Noninvasive respiratory support:why is it working ?

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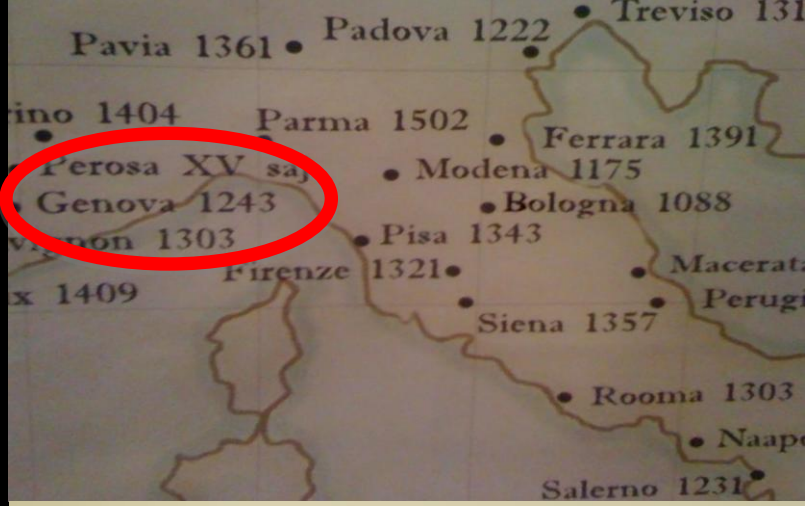
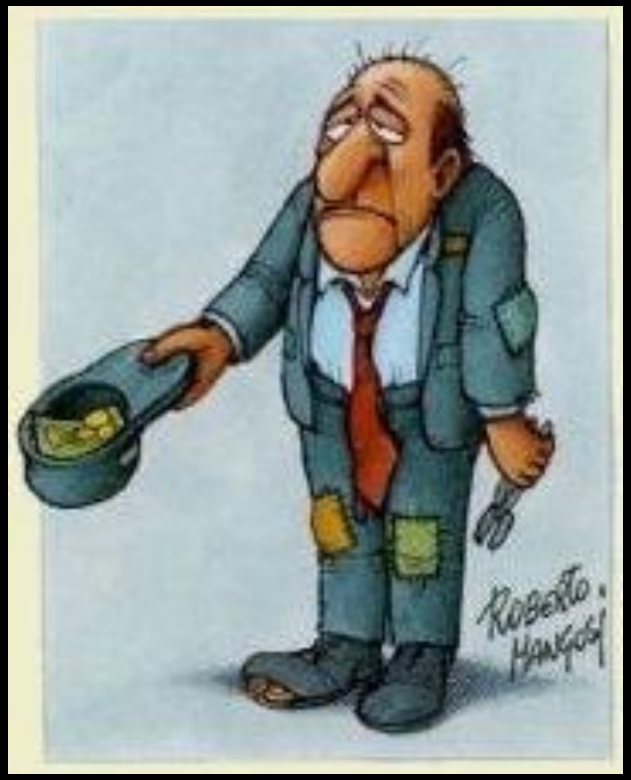
"IX CONGRESSO NAZIONALE SIMEU"
Torino, 6-8 Novembre 2014



Conflicts of Interest

I declare

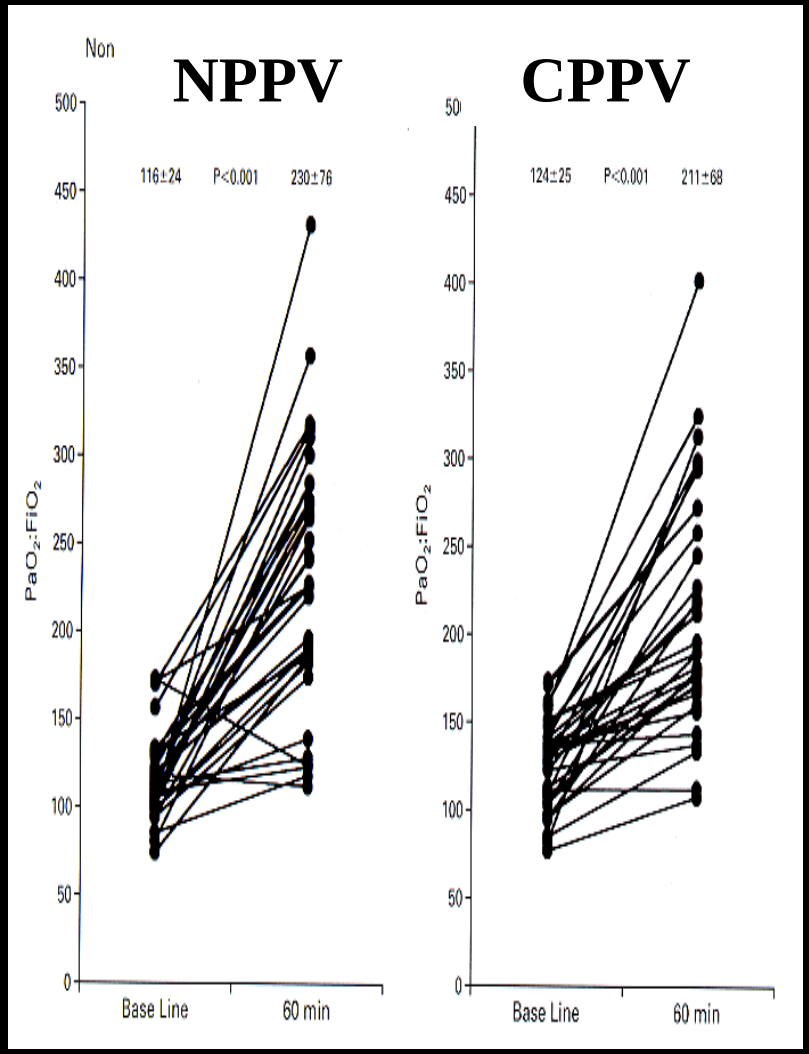
NO conflicts of interest



Non Invasive Ventilation: The Rationale

Brochard L et al Eur Respir J 2003; 22: Suppl. 47, 31s–37s

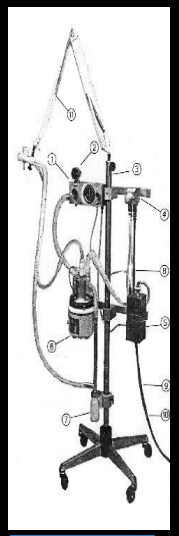
Antonelli M et al. Intensive Care Med. 2008 Mar;34(3):405-22



- Reduced WOB
- Gas-exchange improvement
- Improve cardiac performance
- Reduction of ETI
- Reduction of infection rate
- Increased survival

ACUTE RESPIRATORY FAILURE

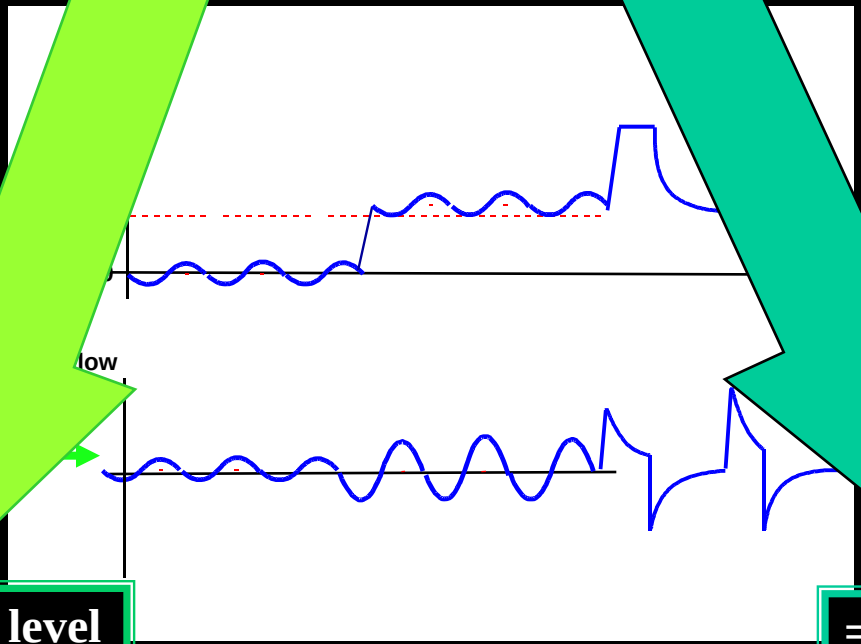
- Cardiogenic edema
- Infectious pneumonia (ARDS)
- Opportunistic pneumonia, immunodepressed pts
- Postoperative respiratory failure
- Post extubation hypoxiemic ARF
- Before intubation in severe hypoxemia
- COPD exacerbation
- Asthma (?)
- Patients who are not candidate for intubation



Non-invasive Assisted Ventilation (NIV)

CPAP = SB+PEEP

= PSV+PEEP
= NIV
= NPPV
= NIPSV
= IPAP+EPAP
= (BIPAP = bi-level)

