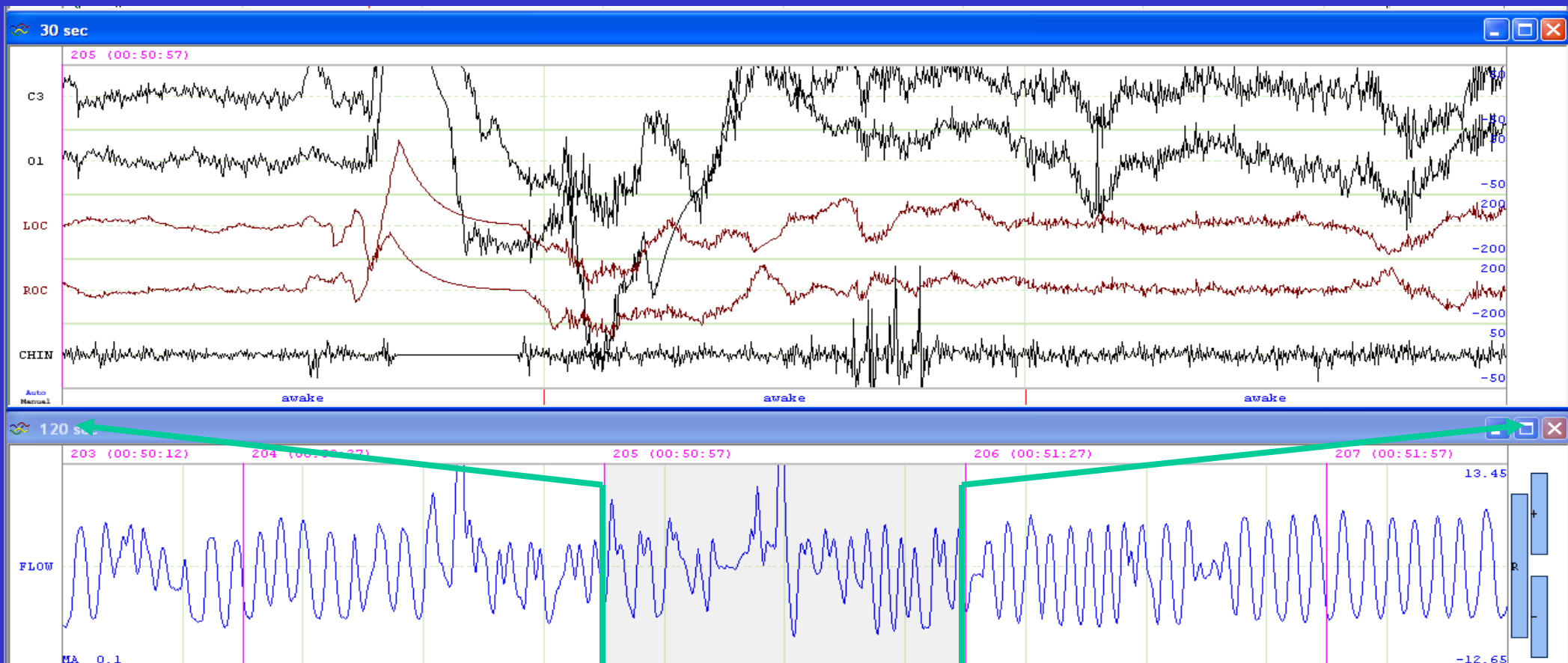
Raise CPAP based on detection of SDB (AutoPAP)

Stable Breathing During Sleep



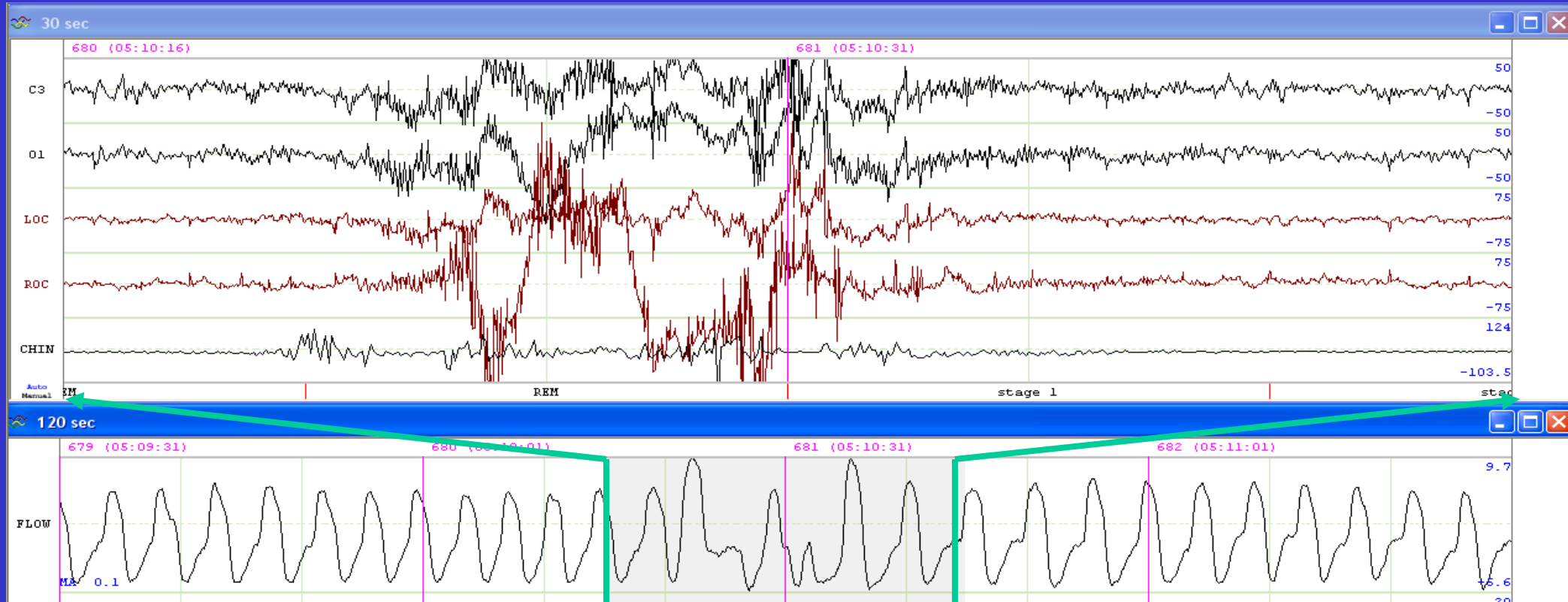
Ayappa I, Sleep 2009; 32:99-104:

