Gestire un paziente intubato connesso al ventilatore:

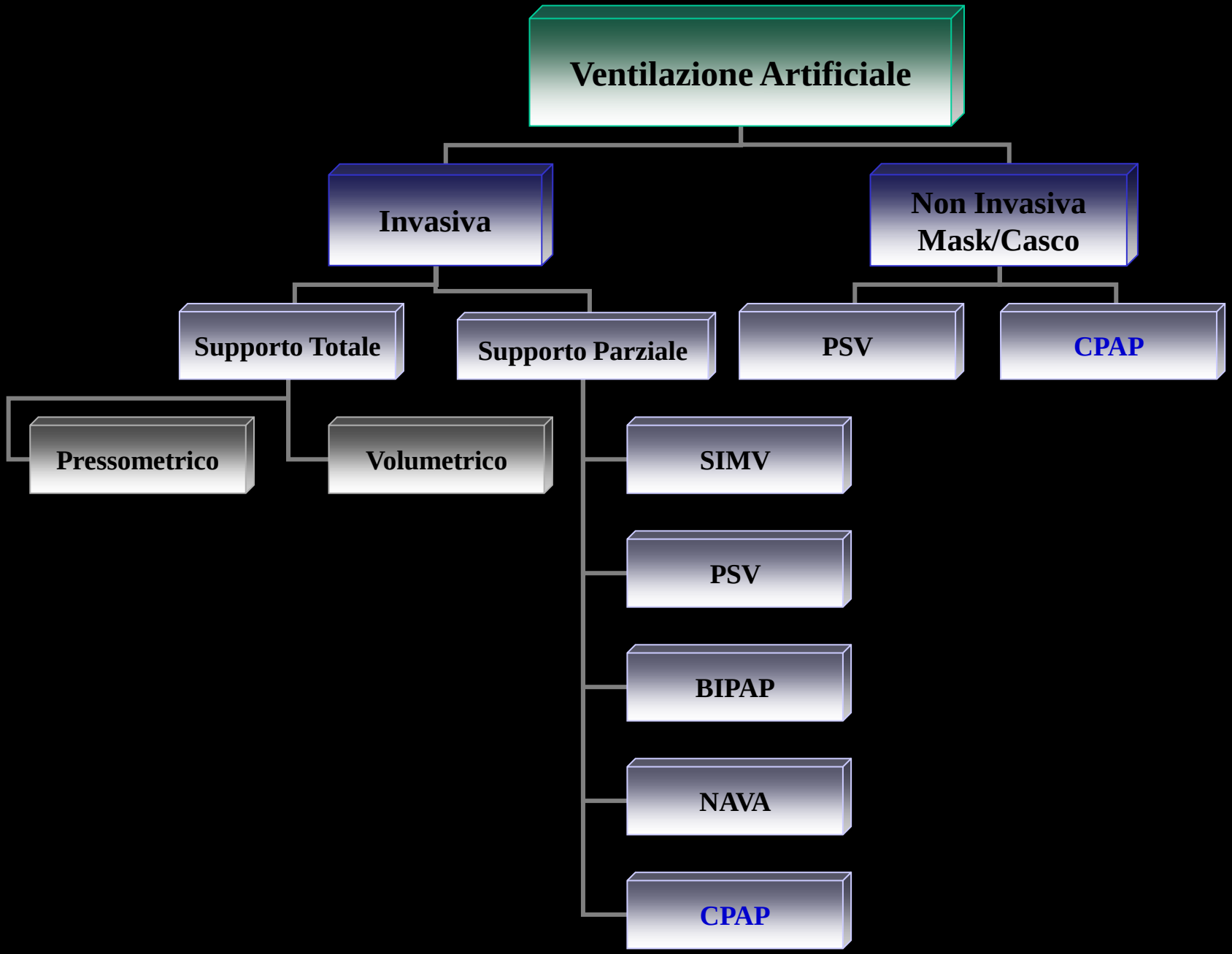
gli elementi essenziali da controllare,
le modalità di ventilazione, prevenire le complicanze