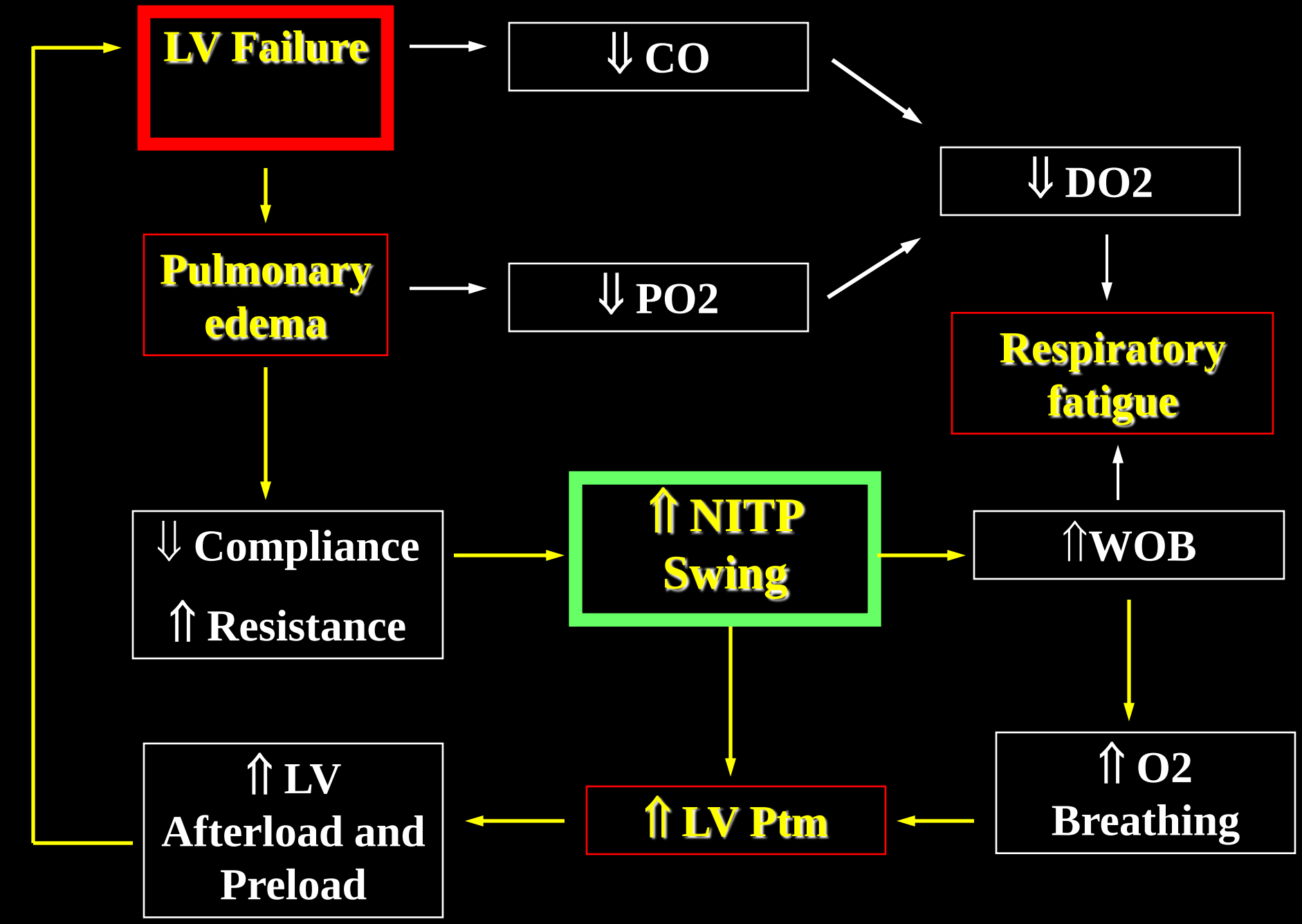


Sinusal flow

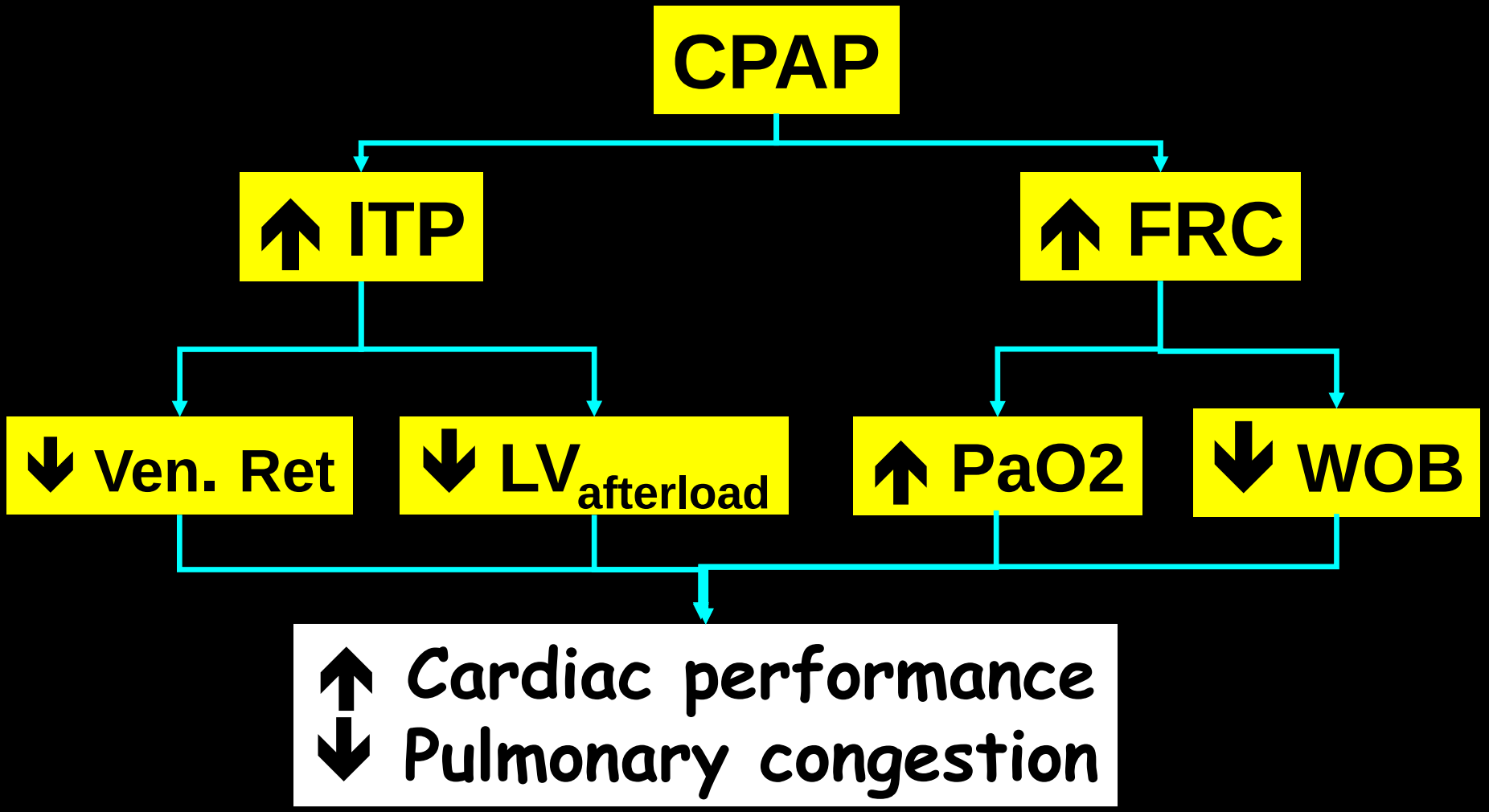
Decelarating flow

= 1 pressure level (= CPAP = PEEP)

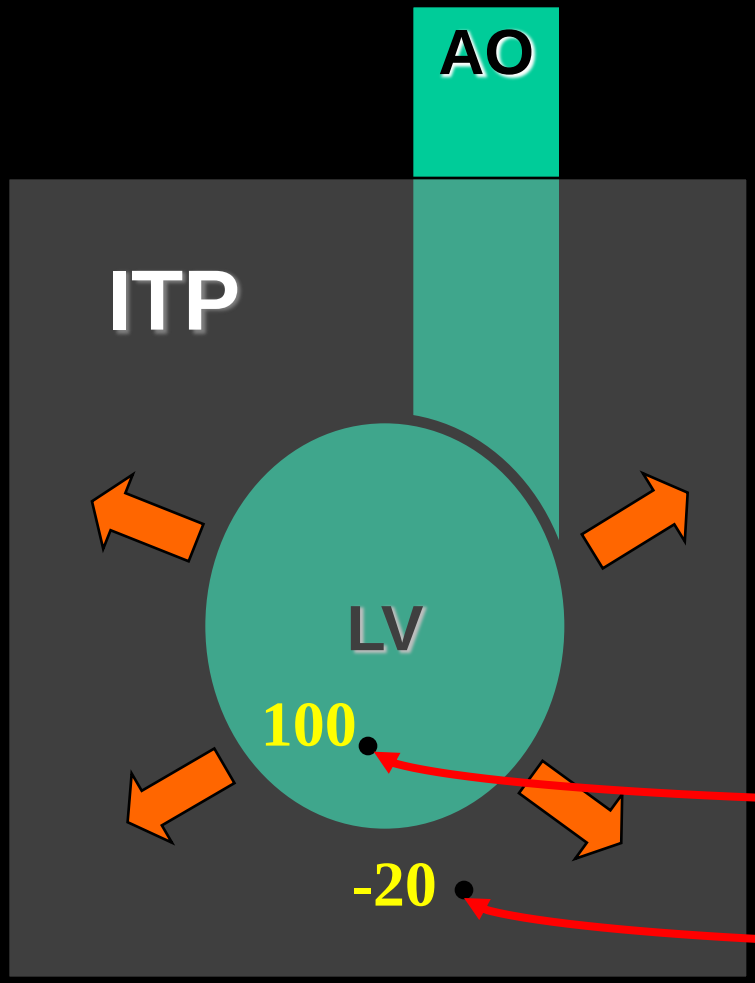
= 2 pressure levels (NIV = PSV+PEEP = BiPAP)


LV Failure
⇓ CO
⇓ DO2
Pulmonary edema
⇓ PO2
Respiratory fatigue
⇓ Compliance
⇑ Resistance
⇑ NITP Swing
⇑WOB
⇑ LV Afterload and Preload
⇑ LV Ptm
⇑ O2 Breathing

Rationale of CPAP in ACPE



Intra-Thoracic Pressure and LV function (without PEEP)



Ptm = 100-(-20) = 120

↑ effort = ↓ ITP = ↑Ptm

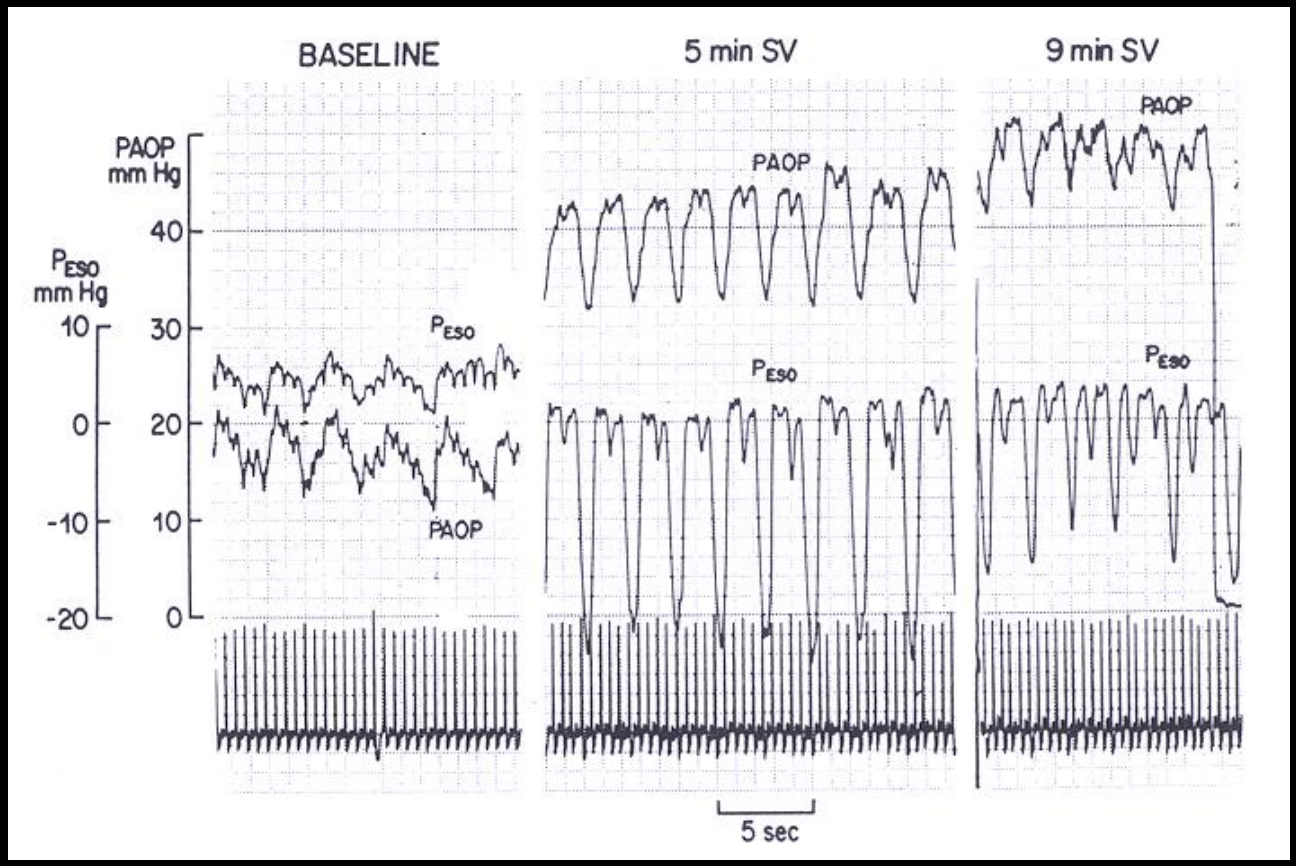
↓

↑ LV afterload

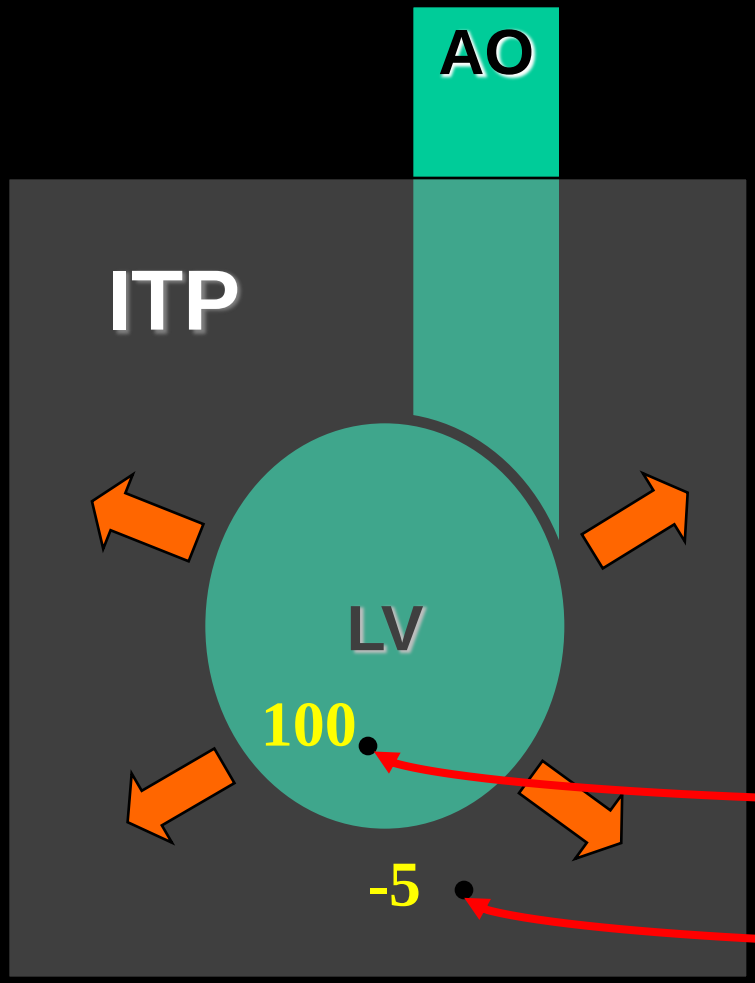
Anesthesiology
69:171–179, 1988

Acute Left Ventricular Dysfunction during Unsuccessful Weaning from Mechanical Ventilation

Francois Lemaire, M.D., Jean-Louis Teboul, M.D.,† Luc Cinotti, M.D.,‡ Guillen Giotto, M.D.,§ Fekri Abrouk, M.D.,§ Gabriel Steg, M.D.,§ Isabelle Macquin-Mavier, M.D.,¶ Warren M. Zapol, M.D.***