Chaotic Breathing During Wake



Ayappa I, Sleep 2009; 32:99-104:

Chaotic Breathing During Brief Arousal



How Good Is Detection of Wake/Arousal From Irregular Pattern of Breathing?

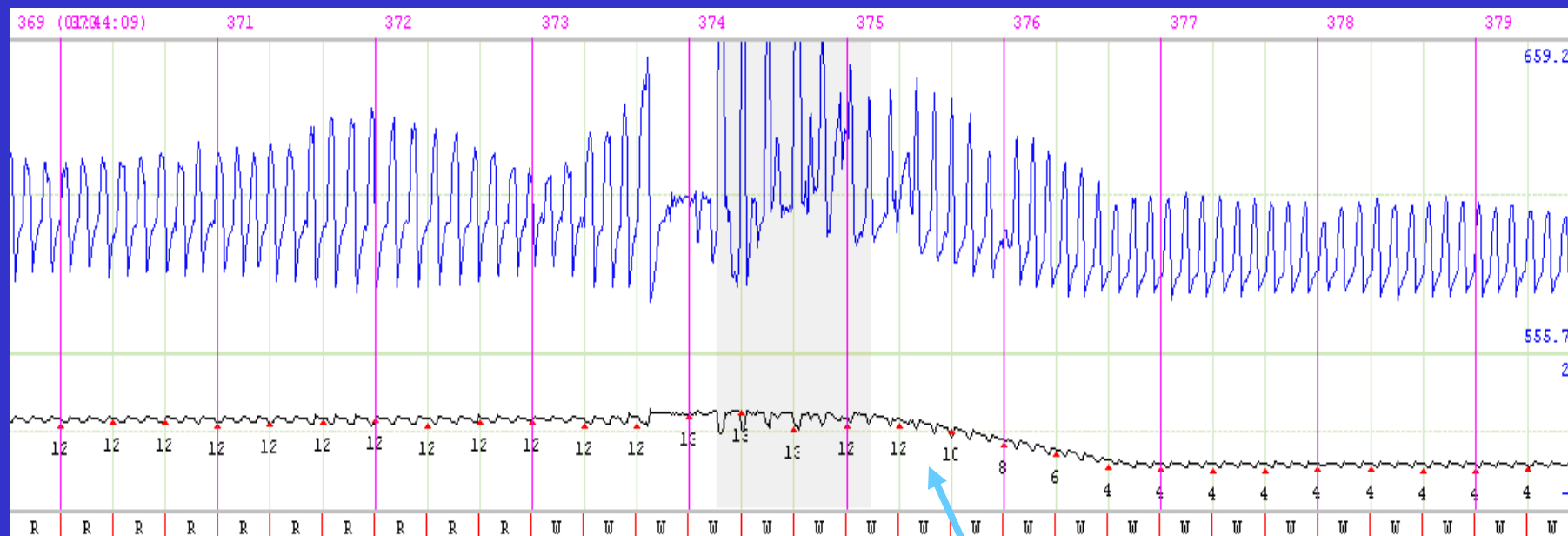
	Positive Predictive Value
Detection of Wakefulness	
Visual (Manual)	0.89
Automated (ANN)	0.66
Detection of Wakefulness or Arousal	
Visual (Manual)	0.98
Automated (ANN)	0.86

Note: only 24% of epochs scored as “wake” show irregular breathing,
but 52% of wake periods show irregular breathing within 2 min.