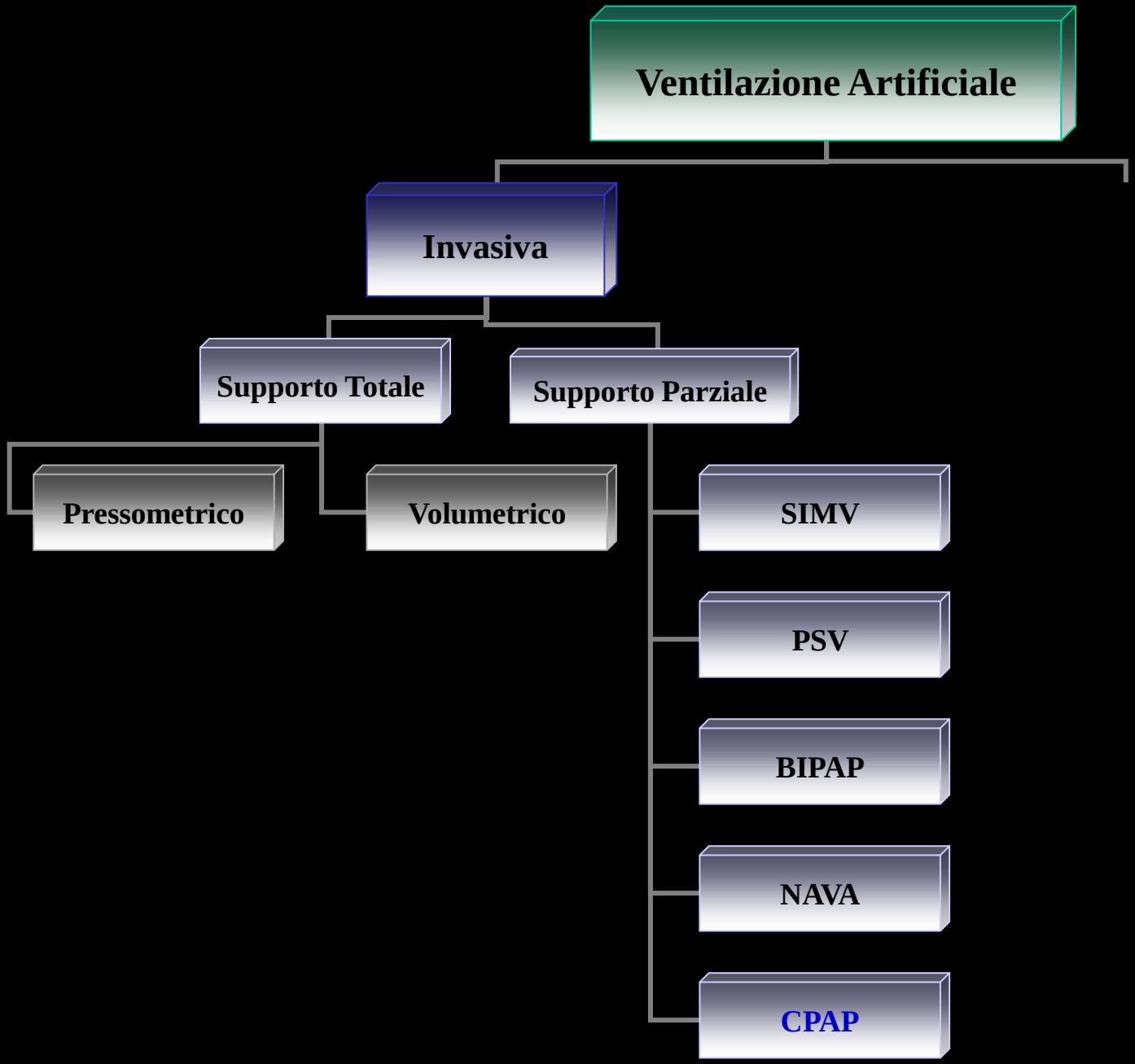
Giuseppe Foti

UOS Terapia Intensiva Generale
Az. Ospedaliera S. Gerardo Monza

UOC Anestesia e Rianimazione 2
Ospedale A. Manzoni Lecco

Milano 28 Novembre 2011


Ventilazione Artificiale
Invasiva
Non Invasiva
Mask/Casco
Supporto Totale
Supporto Parziale
PSV
CPAP
Pressometrico
Volumetrico
SIMV
PSV
BIPAP
NAVA
CPAP