Intra-Thoracic Pressure and LV function (with PEEP 15)



Ptm = 100-(-5) = 105

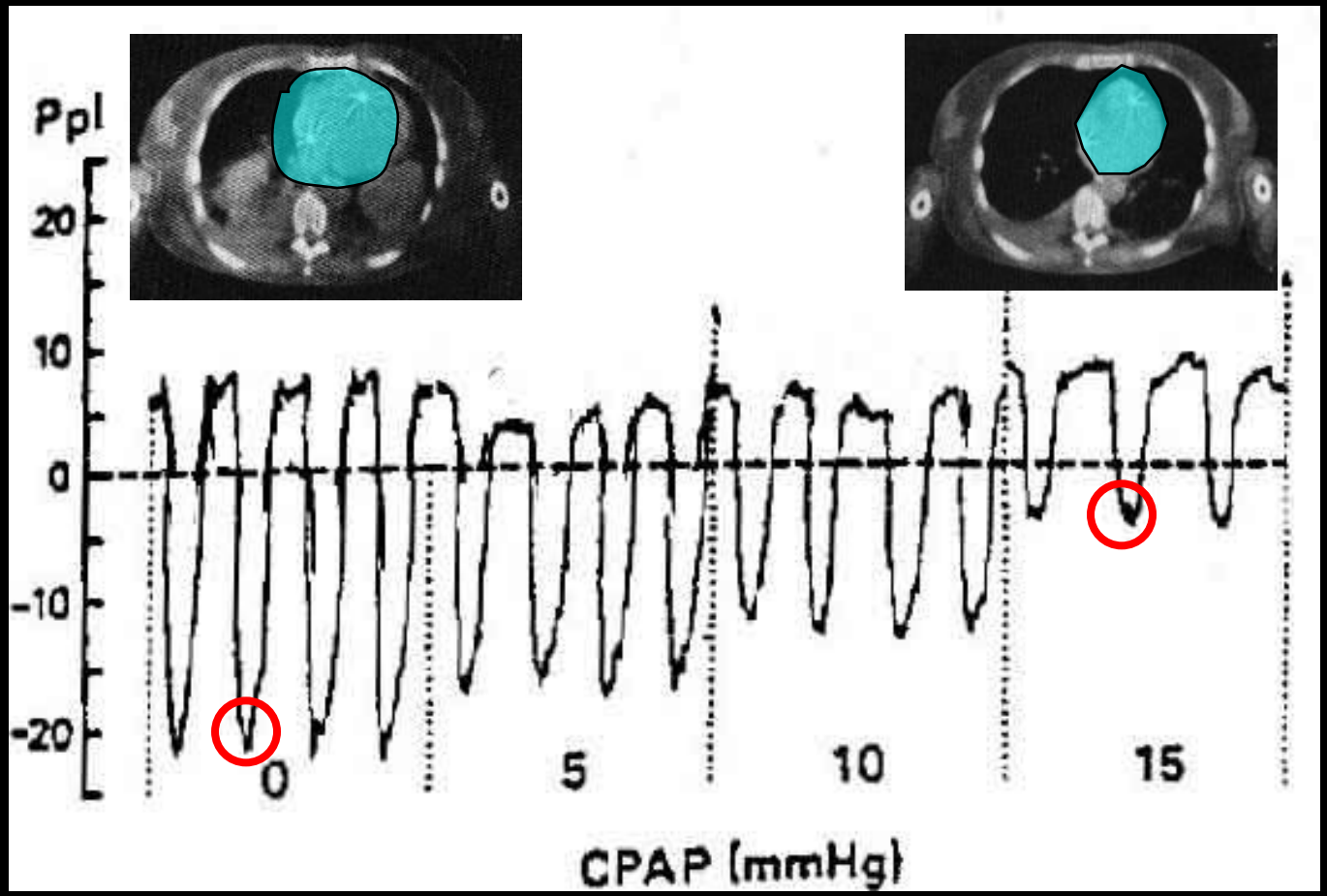
↑ effort = ↓ ITP = ↑Ptm

↓

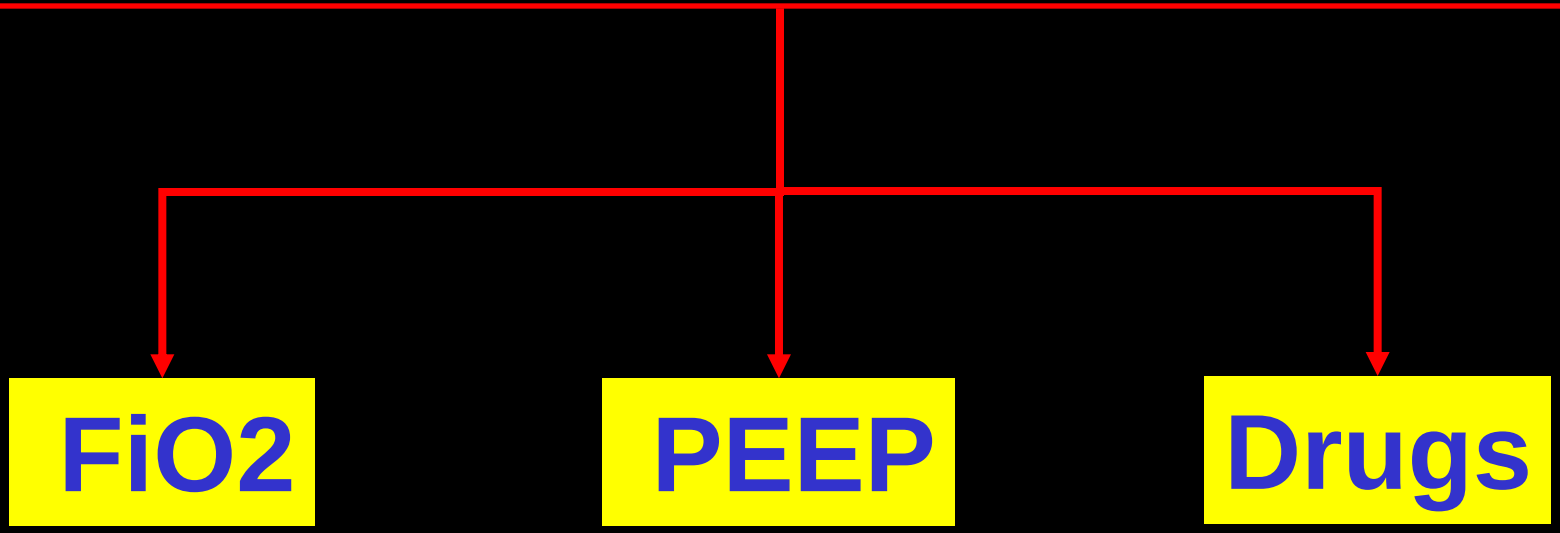
↑ LV afterload

CPAP IN CARDIOGENIC PULMONARY EDEMA

Rasen et al: Chest 1985; 87: 158-162



Why SpO_2 improves during CPAP in ACPE ?

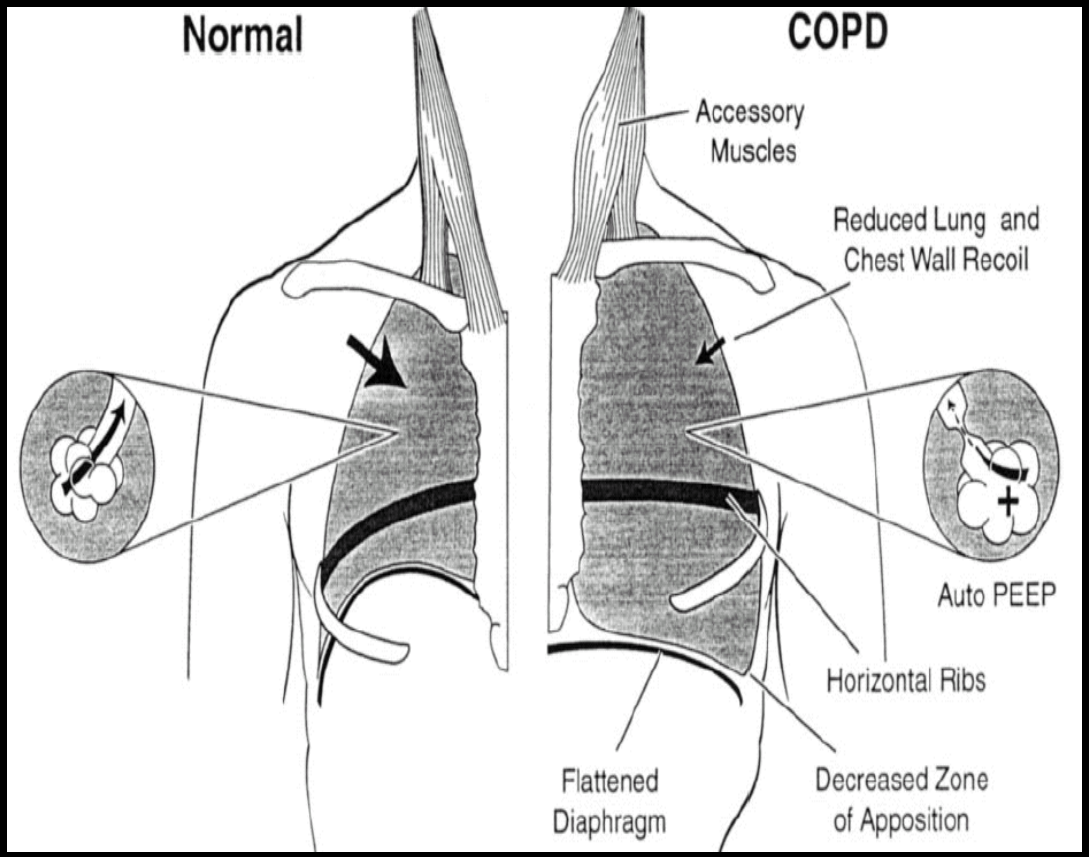


The role of drugs in the first minutes of treatment of severe ACPE is

MARGINAL !

COPD: Increased Ventilatory Muscle Workload

Unbalance beween demand and power !



