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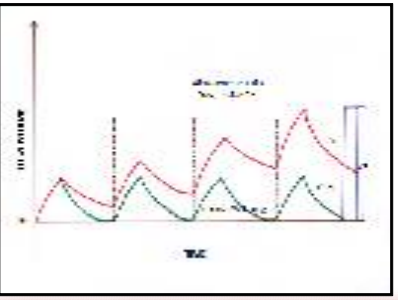
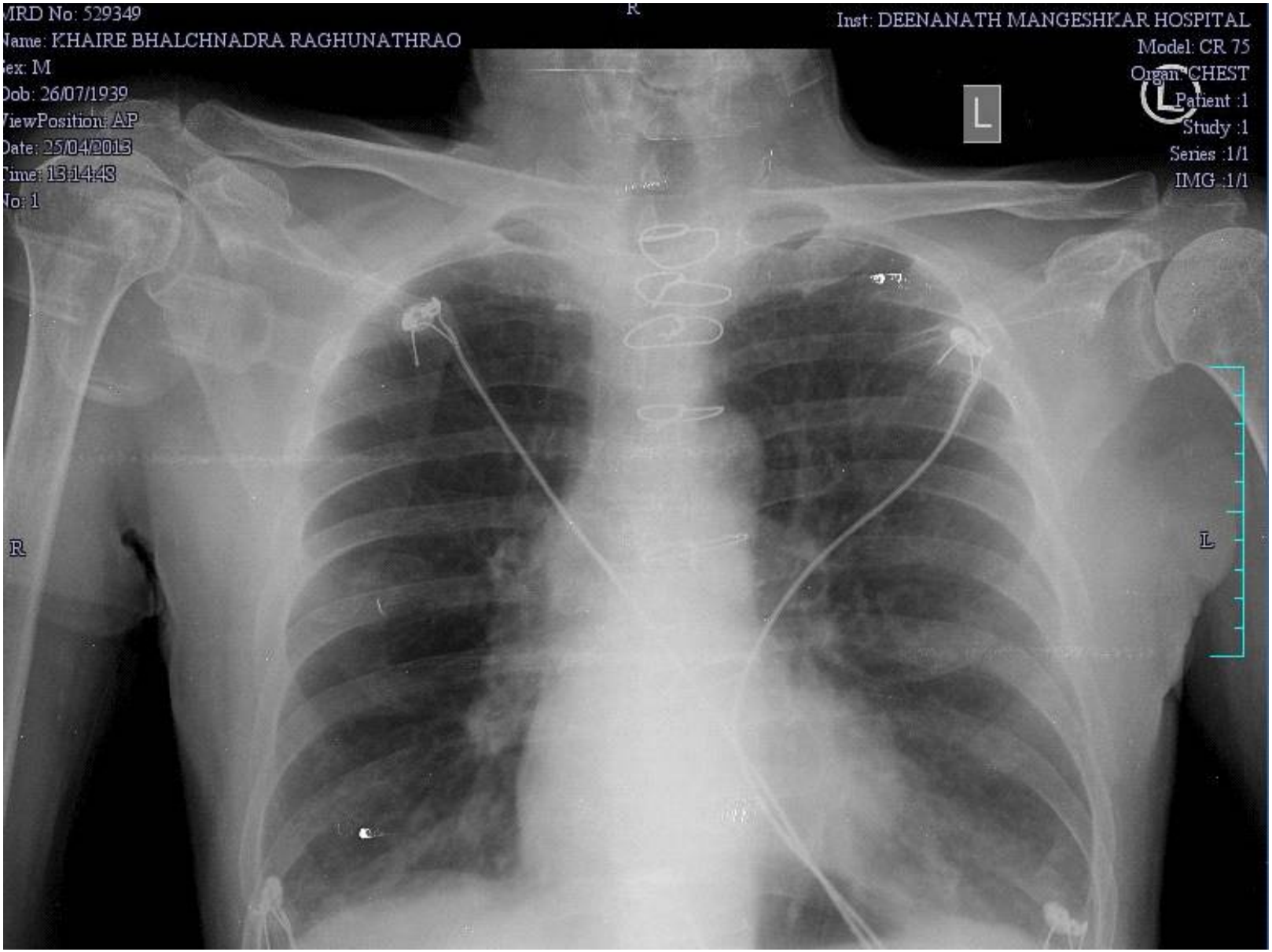


# How I ventilate COPD?

- 53 year male, previous CABG , COPD non compliant to Rx presented with worsening dyspnea, increasing amount and purulence of sputum for 6 days.
- PR 126/min, RR 34/min, $SPO_2$ on RA 84%, BP 124/78 mmHg. Flaps +, GCS 14/15, flaps present
- Given Inj. Hydrocortisone 100mg and Nebulized salbutamol 5mg and supplemental $O_2$
- ABG (RA)- 7.36/ $CO_2$- 46 mm $PO_2$- 58mm HCO3 – 26, Lact 1 mmol
- Does this patient require ICU admission?


MRD No: 529349
Name: KHAIRE BHALCHNADRA RAGHUNATHRAO
Sex: M
Dob: 26/07/1939
ViewPosition: AP
Date: 25/04/2013
Time: 13:14:43
No: 1
R
Inst: DEENANATH MANGESHKAR HOSPITAL
Model: CR 75
Organ: CHEST
Patient :1
Study :1
Series :1/1
IMG :1/1
L
R
L

# Will he need ventilator?

BAP 65-

- BUN >24mg/dl
- Altered  sensorium
- Pulse rate >110/min
- Age >65

- Better predictor of requirement for ventilation as compared to CURB 65 ( Confusion, Urea, RR, Sys BP ,Age > 65)

Thorax
AN INTERNATIONAL JOURNAL OF RESPIRATORY MEDICINE

# BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults

April 2016

# NIV Tips and Tricks

- NIV should be started when pH<7.35 and $pCO_2$ >6.5 kPa ( 48.7 mmg) persist or develop despite optimal medical therapy (Grade A).
- Severe acidosis alone does not preclude a trial of NIV (Grade B).
- Advanced age alone should not preclude a trial of NIV(Grade A).
- Use of NIV should not delay escalation to IMV (Grade C)

# NIV tips and tricks

- Pressure-targeted ventilators are the devices of choice for acute NIV ( Grade B)
- Both pressure support (PS) and pressure control modes are effective. (BPS)
- Full face mask (BPS)
- Oxygen enrichment- $SaO_2$ 88–92% in all causes of acute hypercapnic (Grade A)
- Humidification is not routinely required (Grade D).
- Heated humidification - mucosal dryness or if secretions are thick and tenacious.(BPS)

# NIV tips and tricks

- Inhalations- MDI spacer or Nebuliser ( air driven, not high flow $O_2$) ( BPS)
- Intravenous morphine 2.5–5 mg (± benzodiazepine) may provide symptom relief and may improve tolerance of NIV (BPS)
- Heliox should not be used routinely in the management of (Grade B).

# Contraindication of NIV

- Respiratory or cardiac arrest
- Life threatening hypoxia
- Severe ventricular arrhythmias
- Persistent shock despite fluids and Norepi > 0.1 mcg/kg/min

- Inability to clear secretions, vomiting
- Non co-operative patient

- Altered sensorium ( cause other than hypercapnoea)

# NIV protocol

- Start with an IPAP of 8 cm $H_2O$ and EPAP of 4 cm $H_2O$
- Increase IPAP and EPAP by 2 and 1 cm $H_2O$, respectively
- Titrate to VT 6-8 mL/kg, RR <35/min, subjective comfort & BG
- Max IPAP & EPAP generally used is 30 and 10cm $H_2O$
- Air leaks should be minimized

# ABG after 1 hour

| Parameter | Value |
|---|---|
| pH | 7.30 |
| $PCO_2$ | 69 mm Hg |
| $PO_2$ | 72 mm Hg |
| Lact | 1.1 mmol/Lit |
| $HCO_3$ | 34 mmol/lit |
| BE | -6.5 |
| $SO_2$ | 94 % |
| Hb | 16. 3 gm% |

- Subjectively comfortable
- Distress much reduced
- RR – 28 per minute
- Hemodynamicaly stable

**NIV settings**

EPAP - 8 cm

IPAP- 18 cm

$FiO_2$ – 0.6

# NIV at 24 Hours

| Parameter | Value |
|---|---|
| pH | 7.28 |
| $PCO_2$ | 72 mm Hg |
| $PO_2$ | 72 mm Hg |
| Lact | 1.1 mmol/Lit |
| $HCO_3$ | 37 mmol/lit |
| B.E. | -8.5 |
| $SO_2$ | 89% |
| Hb | 17. 3 gm% |