Ventilazione Artificiale
Invasiva
Supporto Totale
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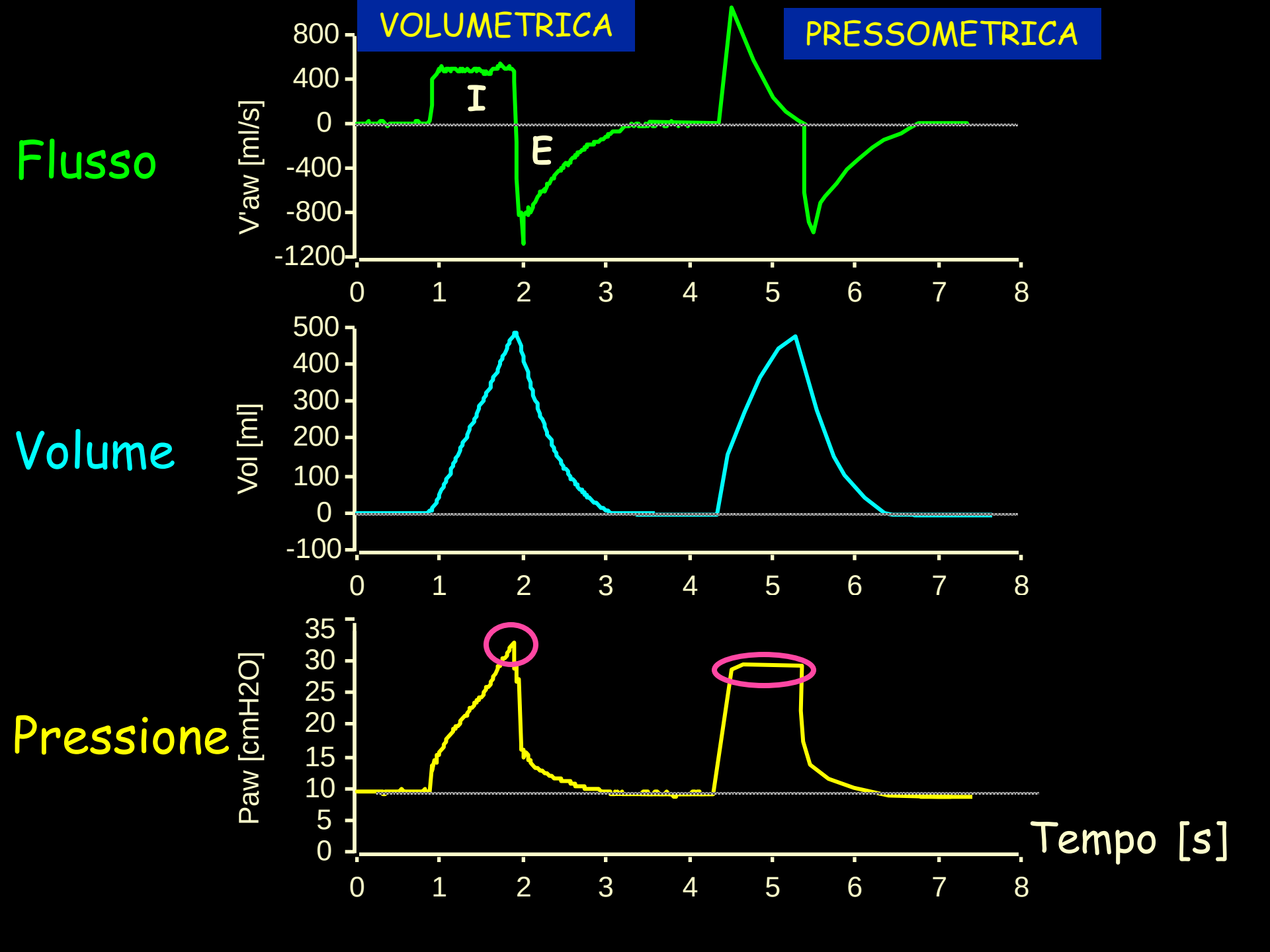
Pressometrico
Volumetrico
SIMV
PSV
BIPAP
NAVA
CPAP


VOLUMETRICA
PRESSOMETRICA
Flusso
Volume
Pressione
V'aw [ml/s]
Vol [ml]
Paw [cmH2O]
I
E
800
400
0
-400
-800
-1200
500
300
200
100
-100
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
Tempo [s]