The Vicious Circle of COPD

↑↑ Airway resistance

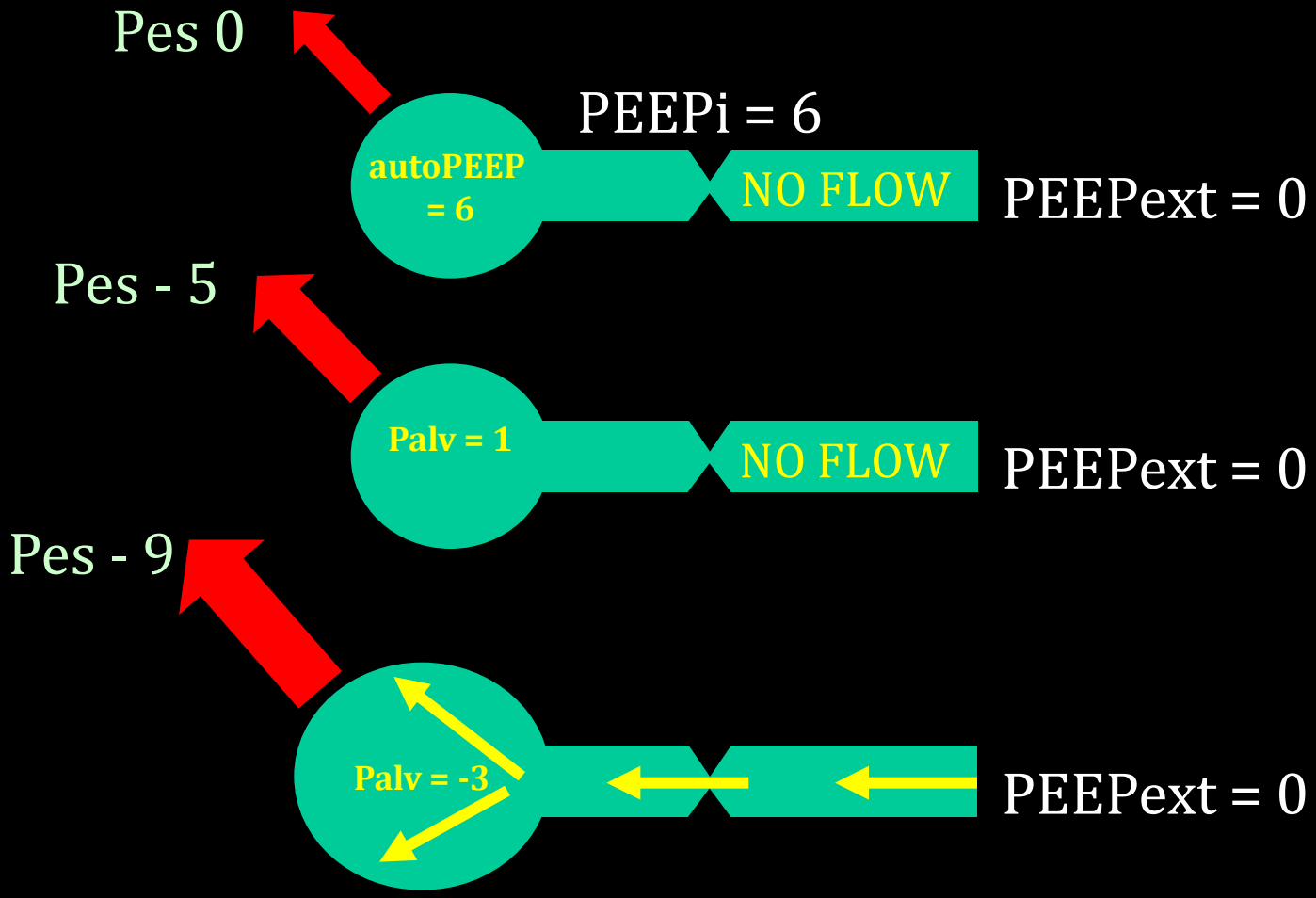
↑↑ Expiration time

Gas trapping

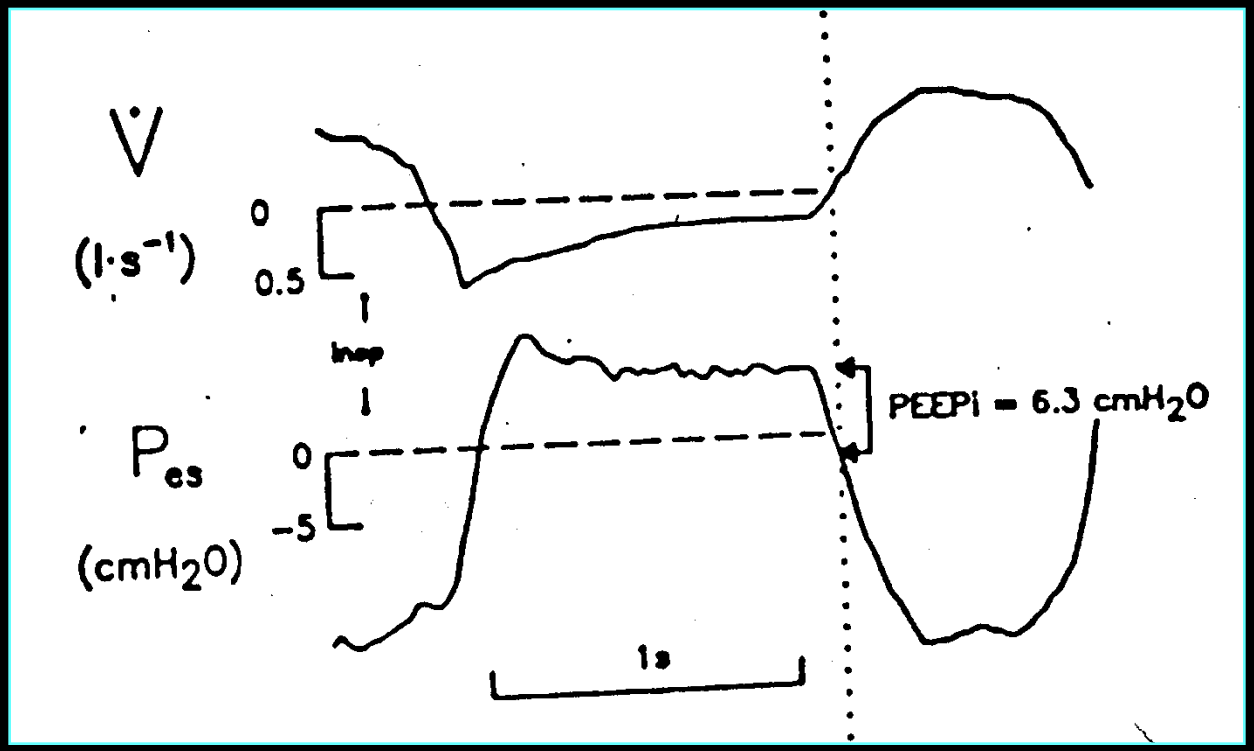
Emphisema

↑↑ Compliance

Auto-PEEP in spontaneously breathing COPD

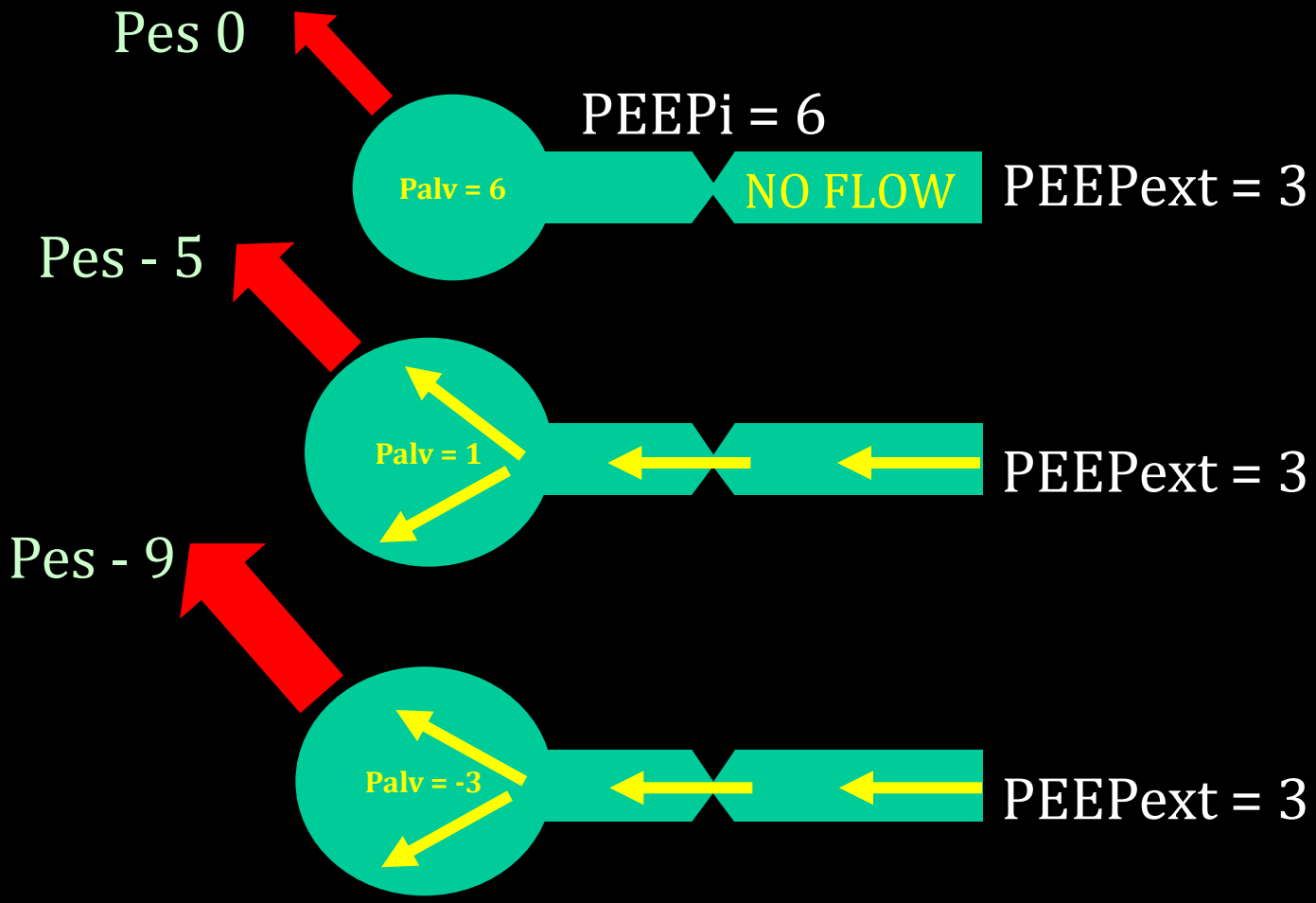


Auto-PEEP in spontaneously breathing COPD



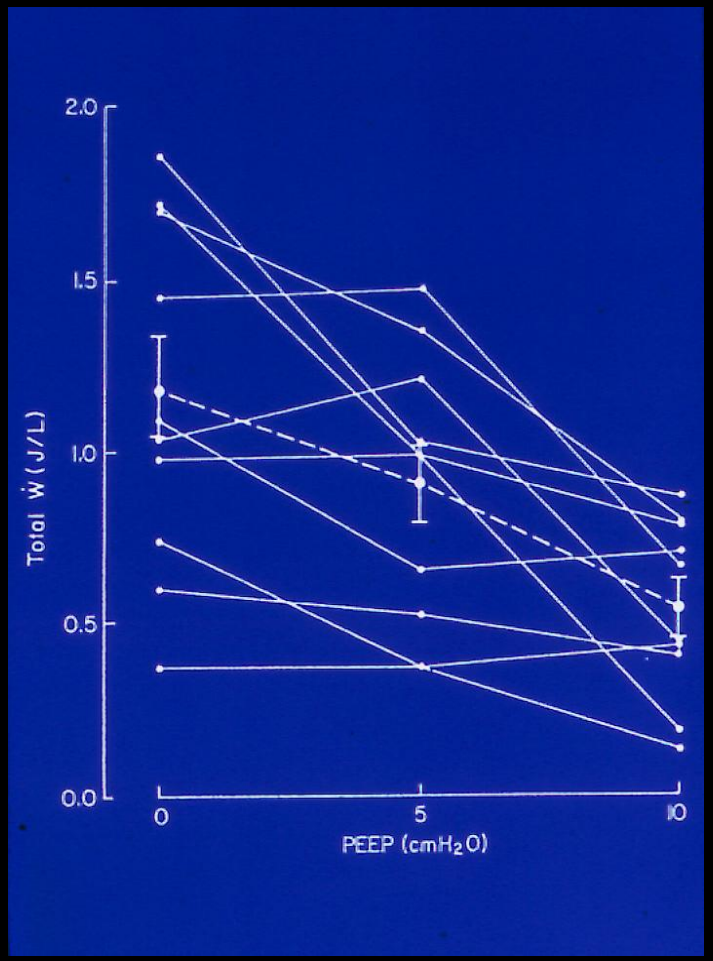
Auto-PEEP is additional workload for the pt!