**NIV setting**

EPAP - 10 cm

P.S.- 18cm

IPAP- 28 cm

$FiO_2$ – 0.7

- Subjectively comfortable
- RR – 30 per minute
- Hemodynamicaly stable
- No shock

# Ventilation – Tu be OR not Tu be

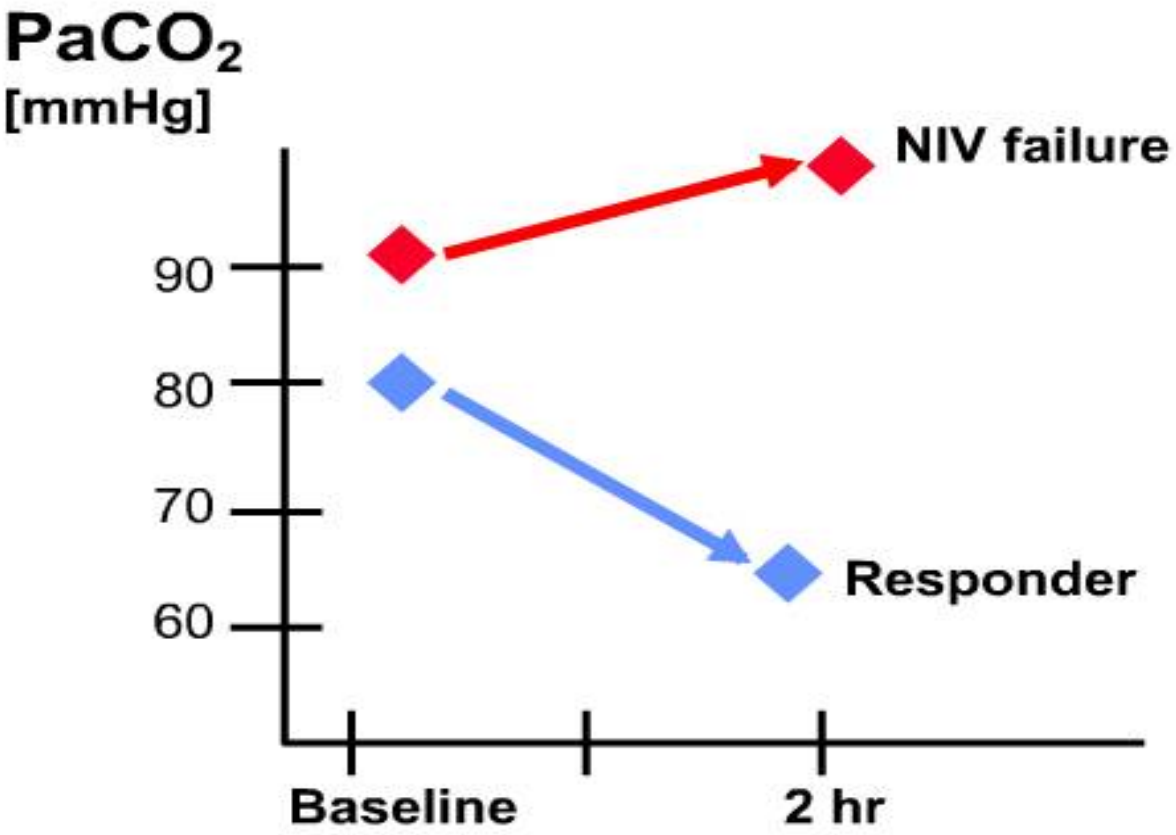
*Upper limit of NIV – settings and time*

*ABG limits for calling off NIV*

*Any clinical or other parameter to decide*

*Especially high VAP incidence ICU*

# NIV failure in hypercapnic ARF




*Meduri et al, Chest, 1996; 109: 179-93*

Name:
NEW PATIENT
Instrument:
Model: GEM 3000
S/N: 24881

Measured (37.0C)

| | | | |
|---|---|---|---|
| pH | | 7.16 | |
| ?pCO2 | > | 115 | mmHg |
| pO2 | | 22 | mmHg |
| Na+ | | 129 | mmol/L |
| K+ | | 3.8 | mmol/L |
| #Ca++ | | 1.03 | mmol/L |
| Glu | | 222 | mg/dL |
| Lac | | 1.4 | mmol/L |
| Hct | | 53 | % |

Derived Parameters

| | | |
|---|---|---|
| ?HCO3- | ------ | |
| ?tCO2 | ------ | |
| ?BEecf | ------ | |
| ?BE(B) | ------ | |
| ?SO2c | ------ | |
| THbc | 16.4 | g/dL |

#=Outside ref. range
?=Review

(On Neb)

# When to intubate on NIV ?

-Respiratory arrest

-NIV failure (When to label???????)

-Somnolence, impaired mental status GCS < 8

-Severe dyspnoea with use of accessory muscles and paradoxical breathing.

-Severe acidosis (pH < 7.15)

-Hypercapnoea ( no consensus value )

# NIV at 24 Hours

| Parameter | Value |
|---|---|
| pH | 7.28 |
| $PCO_2$ | 72 mm Hg |
| $PO_2$ | 72 mm Hg |
| Lact | 1.1 mmol/Lit |
| $HCO_3$ | 37 mmol/lit |
| B.E. | -8.5 |
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**NIV setting**

EPAP - 10 cm

P.S.- 18cm

IPAP- 28 cm

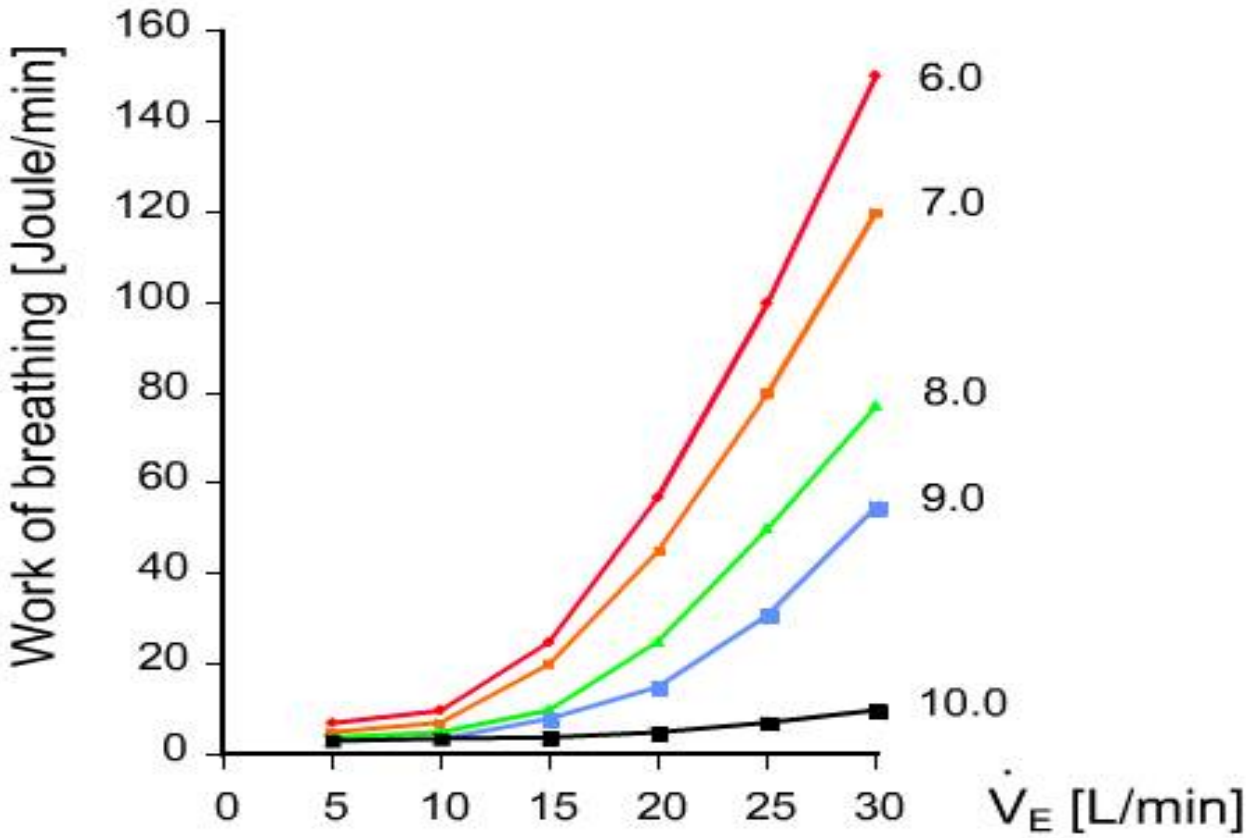
$FiO_2$ – 0.7

- Subjectively comfortable
- RR – 30 per minute
- Hemodynamicaly stable
- No shock

# Before intubation

- Volume load if dehydrated
- Vasopressor if hypotension
- Nebulised  bronchodilator
- 2 IV accesses for fast fluid infusion
- Larger ET
- Ventilator ready with settings

# Work of breathing, Tube size and Gas Flow




Shapiro M, Wilson RK, Casar G, Bloom K, Teague RB.
Work of breathing through different sized endotracheal tubes.
Crit Care Med. 1986;14(12):1028-31.