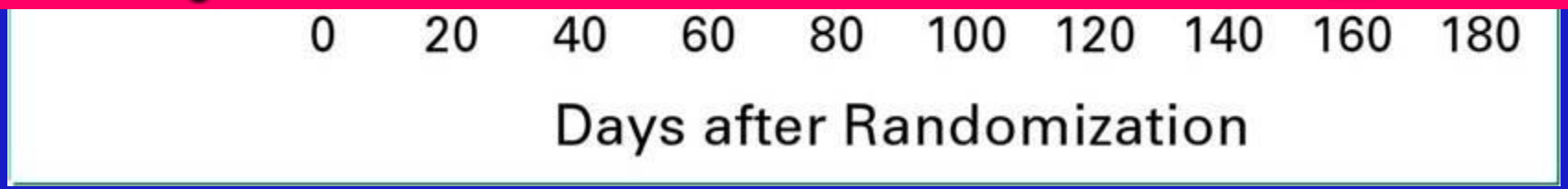
…. con la pressometrica si riduce il PICCO e quindi è meno barotraumatica….

- Del PICCO nun ce ne potrebbe fregà de meno
- Il PICCO è nei tubi, negli alveoli c'è la Pplateau
- Il barotrauma dipende da Volume Corrente e Pplateau

Scelta del Volume corrente

Volume corrente 6 ml/kg

Pplat < 30 cmH_2O



Ridurre spazio morto !