PEEPe in spontaneously breathing COPD

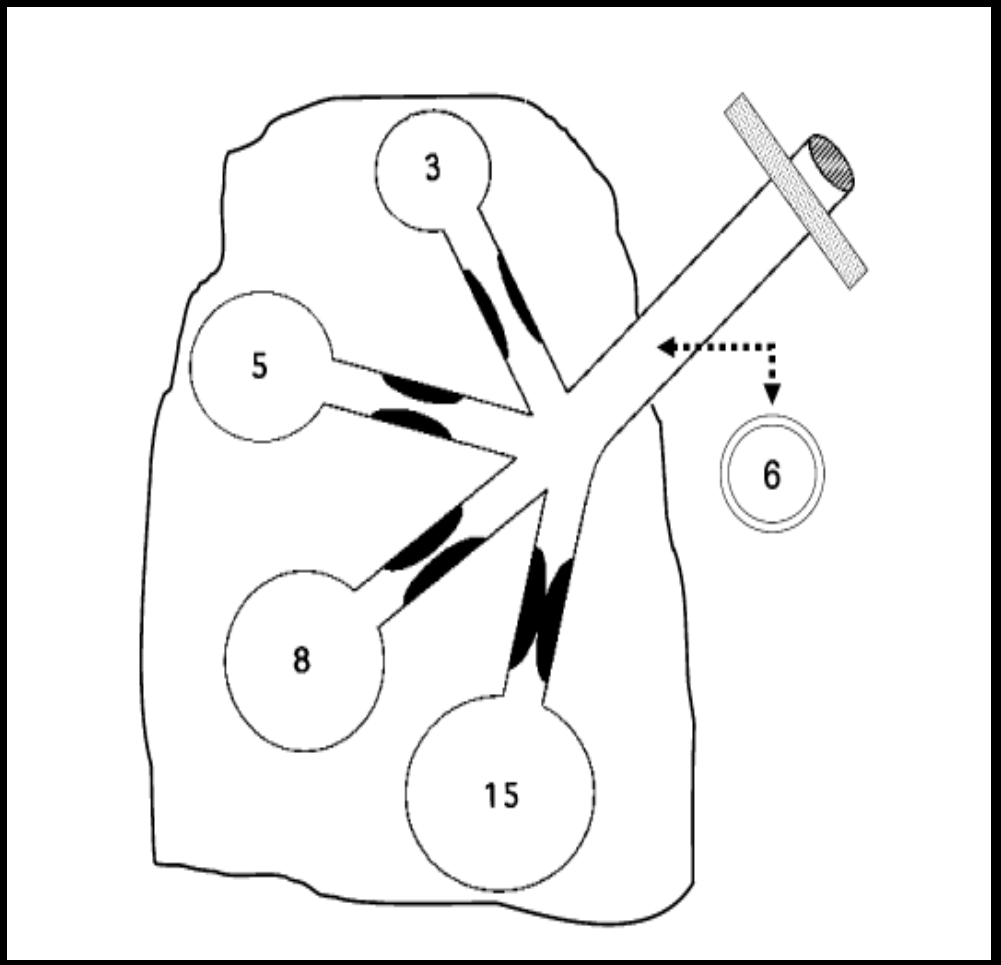


PEEPe in spontaneously breathing COPD

Smith TC, Marini JJ. JAP 1988



Marini et al. AJRCCM 2011



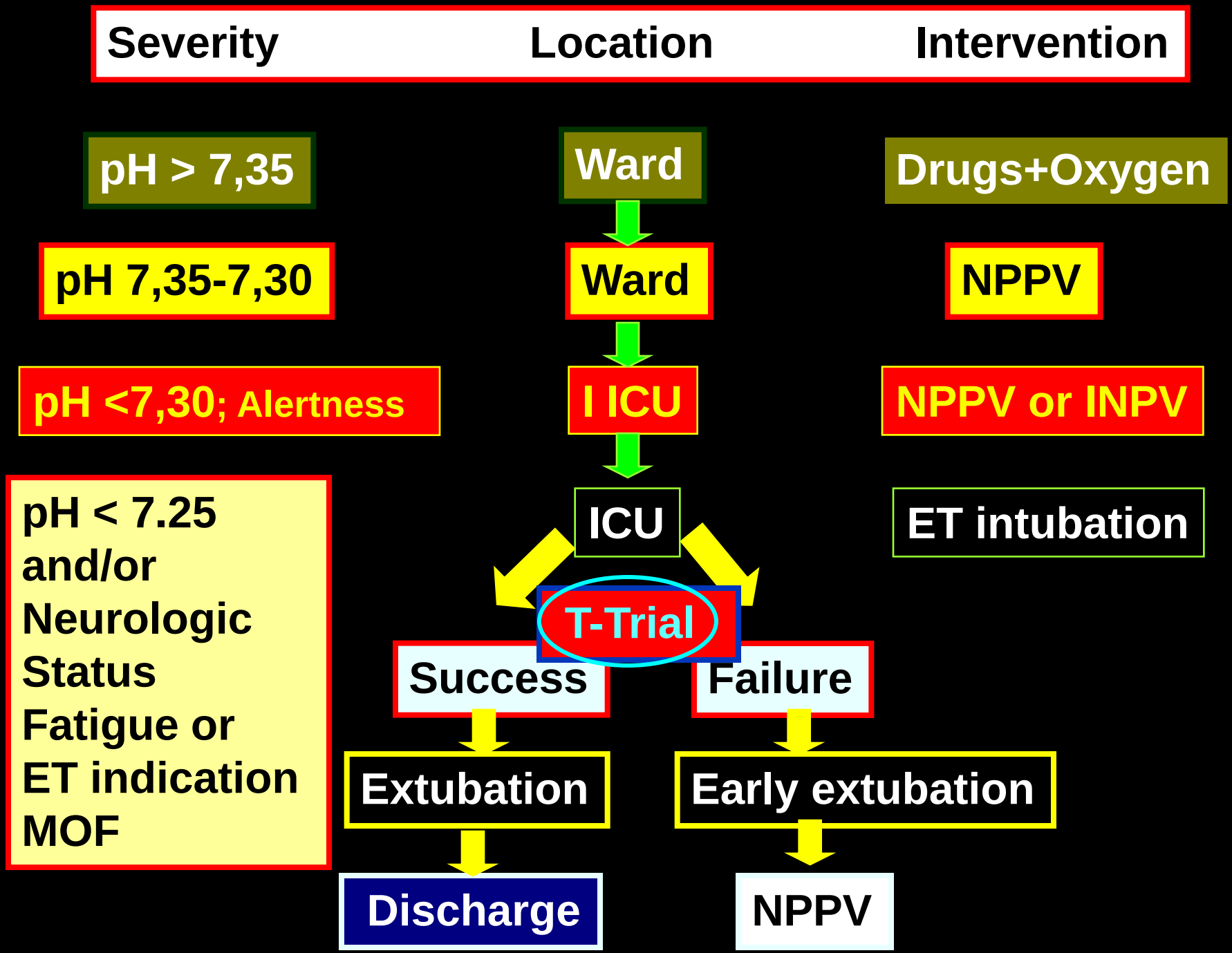
A Chart of Failure Risk for NPPV in COPD

Confalonieri M et al Eur Respir J 2005; 25:348-355

		pH after 2 h <7.25		pH after 2 h 7.25–7.29		pH after 2 h ≥7.30	
	RR	APACHE ≥29	APACHE <29	APACHE ≥29	APACHE <29	APACHE ≥29	APACHE <29
GCS 15	<30	72	35	27	7	11	3
	30–34	88	59	49	17	25	7
	≥35	93	73	64	27	38	11
GCS 12–14	<30	84	51	41	13	19	5
	30–34	93	74	65	28	39	12
	≥35	96	84	78	42	54	20
GCS ≤11	<30	93	74	65	28	39	12
	30–34	97	88	83	51	63	26
	≥35	99	93	90	66	76	40

100 – 75 % 74 -50 % 49 -25 % 24 -0 %

Percentage of patients who fail NIV


Severity
Location
Intervention
pH > 7,35
Ward
Drugs+Oxygen
pH 7,35-7,30
Ward
NPPV
pH <7,30; Alertness
I ICU
NPPV or INPV
pH < 7.25
and/or
Neurologic
Status
Fatigue or
ET indication
MOF
ICU
ET intubation
T-Trial
Success
Failure
Extubation
Early extubation
Discharge
NPPV

Extracorporeal Lung Assist with Spontaneous Breathing: A Feasibility Study

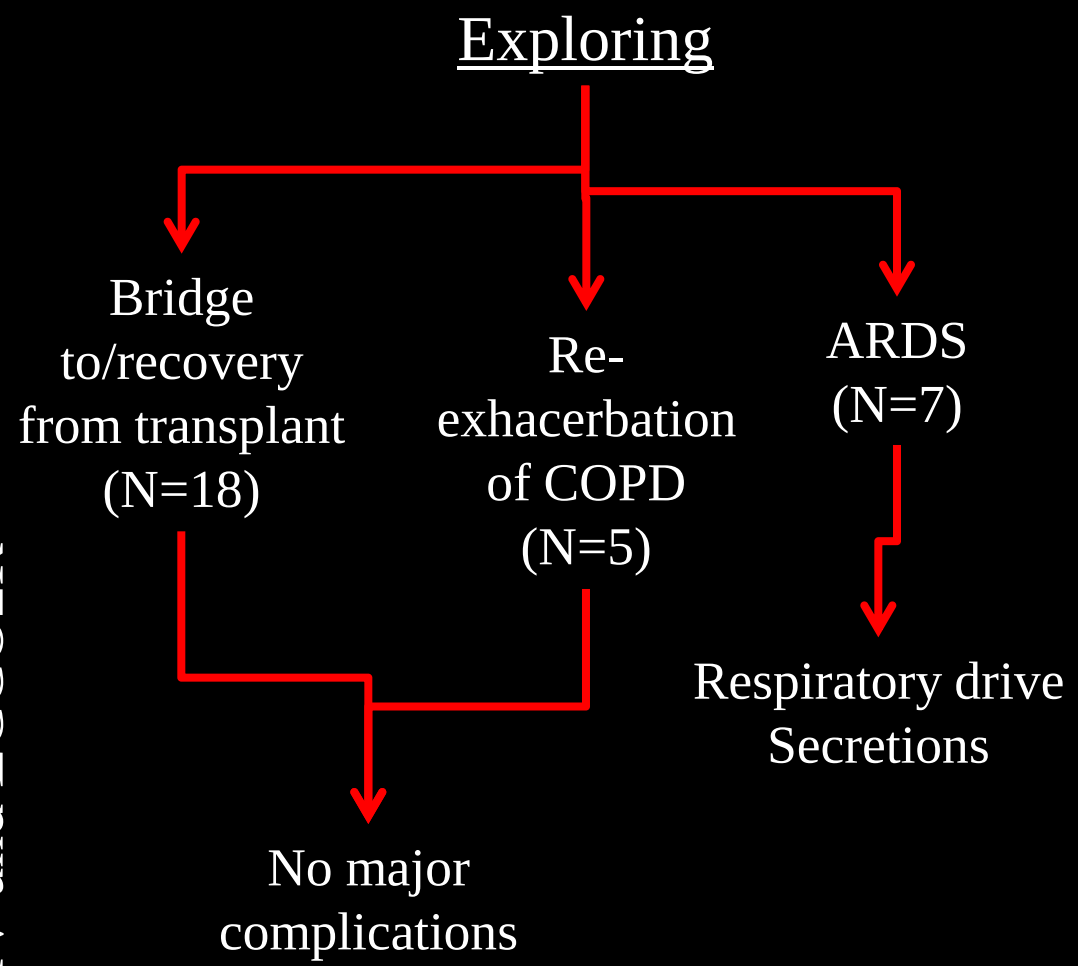
Del Sorbo L et al. CritCare Med 2014 (Epub ahead of print)

Participating units:

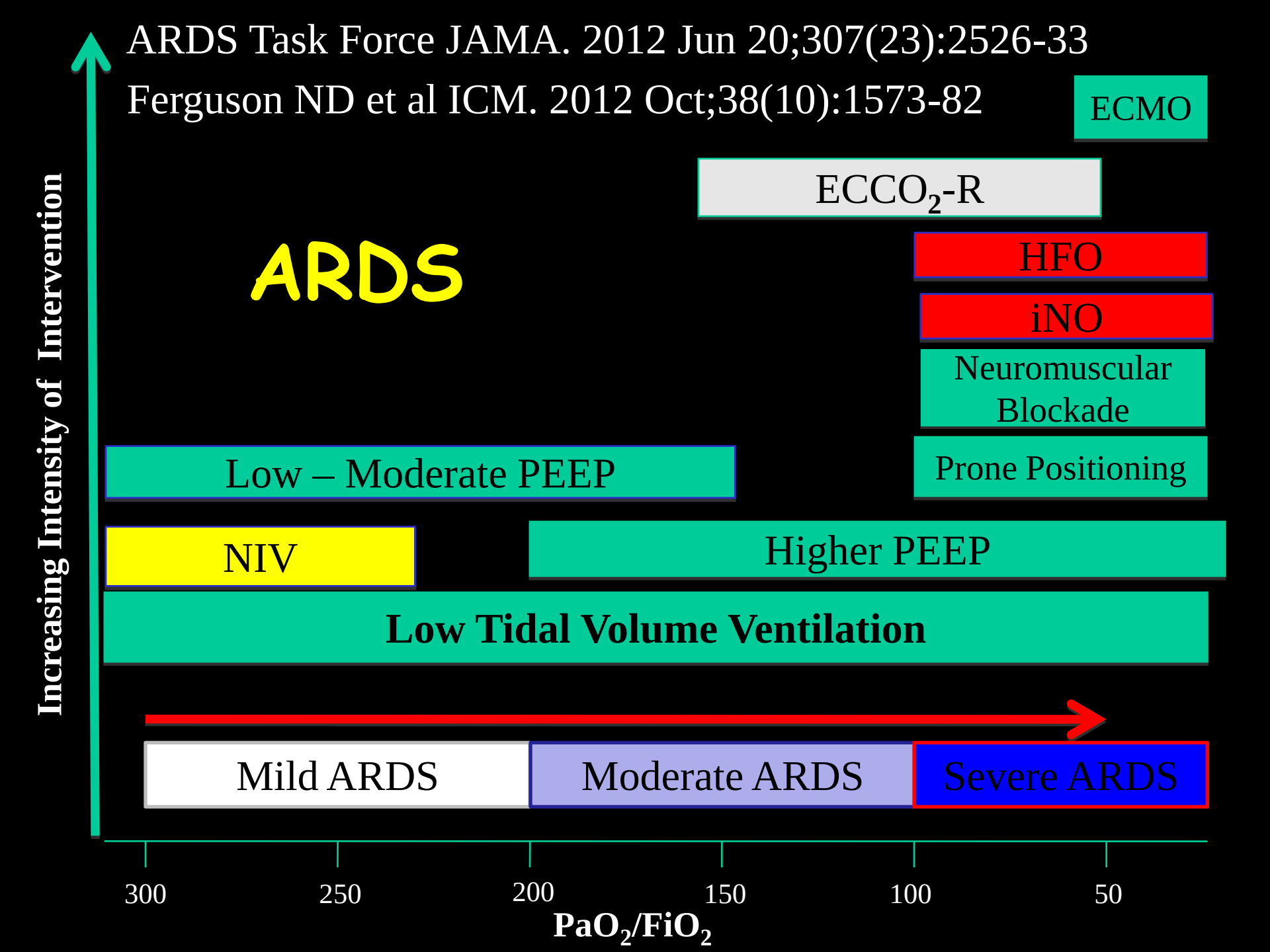
- Policlinico of Milan
- H. San Raffaele (Milan)
- H. San Matteo (Pavia)
- H. San Gerardo (Monza)
- H. Careggi (Firenze)
- Policlinico Santa Maria alle Scotte (Siena)