# Sedation and Paralysis

-Avoid fentanyl, morphine- spasm, stiff chest wall

-**Midazolam** – rapid, short induction and infusion

-**Propofol**- sedation, titrable, rapid awakening, bronchodilation

-**Muscle relaxants**: RSI- succinylcholine, rocuronium

Vecuronium. (atra- histamine> spasm)

-**Dexmedetomidine**- useful during weaning and 'dextubation' onto NIV

# Goals of ventilation

- Minimize air- trapping

-Avoid over-distention (Pplat < 25-30 cm H2O)

- Provide adequate oxygenation

-Provide adequate ventilation (pH > 7.25)

-Give rest to respiratory muscles

# You must know this pathophysiology

## COPD

- Distal airway collapse, leading to cessation of airflow and distal gas trapping
- With expiratory flow limitation ( EFL)
- Serial resistances in situations **with EFL** are not additive
- No hazard in using PEEPe, as long as PEEPe < PEEPi.

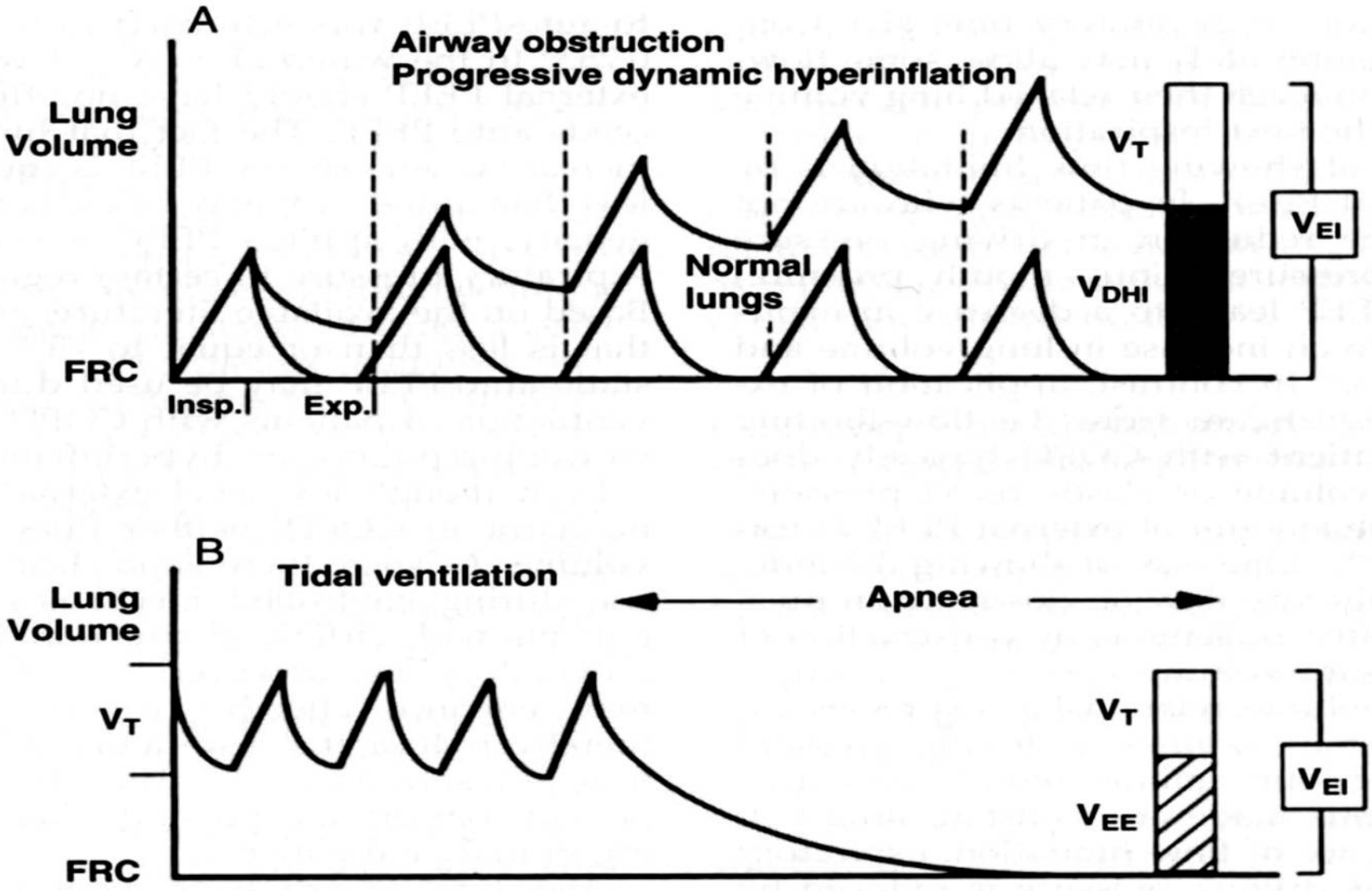
## Asthma

- Expiratory time is too short to exhale the whole tidal volume
- Without expiratory flow limitation ( no EFL)
- Serial resistances are additive, and therefore PEEPe should not be used because it may exacerbate dynamic hyperinflation

# You must know these facts and numbers

- End Insp Vol > 20 ml / kg is predictive of baurotrauma and hypotension
- We cant measure Vei--- measure PEEPi and Pplat
- Dialed PEEP ? 80 % of PEEPi
- Pplat < 30 cm
- Even PIP of 80 cm is acceptable
- Exp Time Const = Airway resistance X Static Compliance

  Exp time = 3 times the Const
- pH > 7.25 is a target than $PCO_2$ value


A
Airway obstruction
Progressive dynamic hyperinflation
Lung Volume
FRC
Insp.
Exp.
Normal lungs
$V_T$
$V_{DHI}$
$V_{EI}$
B
Tidal ventilation
Apnea
Lung Volume
$V_T$
FRC
$V_T$
$V_{EE}$
$V_{EI}$

# Initial Settings

- Volume ventilation is preferred
- Minute ventilation <115 mL/kg
- Tidal volume 6 to 8 mL/kg
- Inspiratory time: ? 1 second
- Flow >80L/min
- Respiratory rate: 10 - 12 breaths/min
- Watch Plat
- PEEP as per hypoxia