Use of Respiratory Irregularity (Arousal) to Drive Reduction of CPAP to Improve Comfort SensAwake™

Flow

CPAP



Arousal triggers drop in
CPAP

Ayappa I, Sleep 2009; 32:99-104:

CPAP



Ayappa I, Sleep 2009; 32:99-104:

Potential Benefits of SensAwake™

(Remain To Be Validated)

Greater subjective comfort

Less WASO (shorter time falling asleep after arousal)

Less “early refusal” of CPAP

Correction of “runaway pressure rises”

Better Compliance/Adherence – more time on CPAP

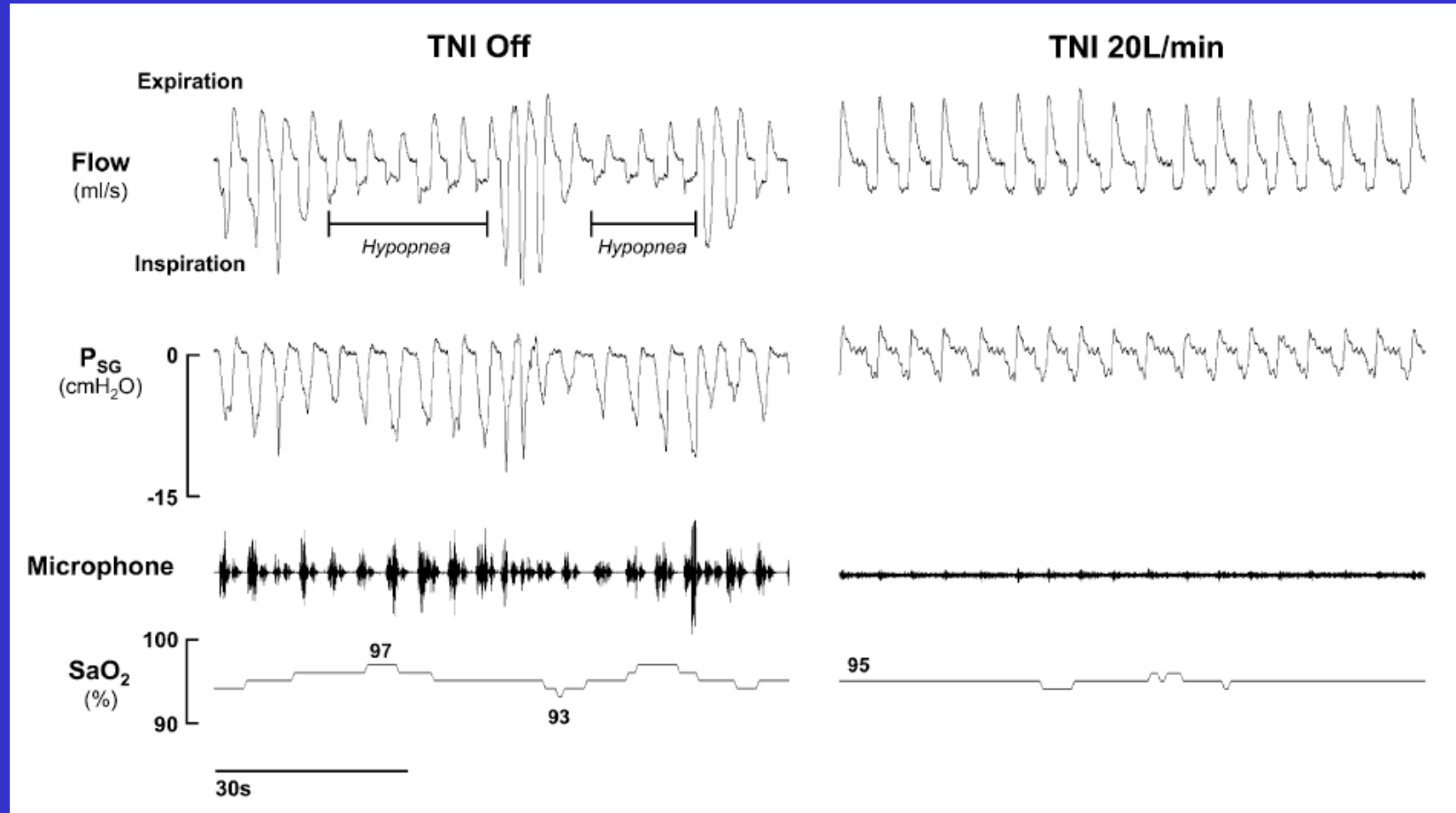
Trans Nasal Insufflation

Use a high flow rate to the nose without a tight seal to generate continuous positive pressure.

10-20 l/min flowrate
30°-33° C
80% humidity



Effect of Trans Nasal Insufflation on SDB



Trans Nasal Insufflation

Possible Mechanisms of Action

Buildup of airway pressure

CPAP ~ 2 cm H₂O in adults (?higher in children)

Reduced dead space due to nasal washout → decreased need for ventilation

Increased lung volume due to pressure ??

Stimulation of nasal receptors ?? (unlikely due to dose effect of pressure)

Treatment of Sleep Disordered Breathing

When in doubt.....

pressurize the snout !!

Philip R. Westbrook, MD

Cyrano De Bergerac, sur la PPC:

Emphatique : "Aucun vent ne peut, nez magistral,
Te soulager tout entier,