Mechanical events
Patient 2 clots in the circuit
Patient 6 clots in the circuit
Patient 9 clots in the circuit
Patient 14 clots in the circuit
Patient 16 membrane lung failure
Patient 18 pump malfunction
Patient 19 clots in the circuit
Patient 22 clots in the circuit
Patient 25 pump malfunction
Patient-related events
Patient 1 significant bleeding (hematuria)
Patient 4 significant bleeding (retroperitoneal hematoma)
Patient 13 vein perforation at cannula insertion
Patient 23 significant bleeding (groin)

25 patients
NIV and ECCO2R

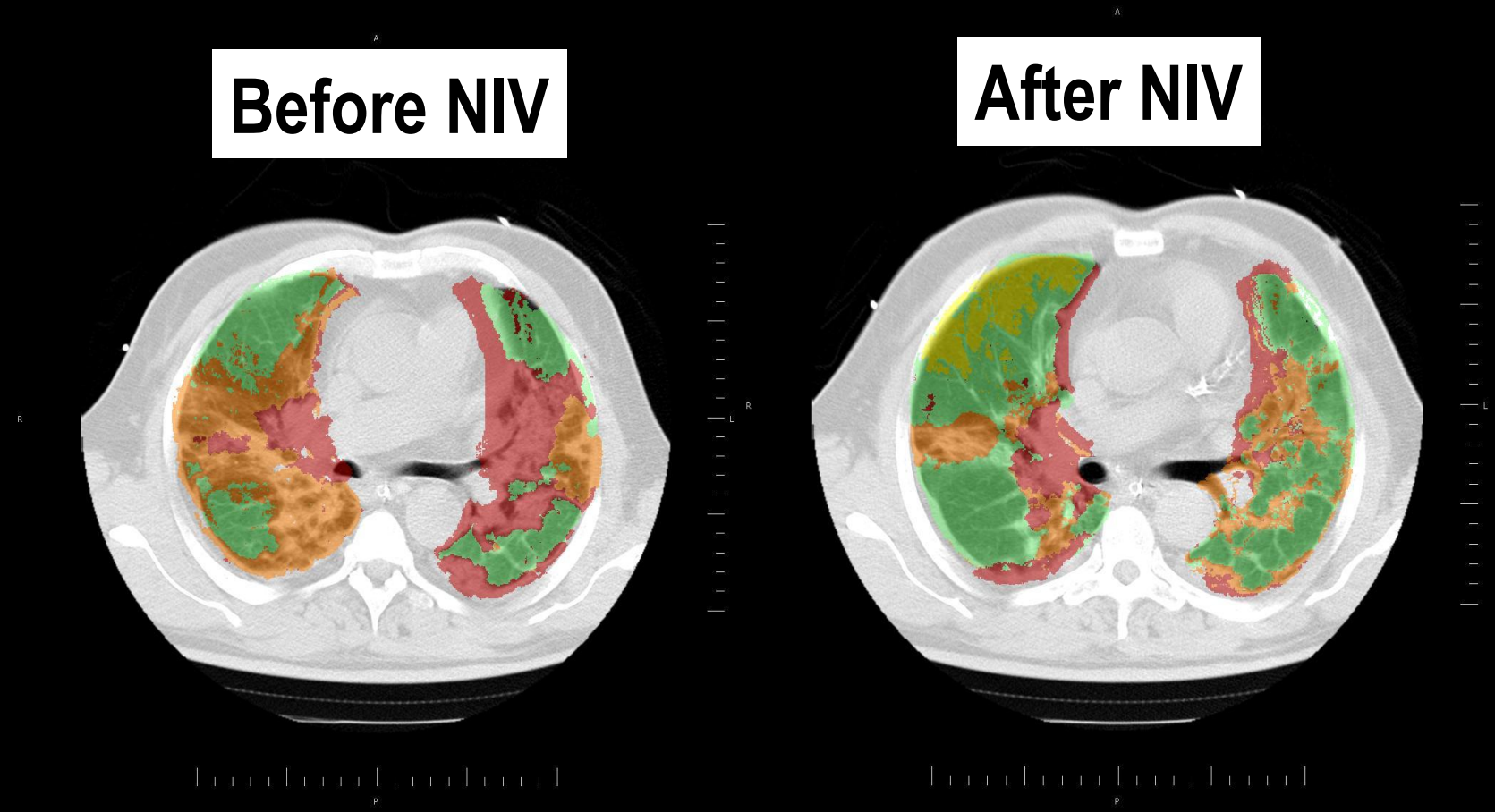


Modified from Prof. Gattinoni


ARDS Task Force JAMA. 2012 Jun 20;307(23):2526-33
Ferguson ND et al ICM. 2012 Oct;38(10):1573-82
ECMO
ECCO2-R
ARDS
HFO
iNO
Neuromuscular Blockade
Prone Positioning
Low – Moderate PEEP
NIV
Higher PEEP
Low Tidal Volume Ventilation
Mild ARDS
Moderate ARDS
Severe ARDS
Increasing Intensity of Intervention
300
250
200
150
100
50
PaO2/FiO2

Non invasive Respiratory Support in ARDS

Pelosi P, Jaber S Current Opinion In Anaesthesiology 2010 Apr; 23(2): 233-8

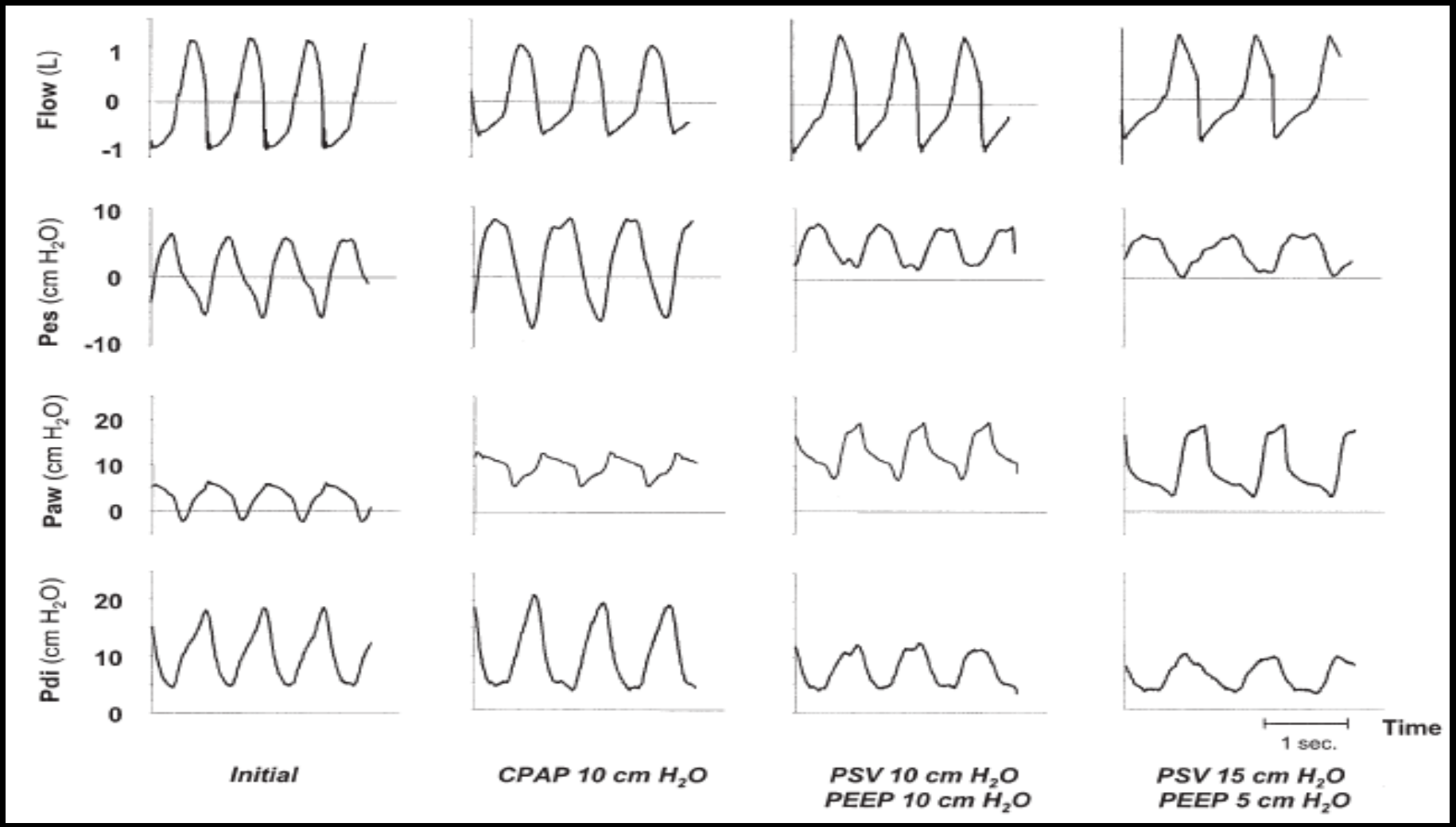


Physiologic Effects of Noninvasive Ventilation during Acute Lung Injury

Am J Respir Crit Care Med 2006

Erwan L'Her, Nicolas Deye, François Lellouche, Solenne Taille, Alexandre Demoule, Amanda Fraticelli, Jordi Mancebo, and Laurent Brochard

Réanimation Médicale–Unité INSERM U492, Hôpital Henri Mondor, Creteil Cedex, France