# Minimize ventilator induced lung injury

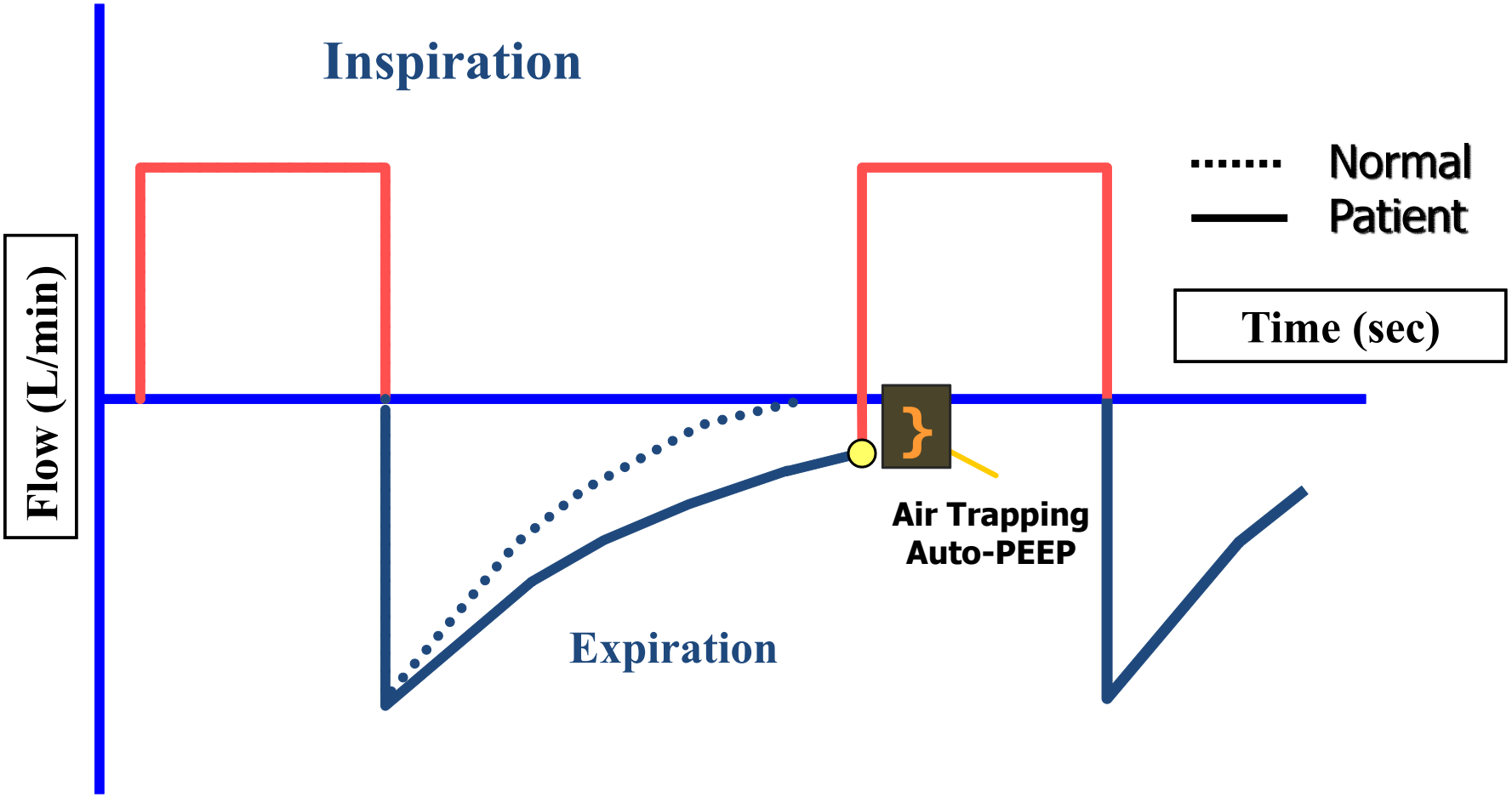
Plateau pressure < 30 cm H2O

If Pplat 25-30 cm----------keep VT < 8 ml/Kg
If Ppl at >30 cm----------keep VT < 6 ml/Kg

Peak Inspiratory Pressure ( PIP)

May accept upto 80 cm as dissipated in airway resistance
Large Peak to Plat gap
With bronchodilatation and therapy PIP should drop

# Identification of Auto PEEP



# Minimize Auto PEEP

1. Relieve obstruction

2. Sedate to control RR (sos paralysis)

3. ? Vt , ? RR , I: E ratio minimum 1:3 upto 1:5

4. ? Vi (inspiratory flow rate)