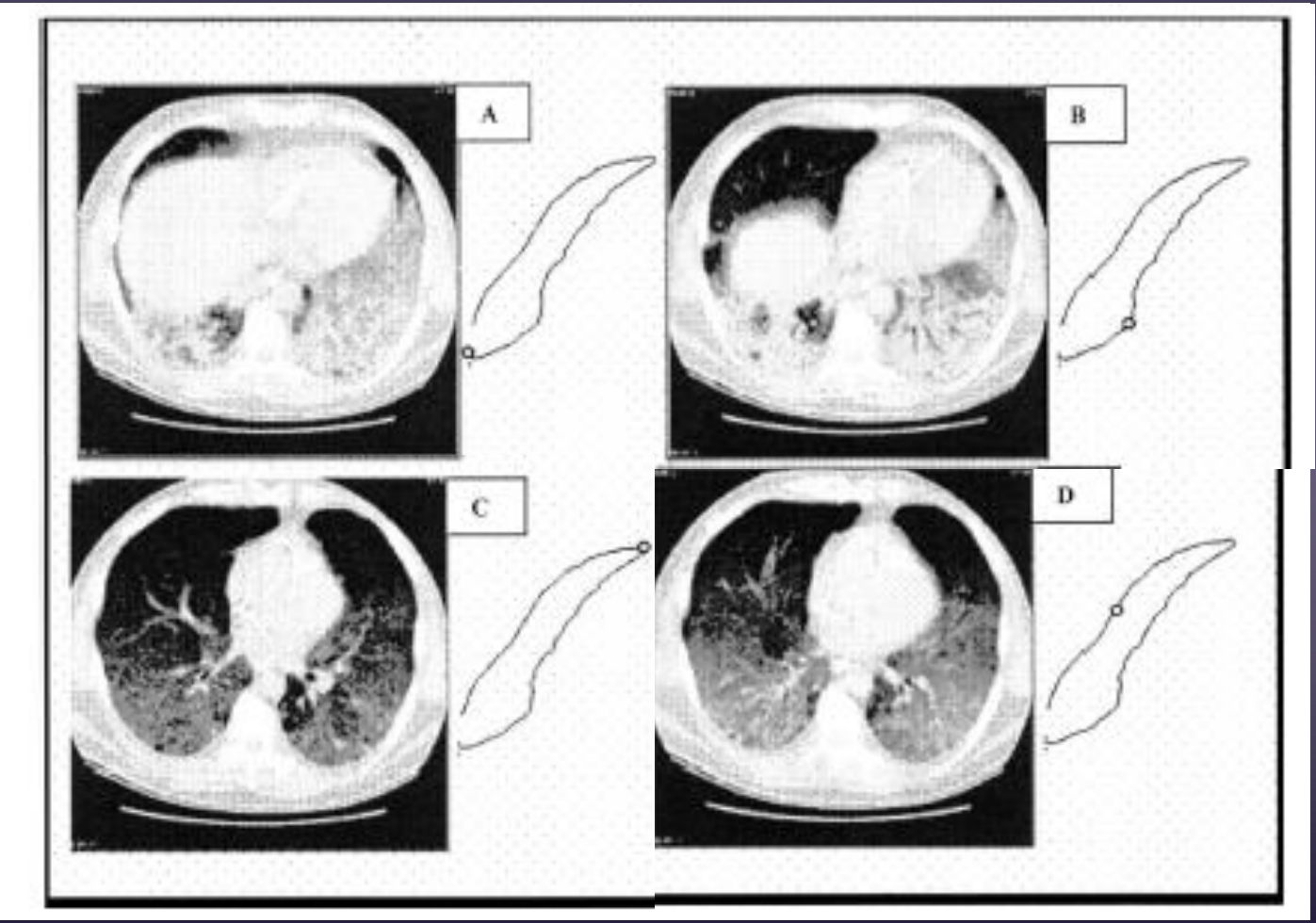
- **MAI filtro HME in ALI-ARDS**

80ml spazio morto

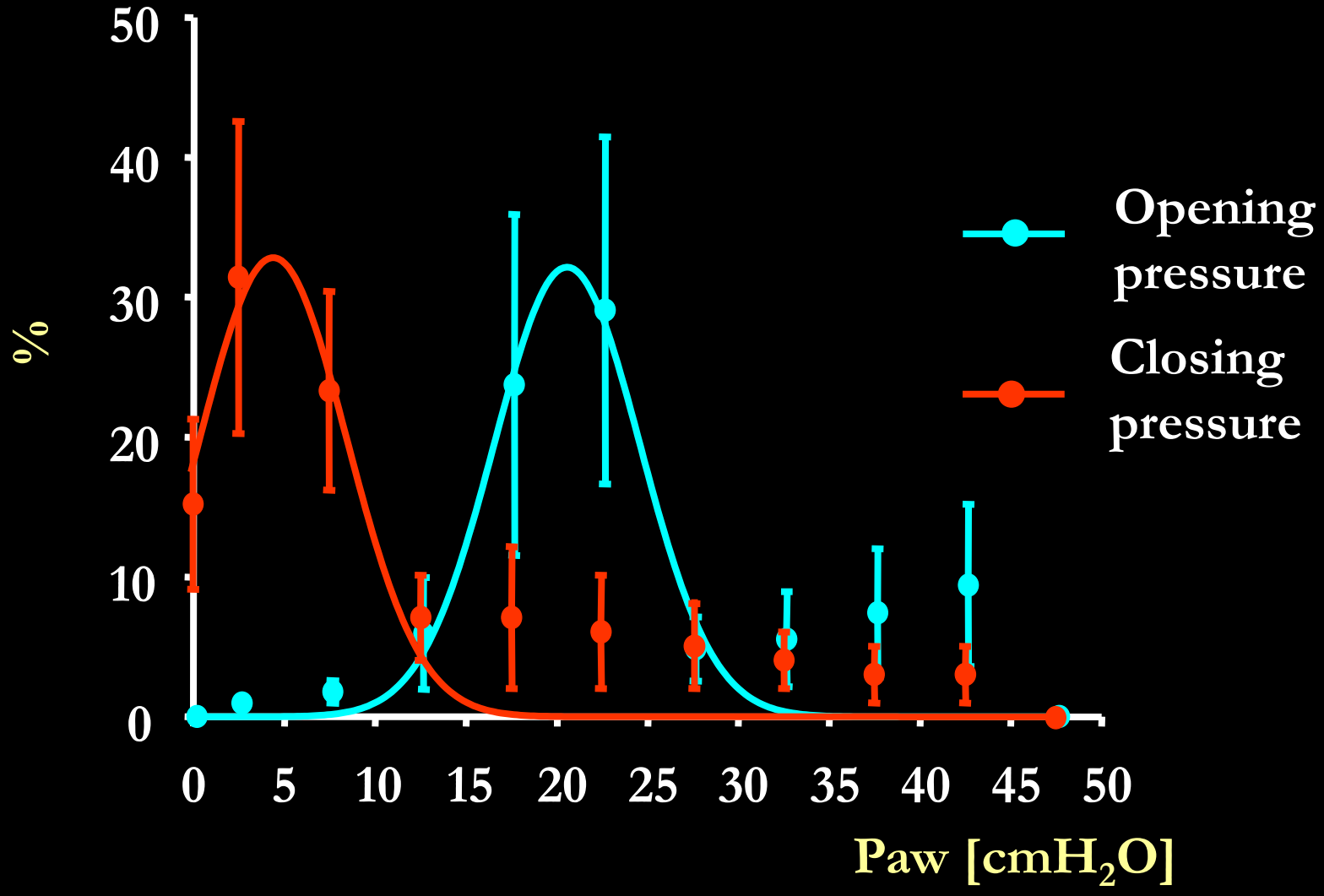
(60 Kg., TV 360 – (100 $_{\text{Vd/Vt an.}}$ -80 $_{\text{HME}}$ - 70 $_{\text{Vd/Vt alv}}$) = 110 ml VA