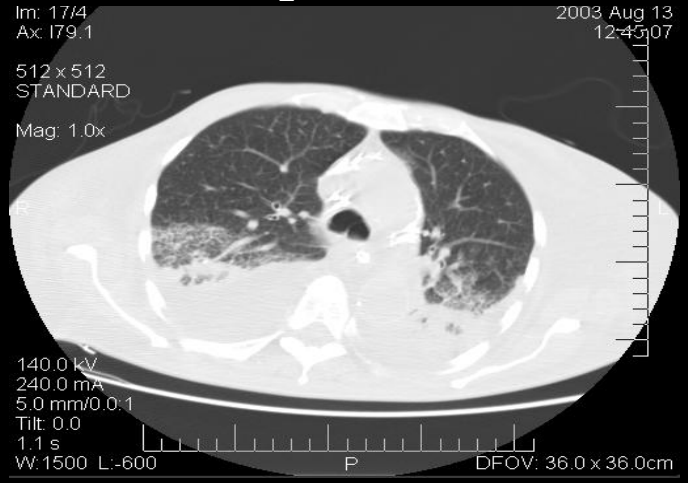
ALVEOLAR RECRUITMENT IN ARDS

Gattinoni L et al. Engl J Med. 2006 Apr 27;354(17):1775-86

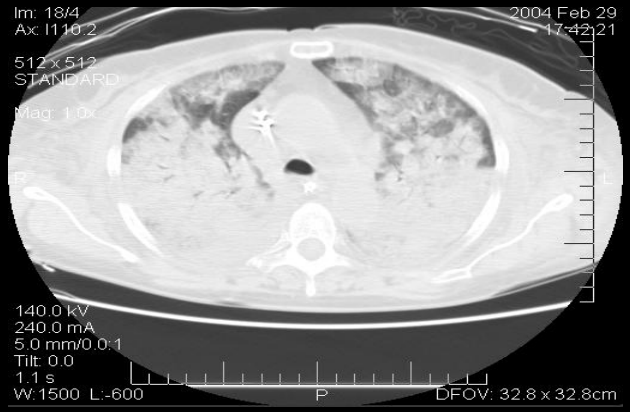
Paw 45cmH_2O

Paw 45cmH_2O

Peep 5 cmH_2O



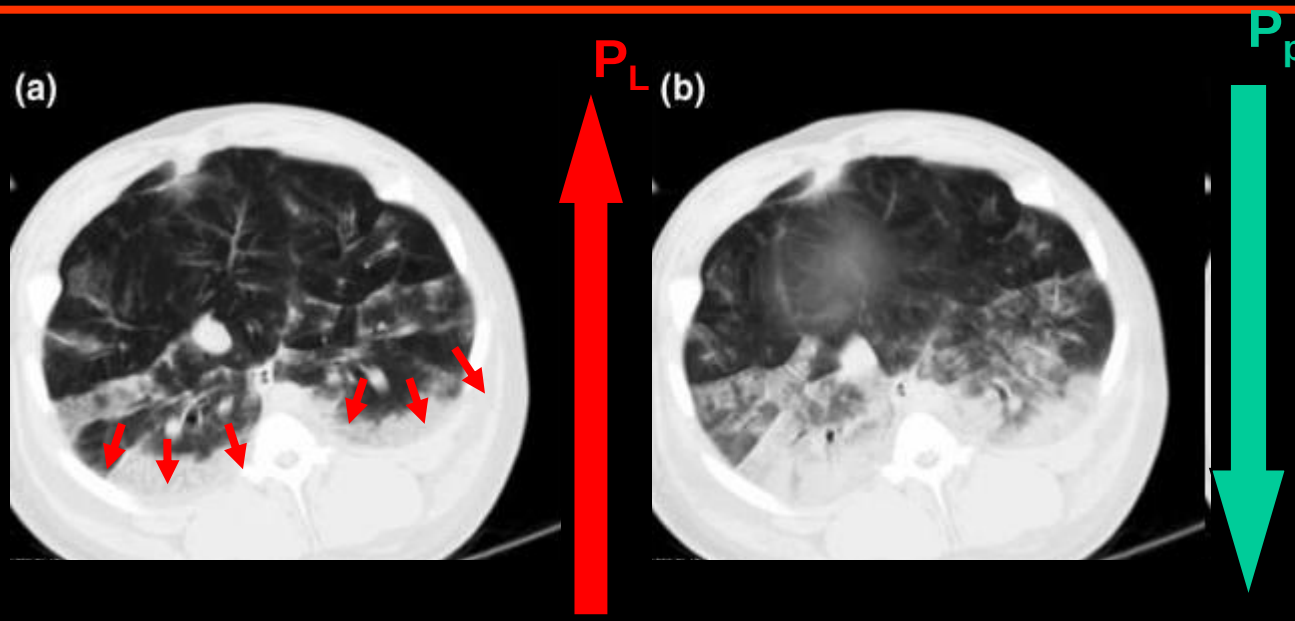
Peep 5 cmH_2O

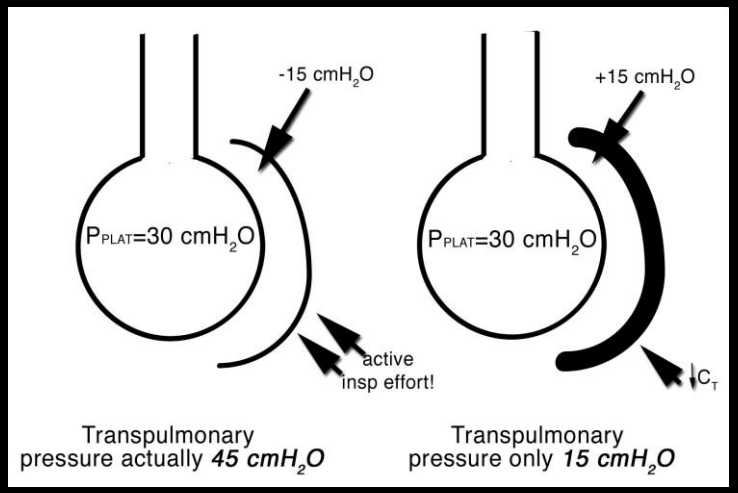


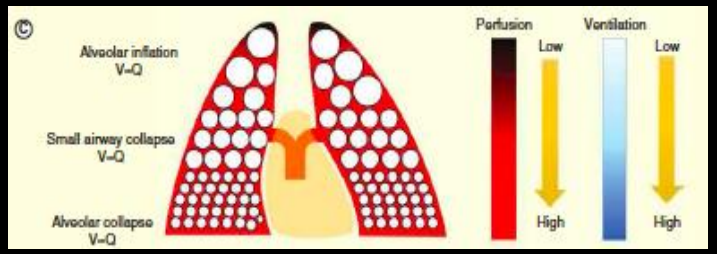
Spontaneous –Assisted Breathing

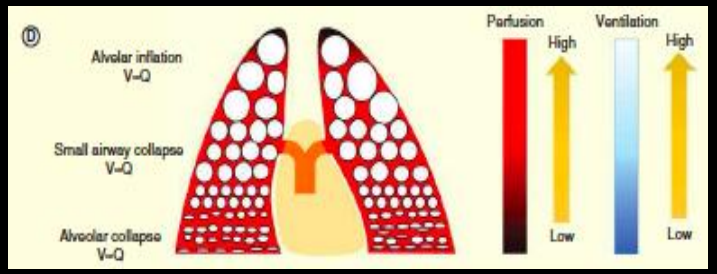
Gama de Abreu M, et al. Curr Opin Anaesthesiol. 2012;25(2):148-55

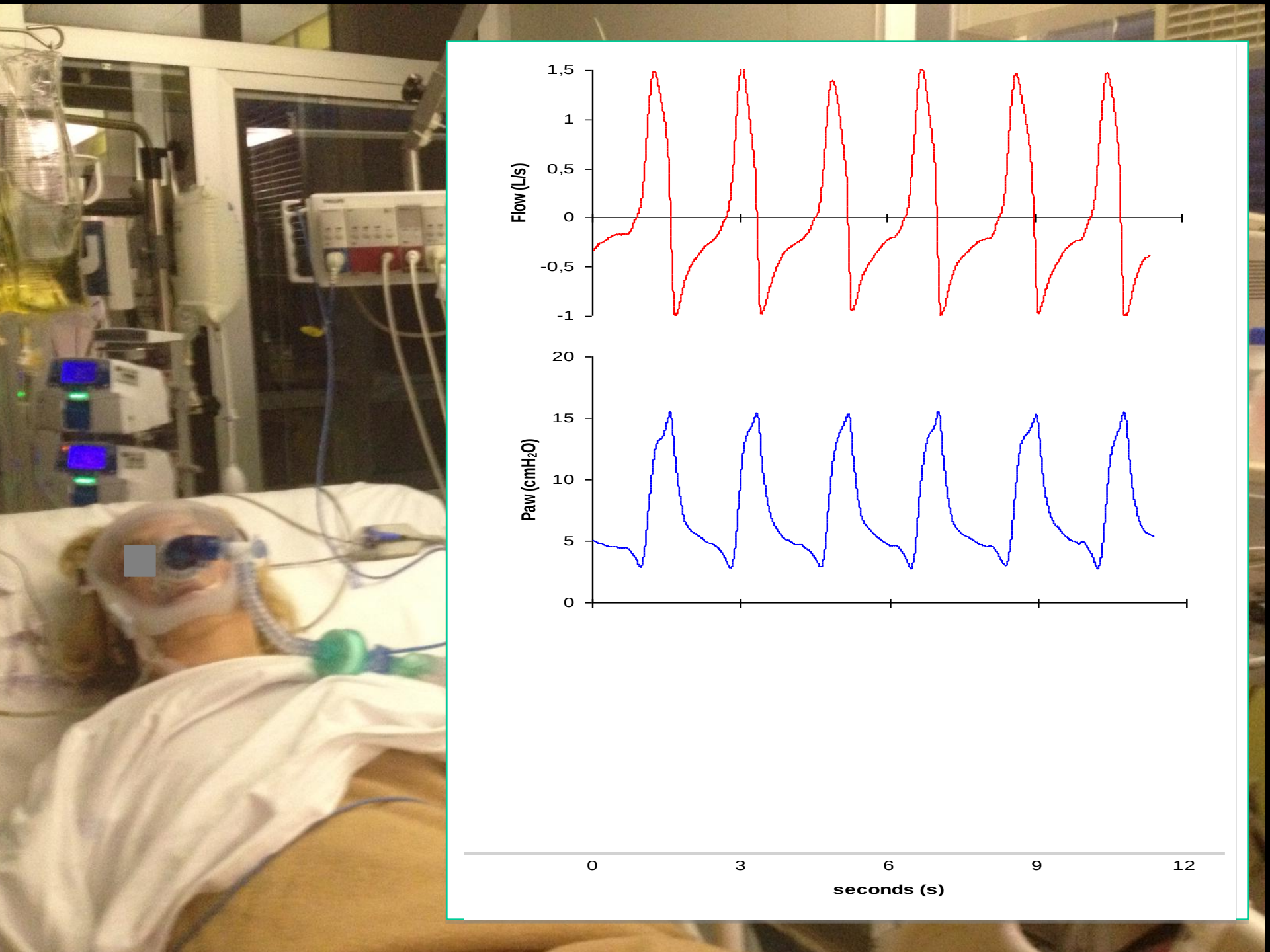
Saddy F et al Semin Respir Crit Care Med. 2014 Aug;35(4):409-17

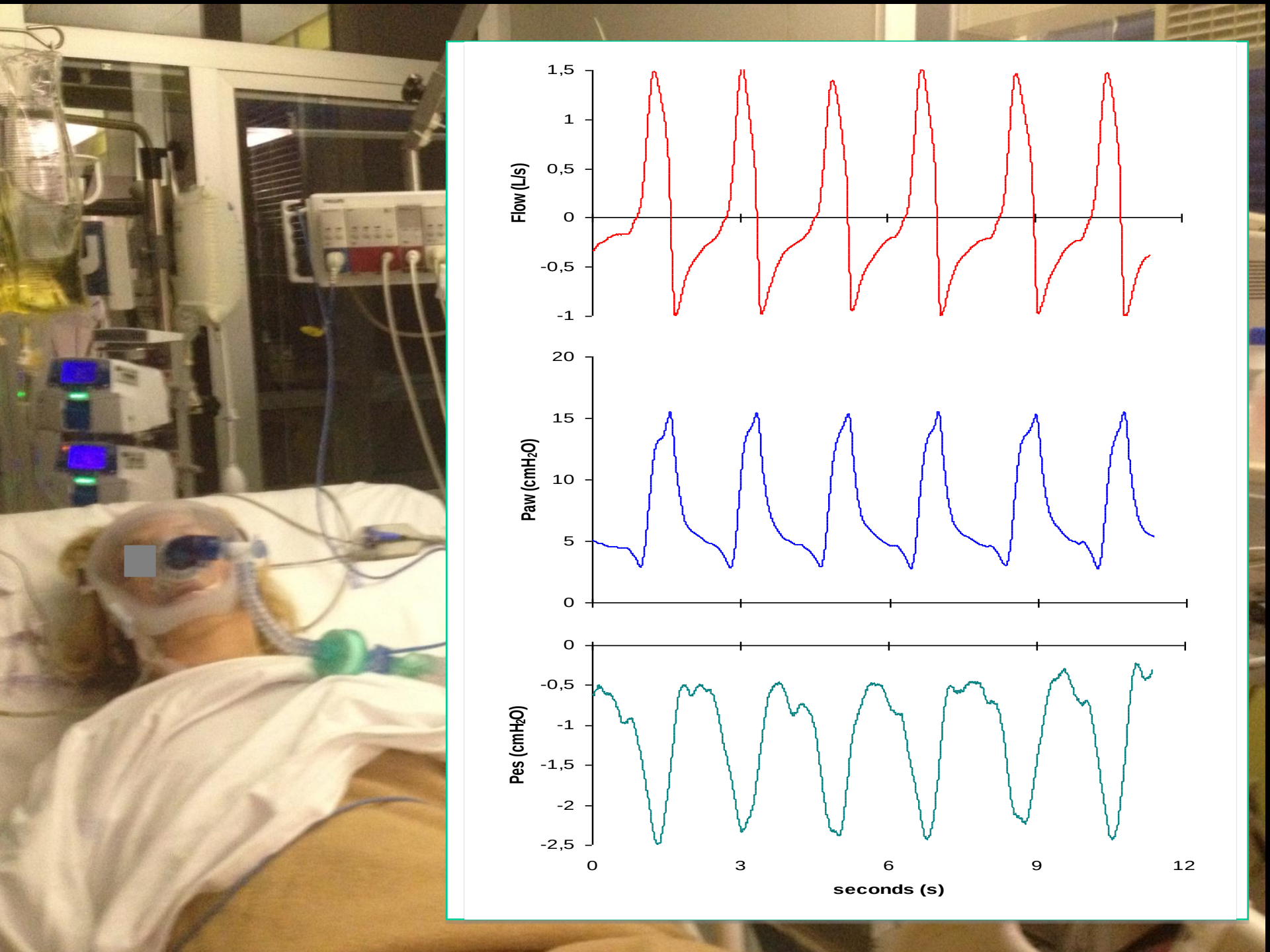









1,5
1
0,5
0
-0,5
-1
Flow (L/s)
20
15
10
5
0
Paw (cmH2O)
0
3
6
9
12
seconds (s)

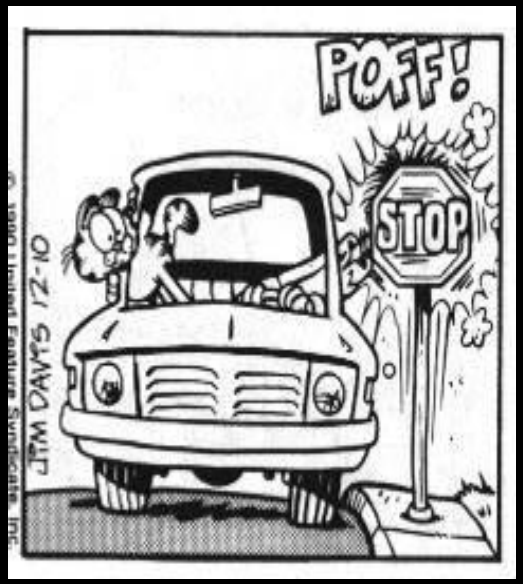

1,5
1
0,5
0
-0,5
-1
Flow (L/s)
20
15
10
5
0
Paw (cmH2O)
0
-0,5
-1
-1,5
-2
-2,5
Pes (cmH2O)
0
3
6
9
12
seconds (s)

When to Start - Stop NIV in ARDS ?