5. Extreme DH disconnect Ventilation for 30 sec

# DH – is detrimental

- During controlled ventilation predominantly hemodynamic effects

  -Acute Rt Heart Failure/ cor pulmonale

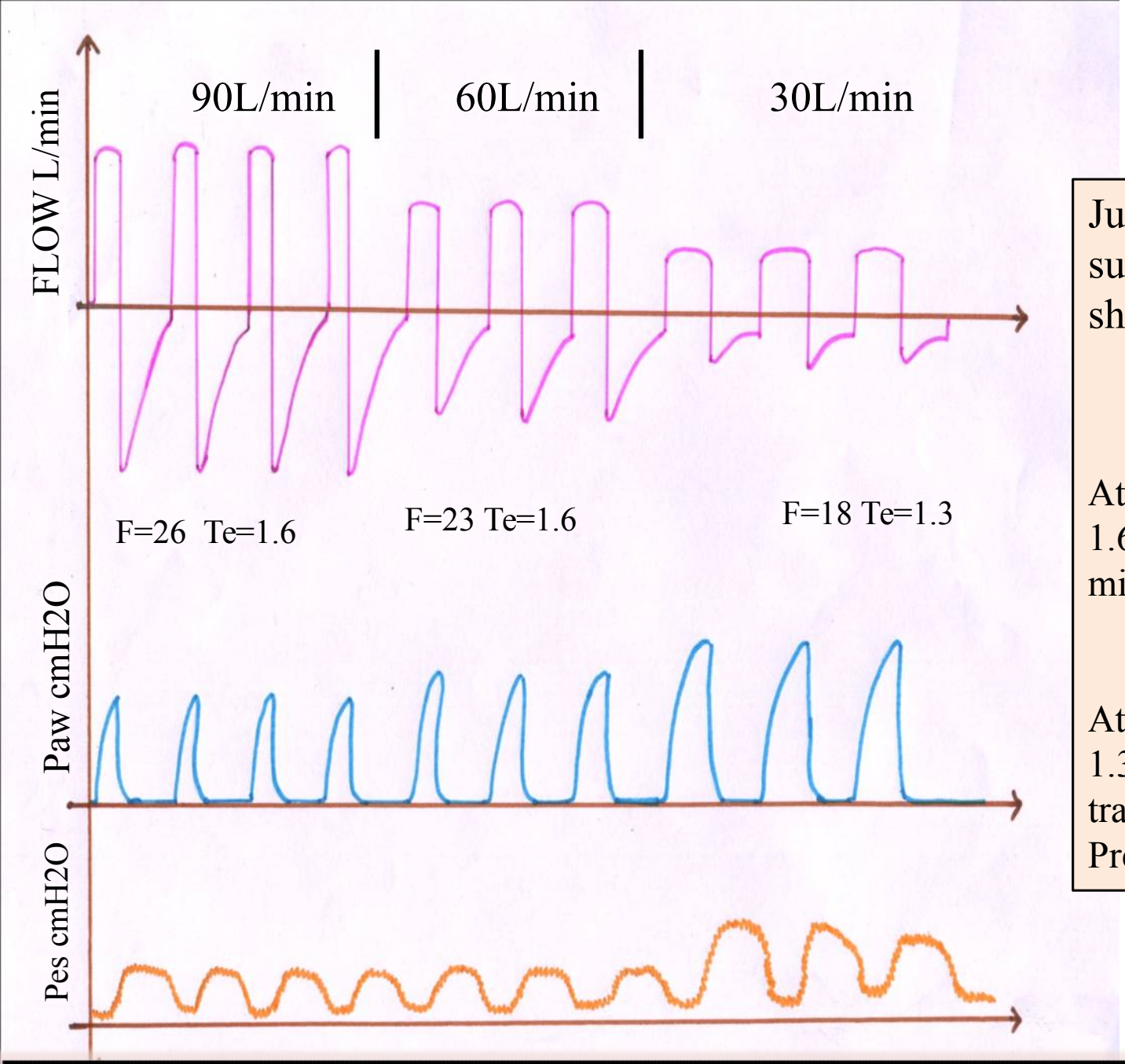
  -Systemic hypotension

  - Baurotrauma

- During weaning

  -Increased WOB, dyscynchrony, agitation,distress

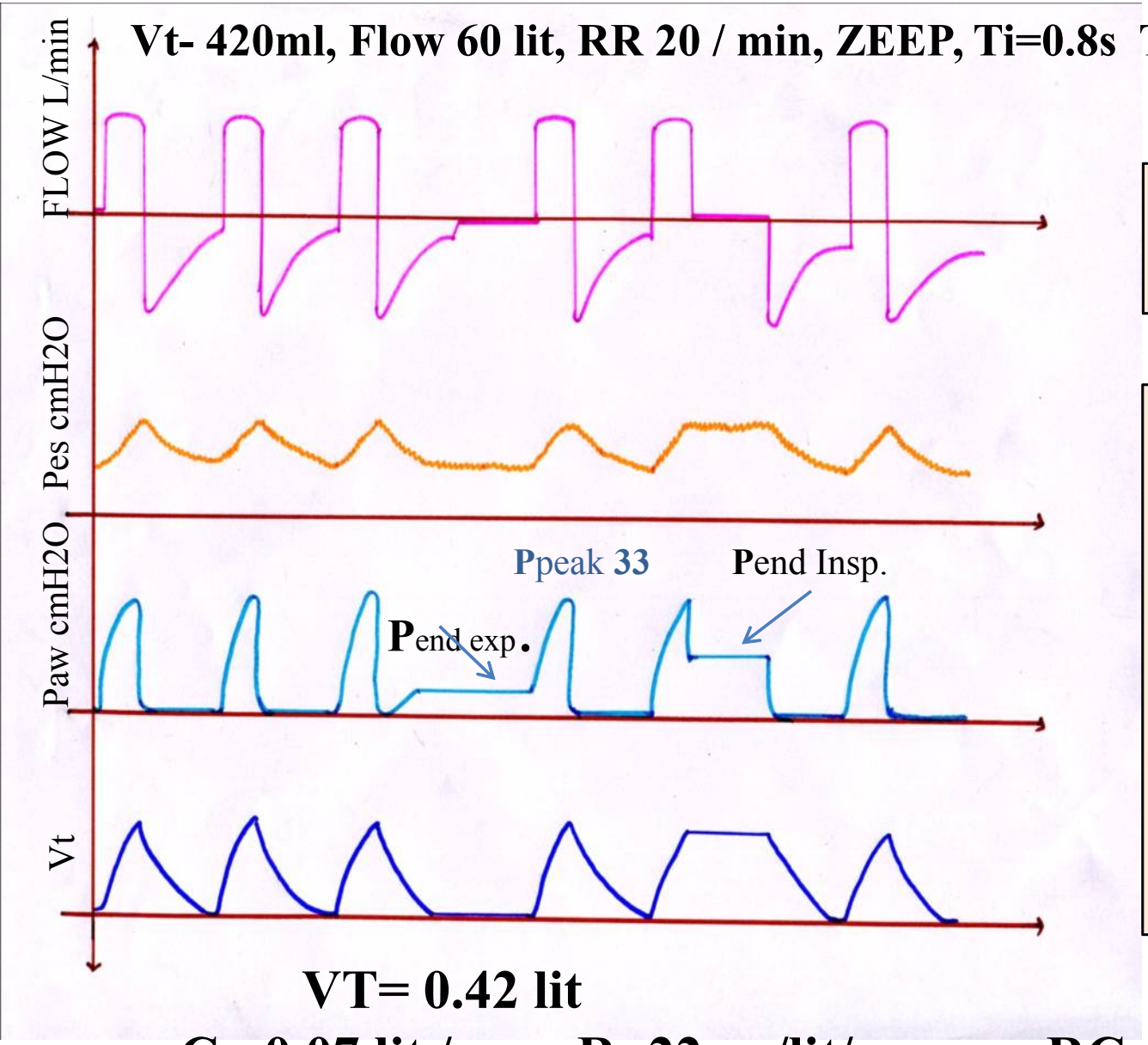
  -Hemodynamic effects




Just low RR is not sufficient. Exp time should be more.

At RR 26 and E time 1.6 sec. There is minimal auto PEEP.

At RR 18 but Exp time 1.3 sec. There is air trapping and increase Pressure




How much should be Exp time ?

In a classic mono chamber model of Lung time required to evacuate-- 3 times the Exp. Time Const.

3X 1.5 = 4.5 sec

# After 50 hours of CMV

| Parameter | Value |
|---|---|
| pH | 7.34 |
| $PCO_2$ | 52 mm Hg |
| $PO_2$ | 104 mm Hg |
| Lact | 1.1 mmol/Lit |
| $HCO_3$ | 27 mmol/lit |
| B.E. | -2.5 |
| $SO_2$ | 98% |
| Hb | 14. 3 gm% |

**CMV**

Vt – 400 ml

RR – 16/ min

PEEP – 0 cm

Flow – 80 lit / min

$FiO_2$ – 0.4

I:E 1:3 Ti- 0.9 Te 3

- Subjectively comfortable
- RR – 16 per minute
- Hemodynamicaly stable
- No shock

# Weaning

- Begins when the precipitating factor of the respiratory failure is partially or totally reversed.
- Co-morbidities and complications treated / optimised
- pH > 7.25
- $FiO_2$ < 0.5 to 0.4 , P/F ratio > 200
- PEEP (for oxygenation ) < 6 to 8cm
- PIP significantly reduced ( compare with starting PIP)

# COPD weaning

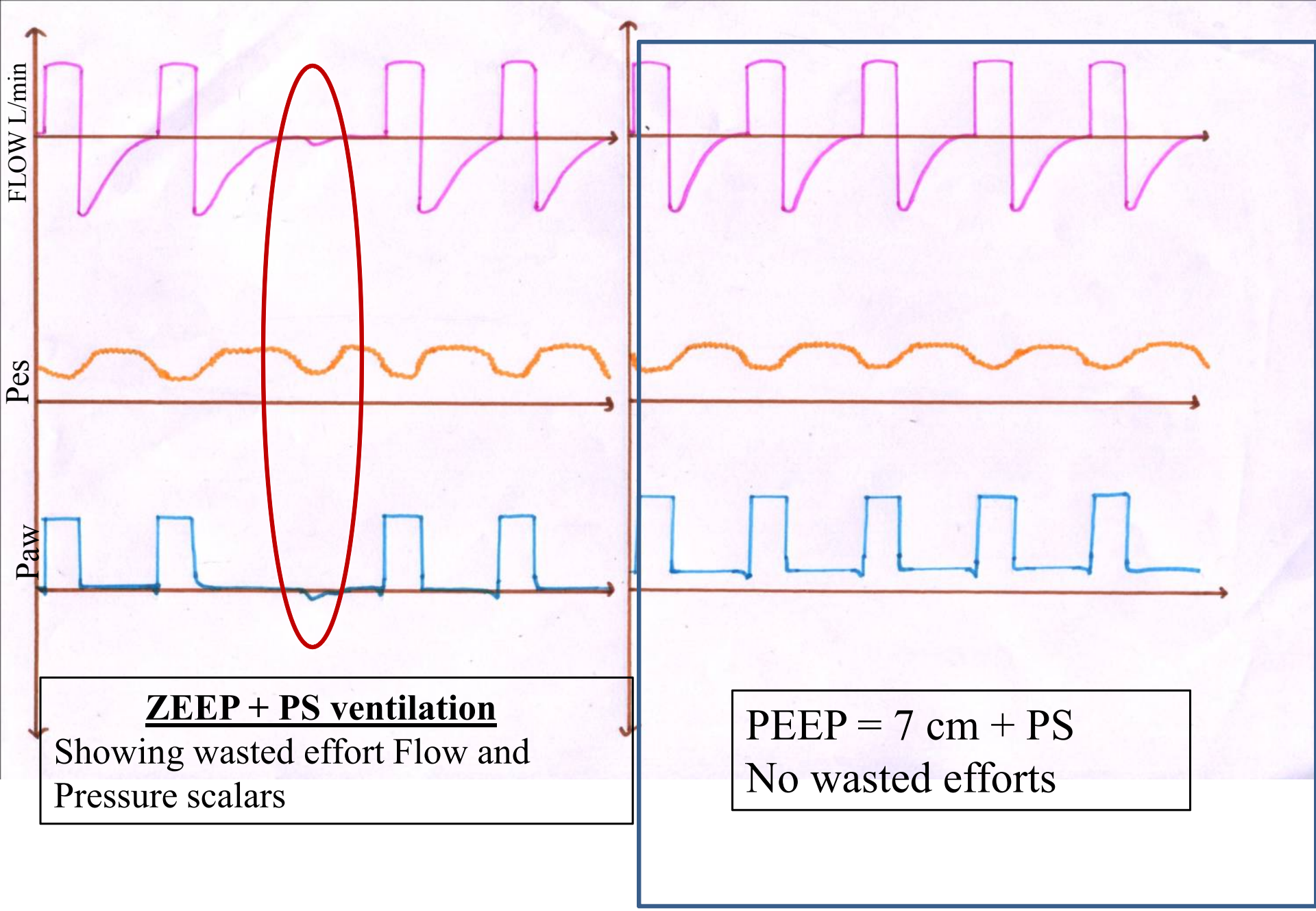
- Pressure support ventilation
- Extubation and elective NIV
- T piece trial
- New ventilatory modes proportional assist ventilation, adaptive support ventilation, knowledge-based expert system, or neurally adjusted ventilatory assist could be useful for difficult to wean patients.