- **Usare umidificazione attiva**
- **Rimuovere corrugati lunghi**

Moderna gestione dell'ipossia

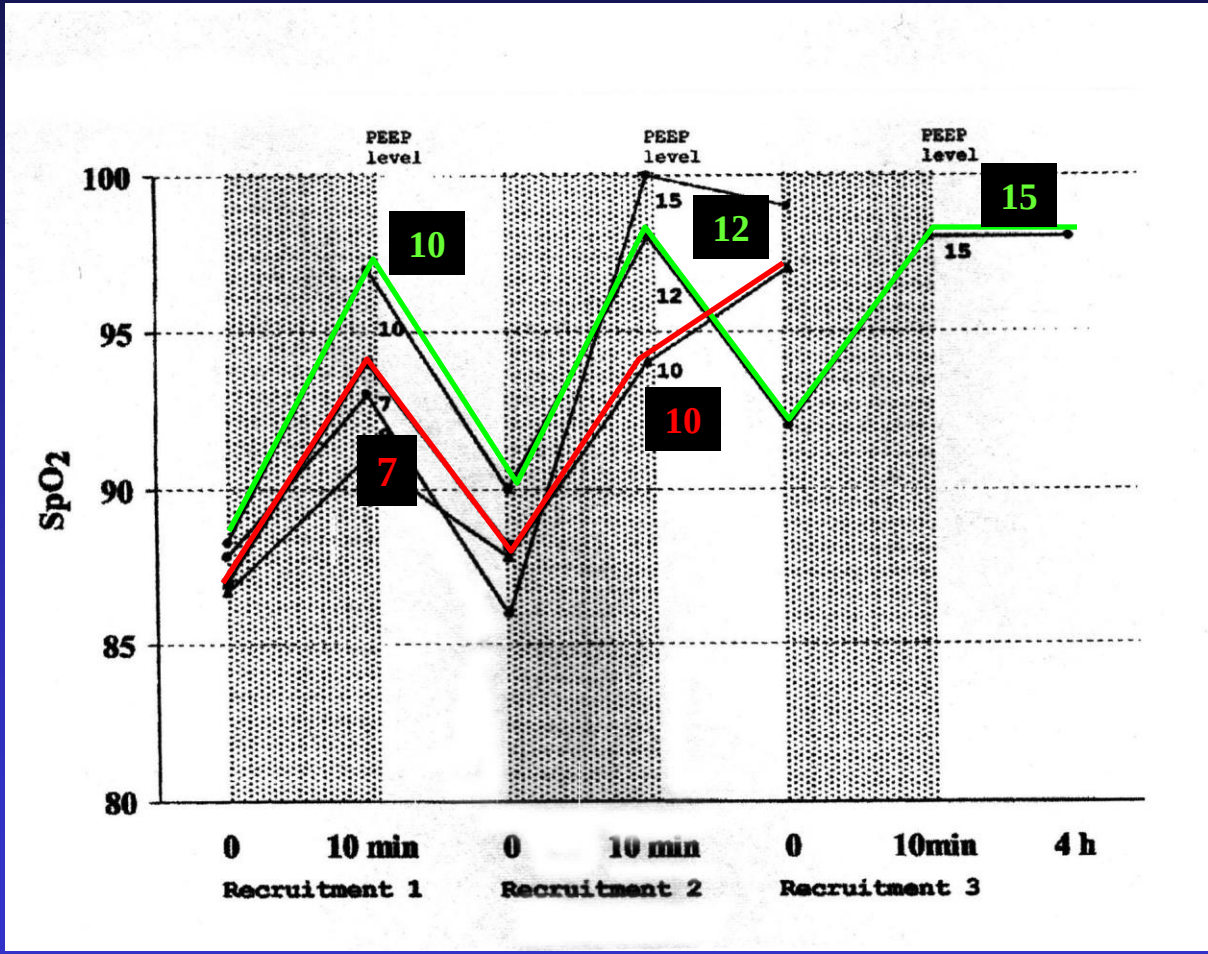


Opening and closing pressures

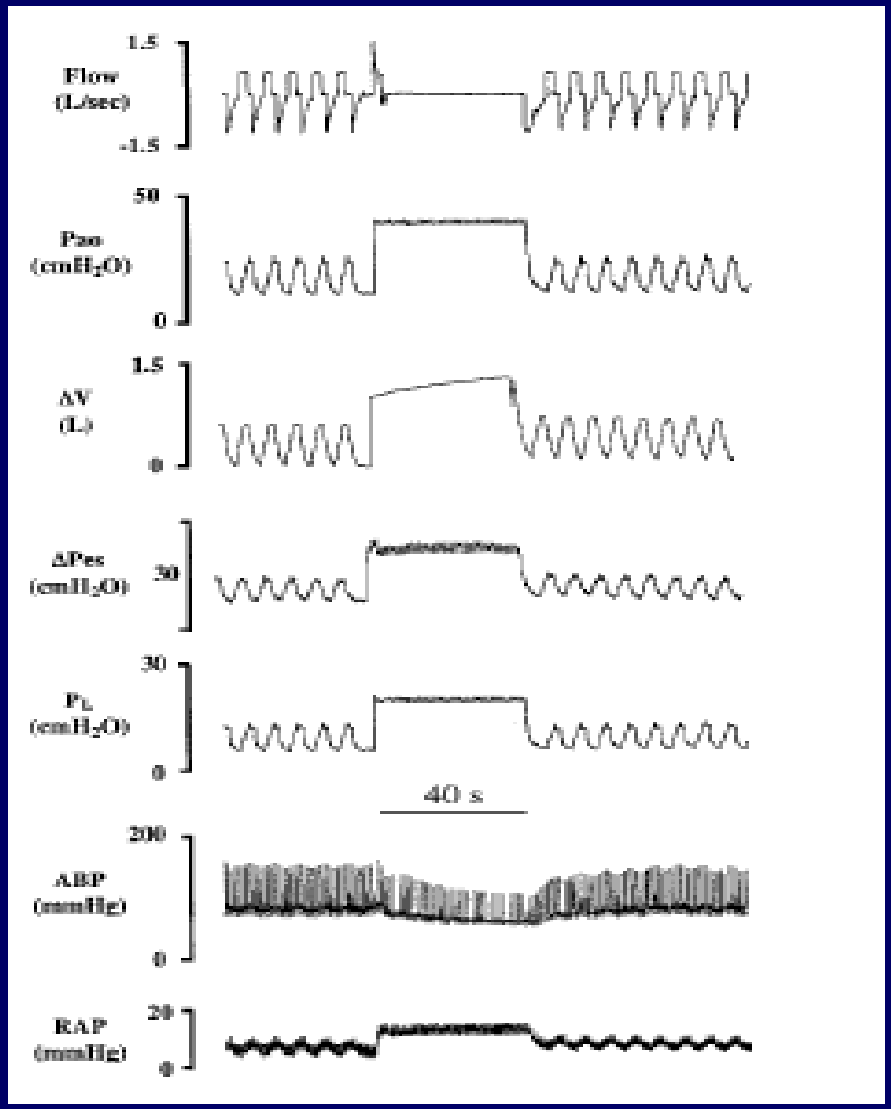


Crotti et al. *Am J Respir Crit Care Med* 2001

Recruitment manoeuvre & PEEP selection



Manovra di Reclutamento



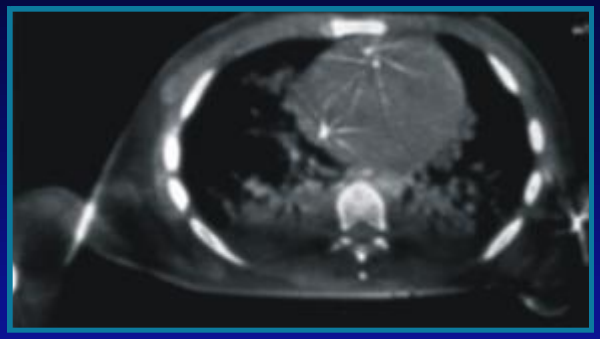
Ricetta manovra di reclutamento

- **Il reclutamento prende tempo**
- **Assicuratevi che flusso inspiratorio = 0**
- **Pressometrica >>> Volumetrica**
- **Non usate le pause di fine inspirazione**
- **NON USATE AMBU**
  - **Controllo PAW**
  - **Controllo FiO2**
  - **Connessione / deconnessione**