Rana C et al. Crit Care 2006;10:R79; Antonelli M et al. CCM 2007;35:18-25

Pelosi P, Jaber S Current Opinion In Anaesthesiology 2010 Apr; 23(2): 233-8

Start NPPV:



- MV < 15 L/min
- Absence of Shock
- BE > - 5 mEq/L
- PaO_2/FiO_2 > 120 mmHg
- Lobar Densities at Chest X Ray
- Ability to cough and clear secretions

Stop NPPV :

- PaO_2/FiO_2 < 175 mmHg after 1-4 Hours

Noninvasive Ventilation for ARDS ?

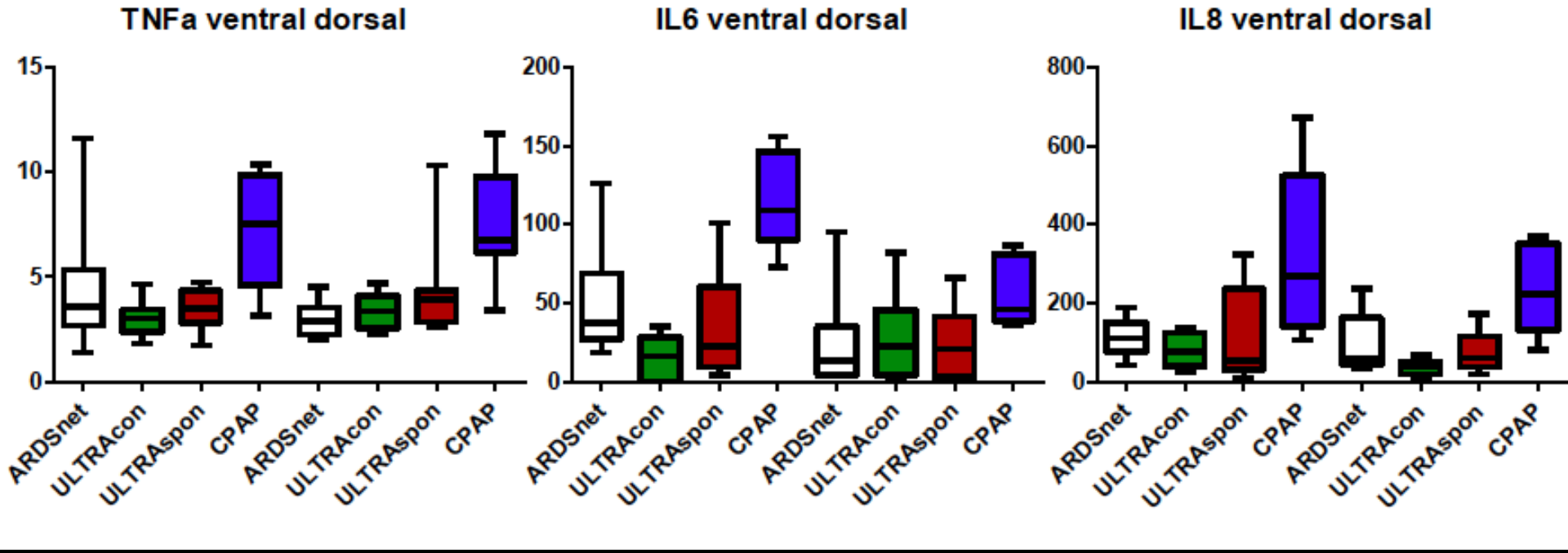
Pelosi P, Jaber S Current Opinion In Anaesthesiology 2010 Apr; 23(2): 233-8

Which is the “Optimal Ventilation” during UP-MV and ECCO2R ?

Guldner A, et al Anesthesiology 2014 (Epub Ahead of Print)

- ULTRAspont and CPAP improves Gas-Exchange and Mechanics
- CPAP increase inflammatory mediators

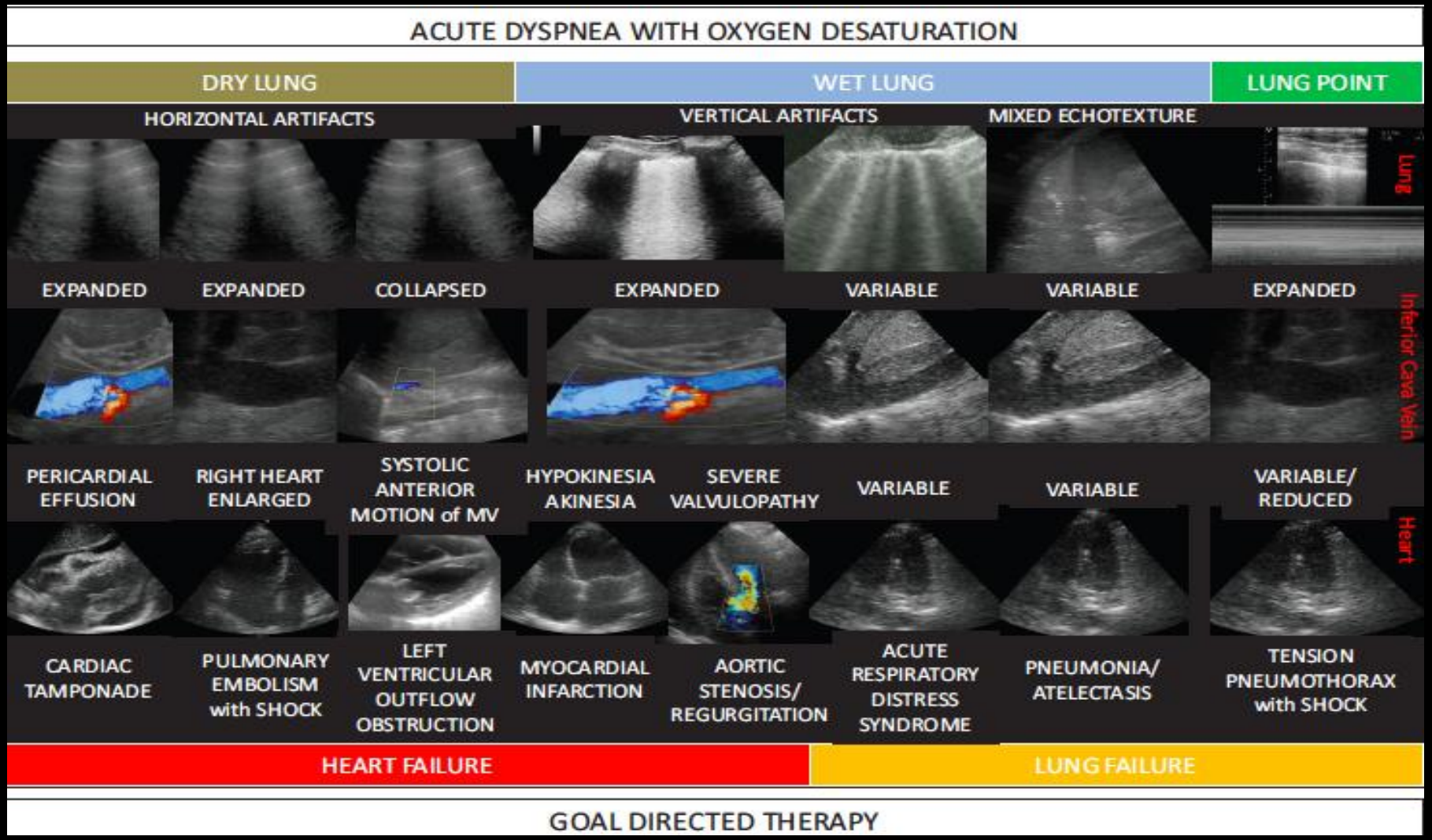
ULTRAspont (APRV and Spont) seem to be the “Optimal Ventilation Setting” during ECCO2-R



Ultrasonography in ICU: Lung, Heart, & Volemia

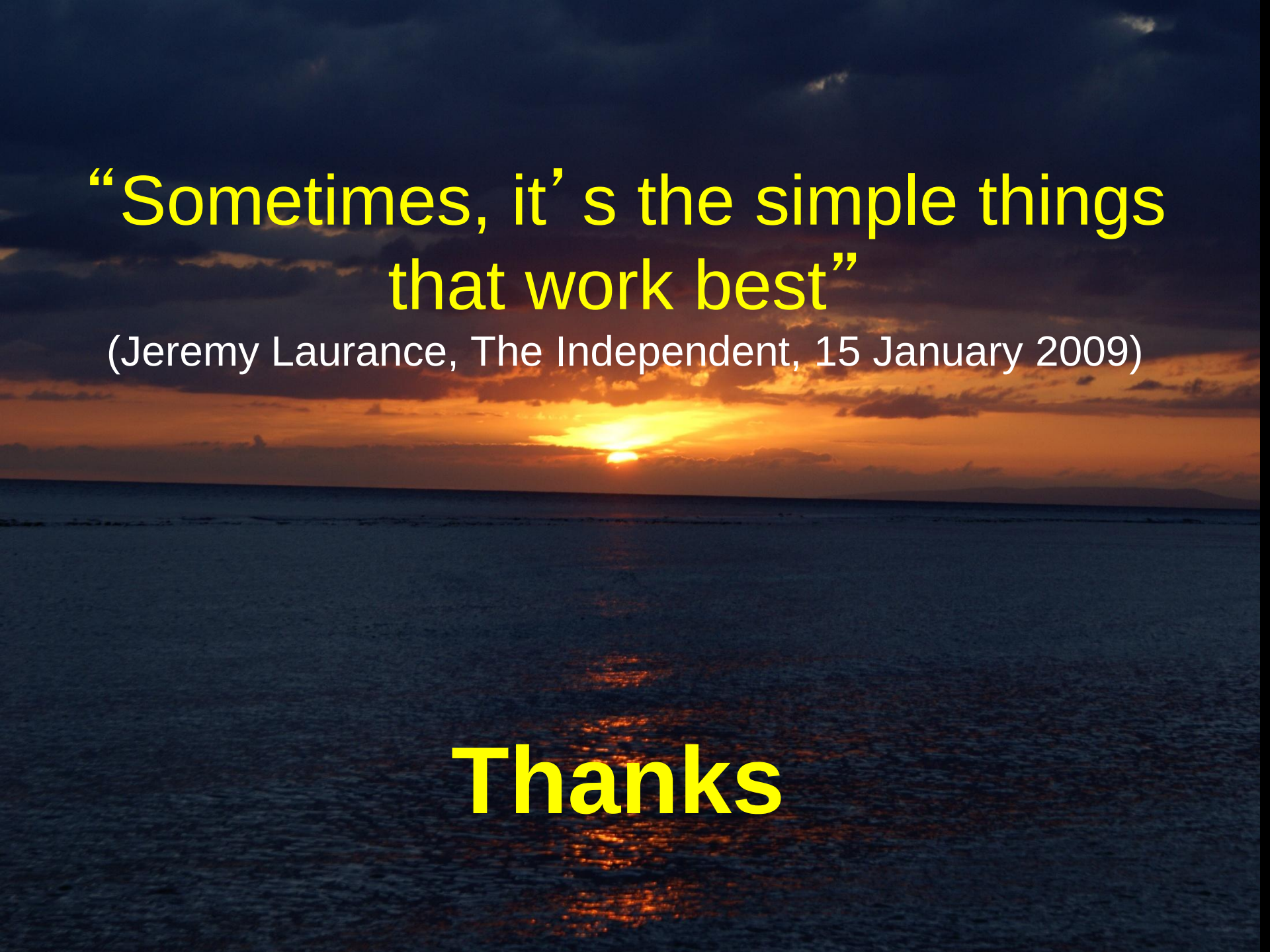
Pelosi P, Corradi F Anesthesiology 117(4):696-698, 2012

Corradi F, Brusasco C, Pelosi P Curr Opin Crit Care. 2014 Feb;20(1):98-103



Evidence to support the use of NPPV for different types of Acute Respiratory Failure

LEVEL OF EVIDENCE	EVIDENCE
Strong (Multiple positive Controlled Trials)	COPD exacerbations ACPE (CPAP) Immunocompromised patients Facilitation of weaning in COPD Avoidance of re-intubation in COPD
Intermediate (Single positive Controlled Trial/ Multiple Case Series)	Pre-intubation oxygenation Prevention (CPAP)/ Treatment of Postoperative Respiratory Failure Diagnostic procedures
Poor/Absent (Multiple negative/conflicting Controlled Trials)	ARDS Avoidance of re-intubation


“Sometimes, it’s the simple things that work best”
(Jeremy Laurance, The Independent, 15 January 2009)
Thanks