# Weaning

- PaO2/FiO2 ratio >150–200 mmHg
- Positive end-expiratory pressure (PEEP) ? 8 cmH2
- pH >7.25
- RSBI/ Tobin's index – CPAP 5 cm + PS 5- 8 cm
- Rapid shallow breathing index < 10

RR / Vt 24 / 0.4 = 60

RR / Vt 32 / 0.32 = 1

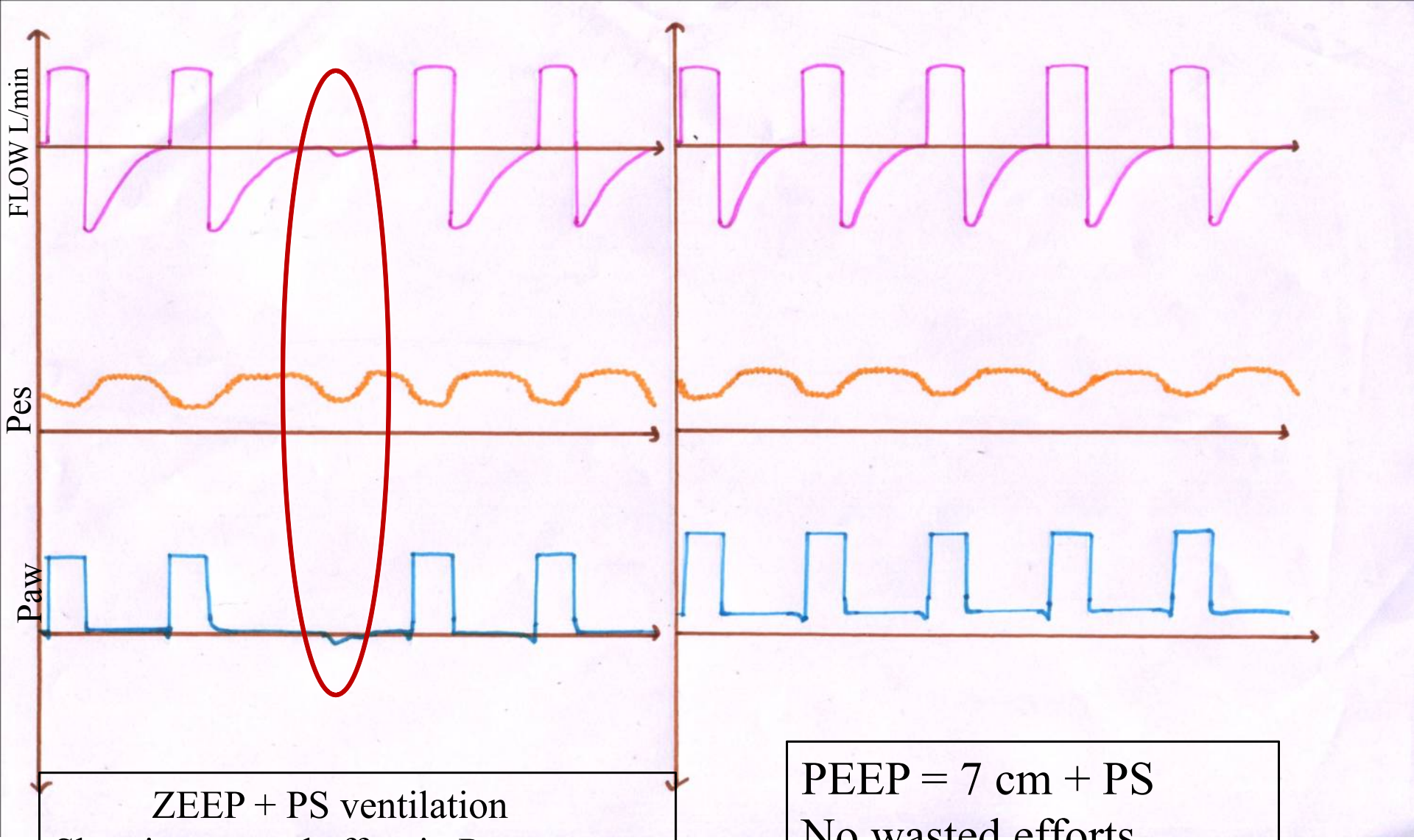



**ZEEP + PS ventilation**

Showing wasted effort Flow and Pressure scalars

PEEP = 7 cm + PS

No wasted efforts

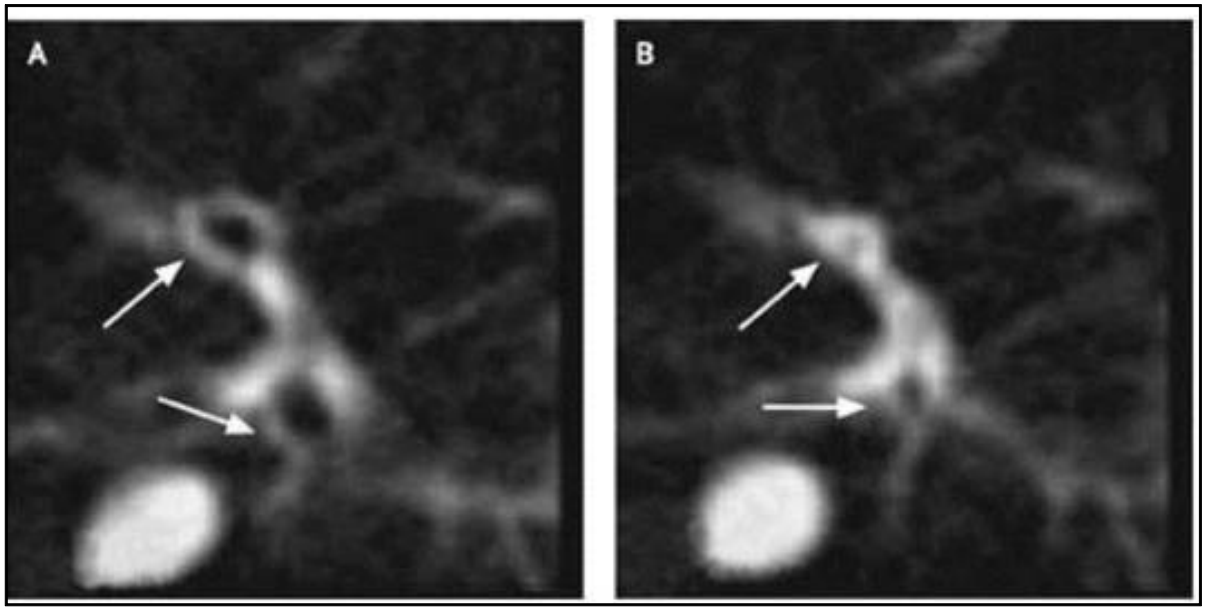



ZEEP + PS ventilation
Showing wasted effort in Pes monitoring as well as in pressure wave monitoring

PEEP = 7 cm + PS
No wasted efforts

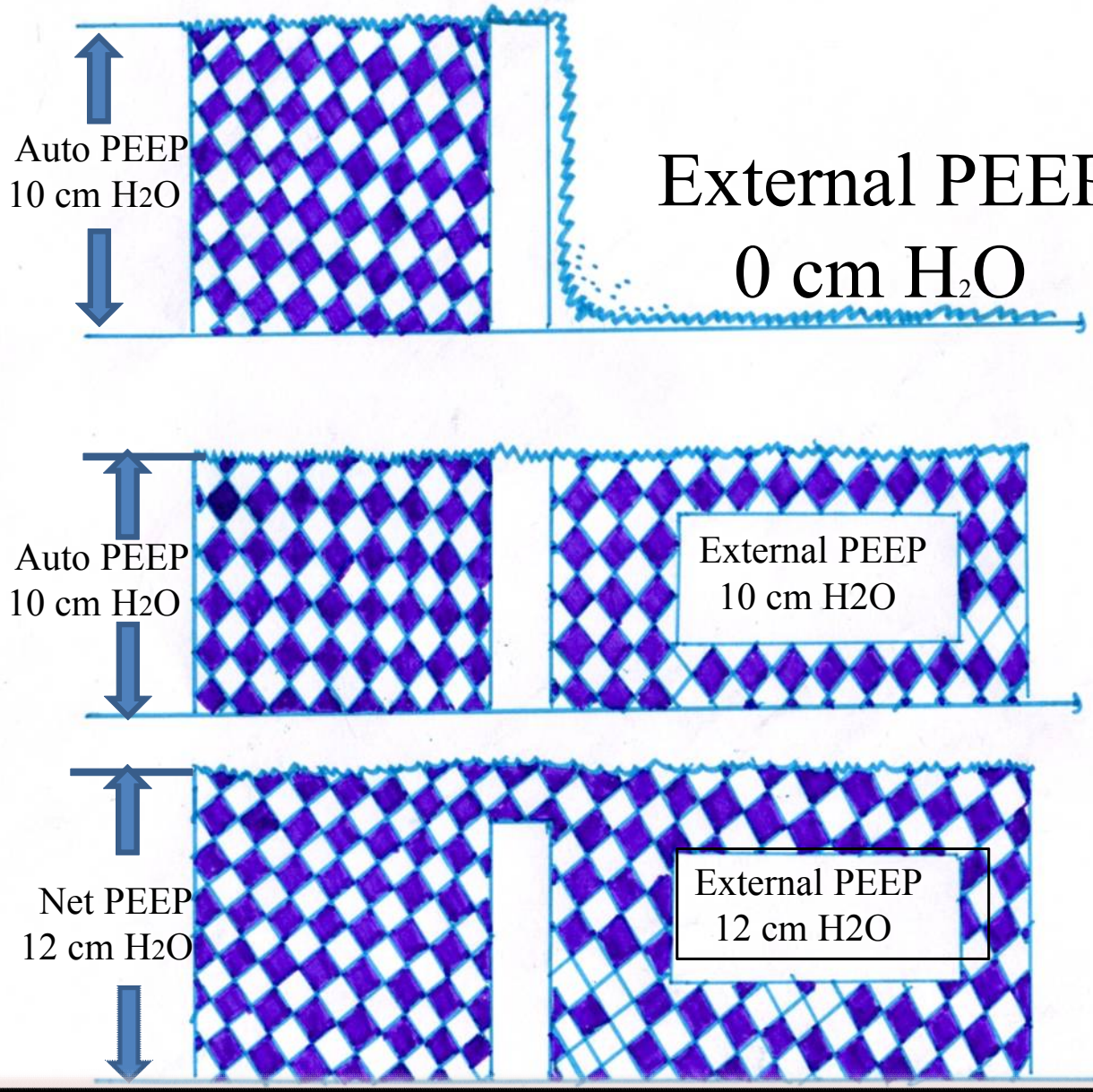
# Dynamic Hyperinflamation You can see it!

NEJM 2004

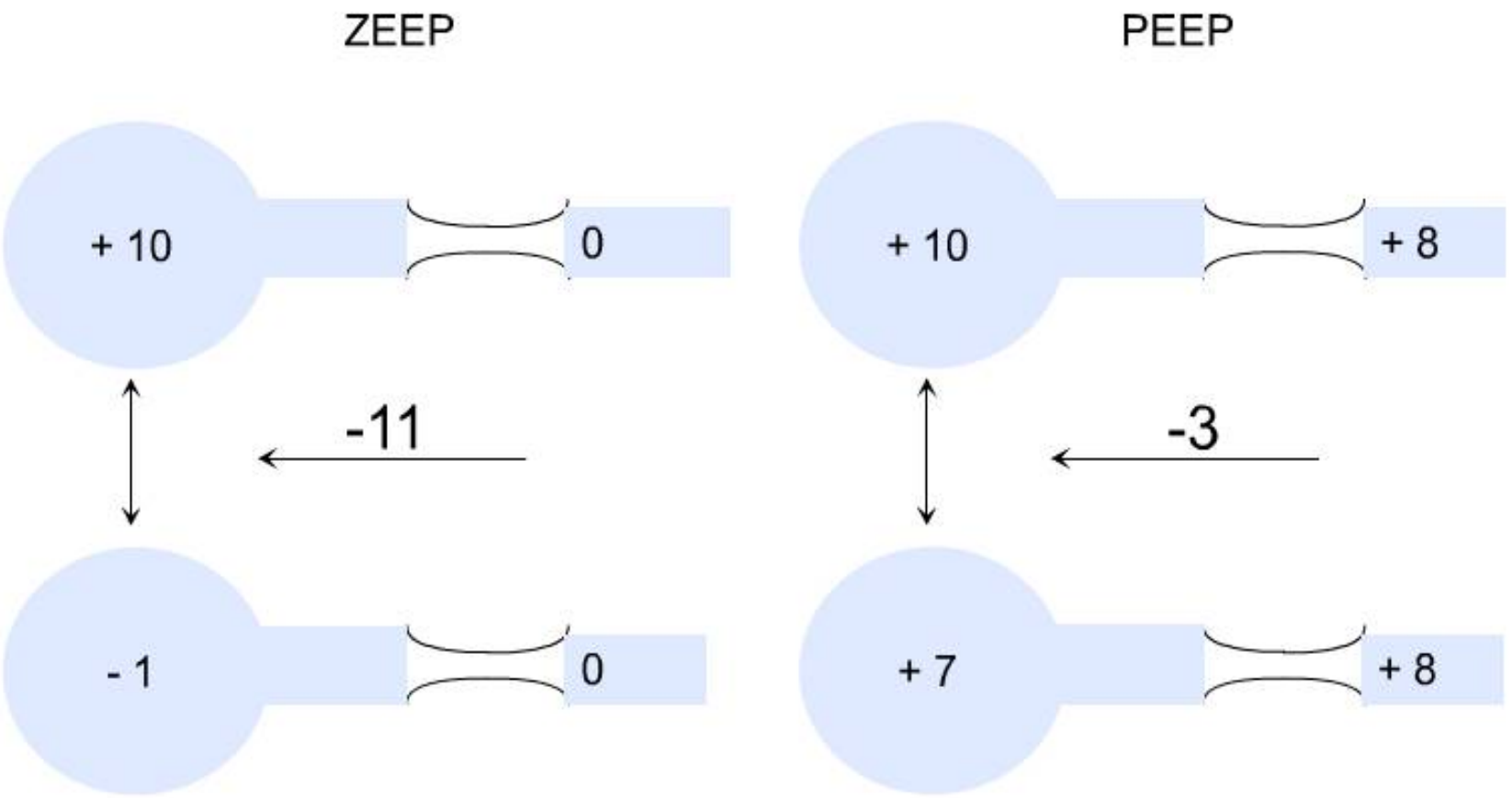



Inspiration - Small airways (approximately 3 mm in diameter) that were open during inspiration

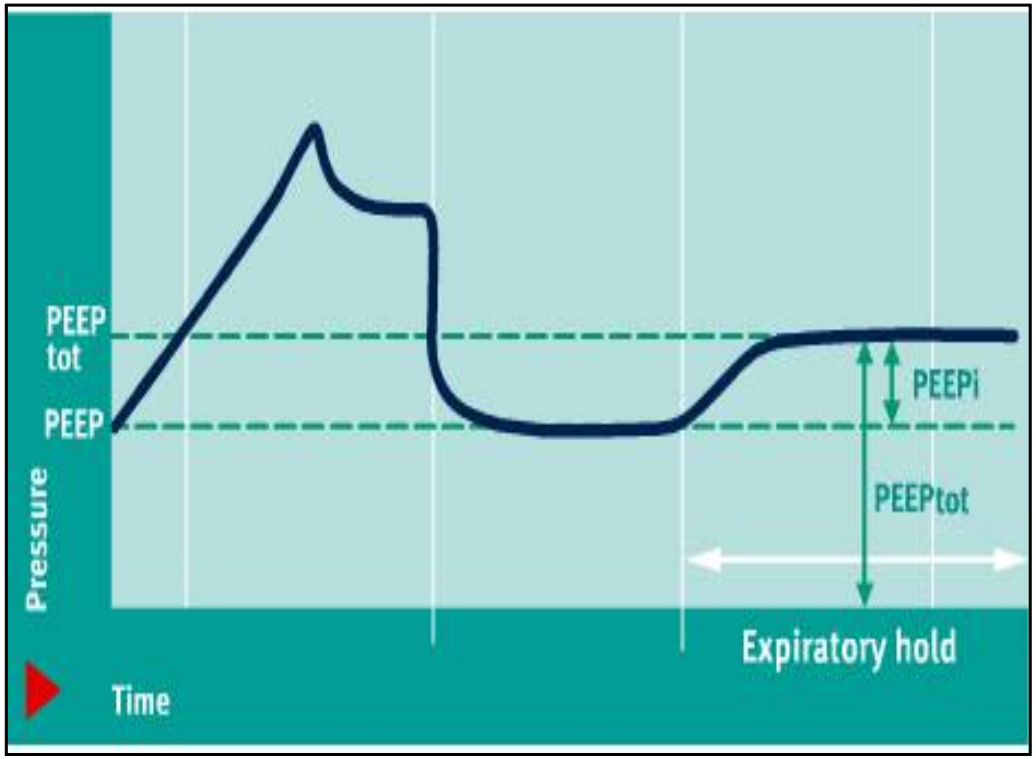
Expiration - Dynamic narrowing


Auto PEEP
10 cm H2O
External PEEP
0 cm H2O
Auto PEEP
10 cm H2O
External PEEP
10 cm H2O
Net PEEP
12 cm H2O
External PEEP
12 cm H2O

# Effect of external PEEP on intrinsic PEEP and work of breathing



# Measure autoPEEP during CMV




Press Expiratory hold button for at least 5 seconds

# Pressure support ventilation (PSV)

- PEEP = at least 80 % of PEEPi
- The level of pressure support is set to avoid Vt over 8 mL/kg of ideal body weight
- FiO2 as per sats > 88% or PO2 > 65 %
- Inspiratory trigger more sensitive
- Flow -125 lit /min ( Factory set)
- Pressurisation time ( Ramp/ ascent) 0.1 - 0.2 sec.
- Expiratory trigger 40 to 70% of the maximal inspiratory flow

# T piece

- Word of caution !
- No pressure support, no PEEP thus may develop fatigue / DH
- Should not be longer than 120 minutes to avoid breathing muscle fatigue
- Daily once trial

# PSV versus T piece

- Neither of these two weaning methods has been proven superior.
- Whichever mode is chosen, a weaning protocol is generally recommended
- Synchronised intermittent mandatory ventilation (SIMV) is no longer recommended since it has been proven less efficient for weaning

# NIV as weaning mode

- Extubation and full face mask NIV
- EPAP= CPAP= PEEP – > 80 % of PEEP i ( record before extubation)
- IPAP / PS to adjusted to alleviate distress, keeping RR <30, subjective feed back
- $FiO_2$ as per oxygenation

# Difficult Weaning

1) NIV and home ( out of ICU) ventilation

2)Trachaestomy

3)Heliox: Helium- oxygen mix, 60-80 % Helium
Lower density, hence lesser resistance,
better flows,
less WOB, lower $pCO_2$

4) Newer modes PAV, NAVA, ASV, NeoGanesh

Intensive Care Med (2012) 38:1632–1639
DOI 10.1007/s00134-012-2649-2

ORIGINAL

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# Avoiding invasive mechanical ventilation by extracorporeal carbon dioxide removal in patients failing noninvasive ventilation

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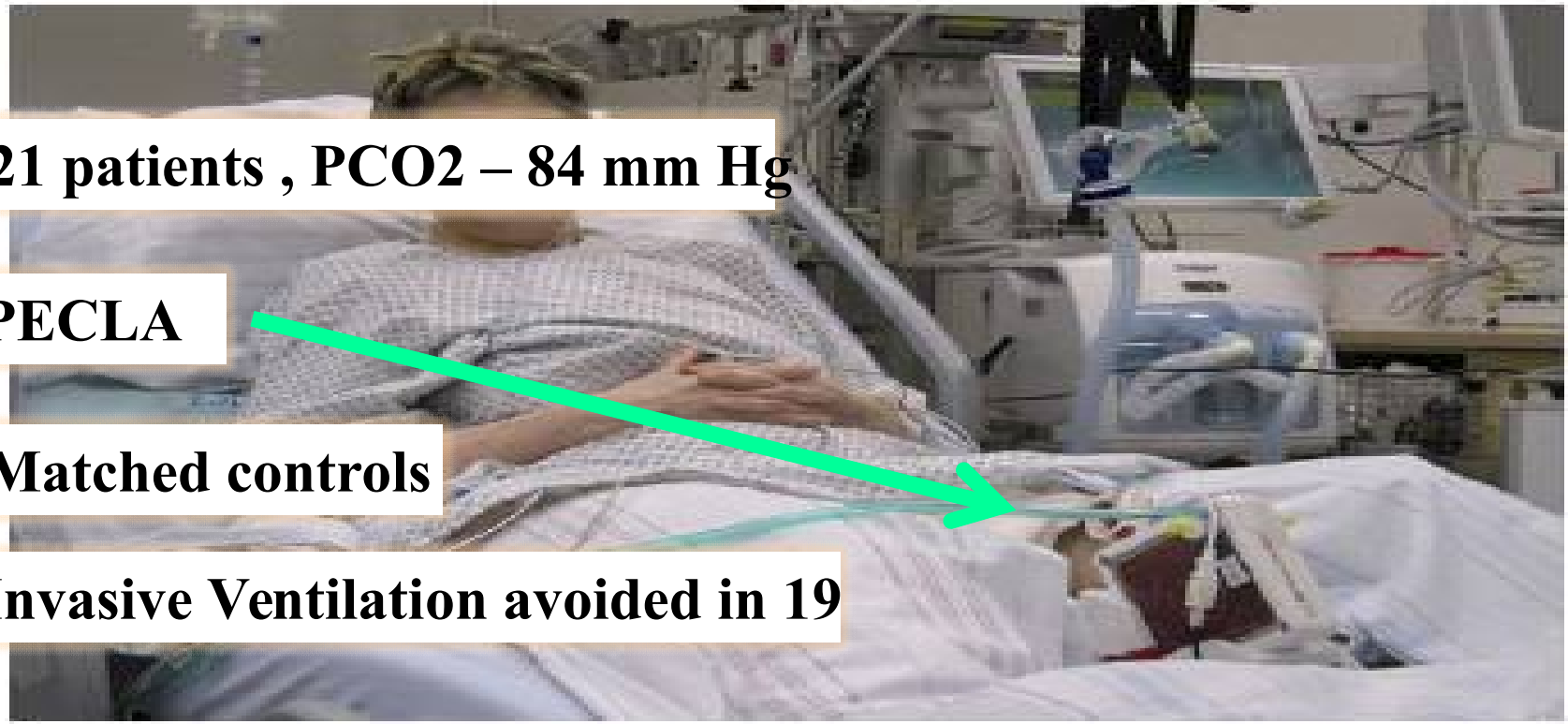
# Avoiding invasive mechanical ventilation by extracorporeal carbon dioxide removal in patients failing noninvasive ventilation



21 patients , PCO2 – 84 mm Hg

PECLA

Matched controls

Invasive Ventilation avoided in 19

# $ECCO_2R$ – Respiratory Dialysis

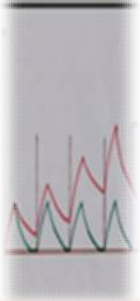

Hemolung

Novalung

Sistema Decap -Hemodec

PALP - Maquet

# In year 2037



Name:
NEW PATIENT
Instrument:
Model: GEM 3000
S/N: 24881

Measured (37.0C)

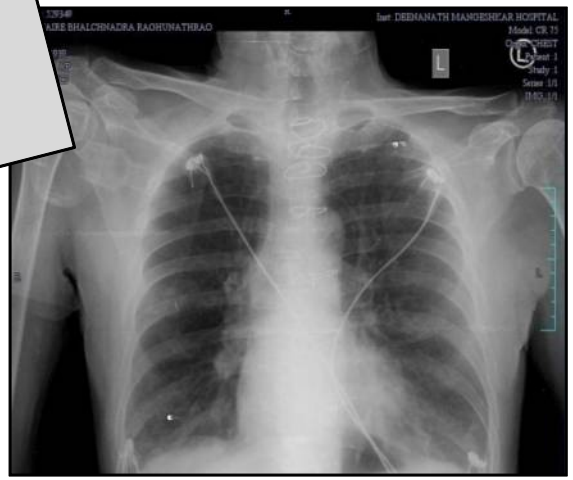
| | | | |
|---|---|---|---|
| pH | | 7.16 | |
| ?pCO2 | > | 115 | mmHg |
| pO2 | | 22 | mmHg |
| Na+ | | 129 | mmol/L |
| K+ | | 3.8 | mmol/L |
| #Ca++ | | 1.03 | mmol/L |
| Glu | | 222 | mg/dL |
| Lac | | 1.4 | mmol/L |
| Hct | | 53 | % |

Derived Parameters

| | | |
|---|---|---|
| ?HCO3- | ----- | |
| ?TCO2 | ----- | |
| ?BEecf | ----- | |
| ?BE(B) | ----- | |
| ?SO2c | ----- | |
| THbc | 16.4 | g/dL |

#=Outside ref. range
?=Review
(On Neb)

65 yr doctor
Fever ,cough, SOB
Non smoker
Non diabetic, non HT
Hypercapnoeic
resp failure
Put on NIV



**No consent for Invasive Ventilation**

# Indian ICU bugs in 2037

- XDR  Pseudomonas
- Colistin resistant MBL Klebsiela
- Fosfomycin resistant Acinetobacter
- VRSA
- Echinocandin  resistant Candida

# ECCO2R – Future therapy of Hypercapnoeic failure

# ECCO2R – Current status

- Metaanalysis  Apr 2017
- 3 studies on COPD
- ECCO2R devices could avoid endotracheal intubation
- ICU-LOS and survival was not influenced by ECCO2R when compared to controls.


F. Taccone et al

This ppt is available on our departmental website

**www.dmhemcrit.com**