Non Recruiter

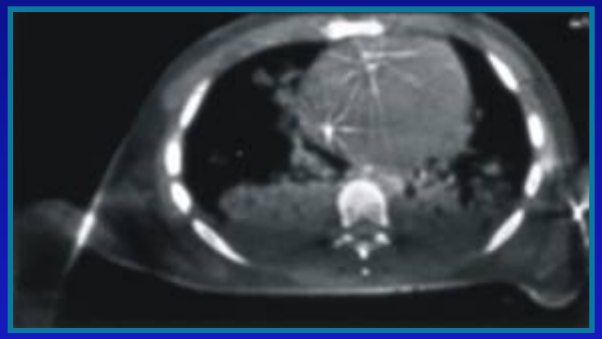
15 cm H_2O

PaO_2: 104 mm Hg



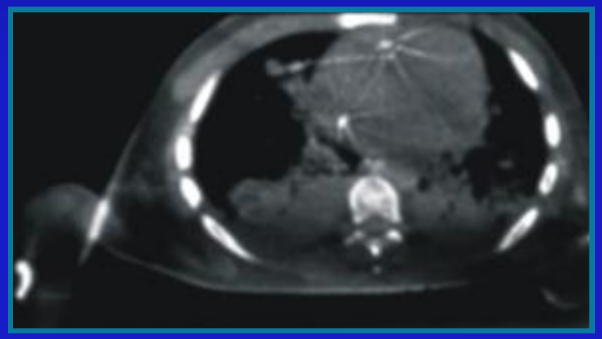
10 cm H_2O

PaO_2: 103 mm Hg



5 cm H_2O

PaO_2: 97 mm Hg

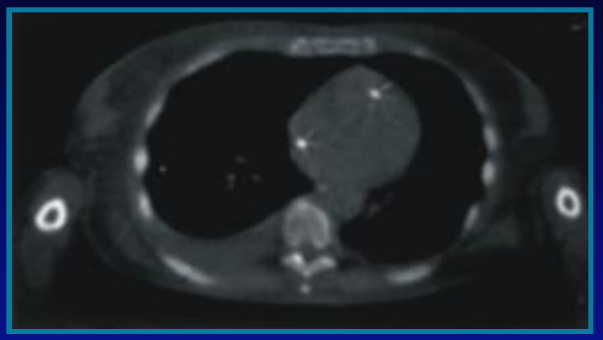


Polmonite

Recruiter

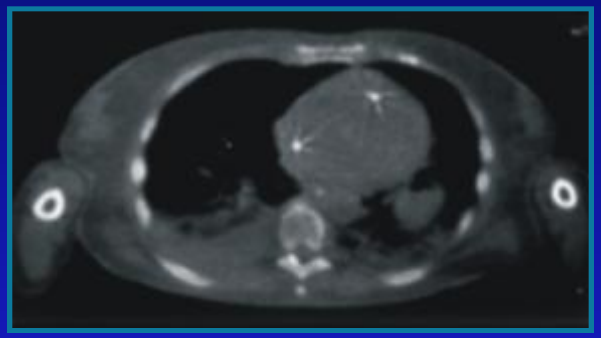
15 cm H_2O

PaO_2 : 141 mm Hg



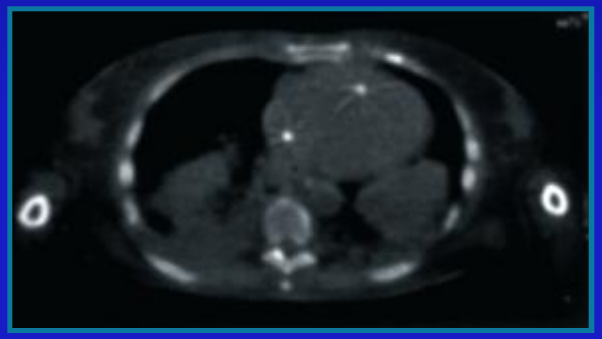
10 cm H_2O

PaO_2 : 69 mm Hg



5 cm H_2O

PaO_2 : 54 mm Hg



Sepsi addominale

Spo2 e RM's

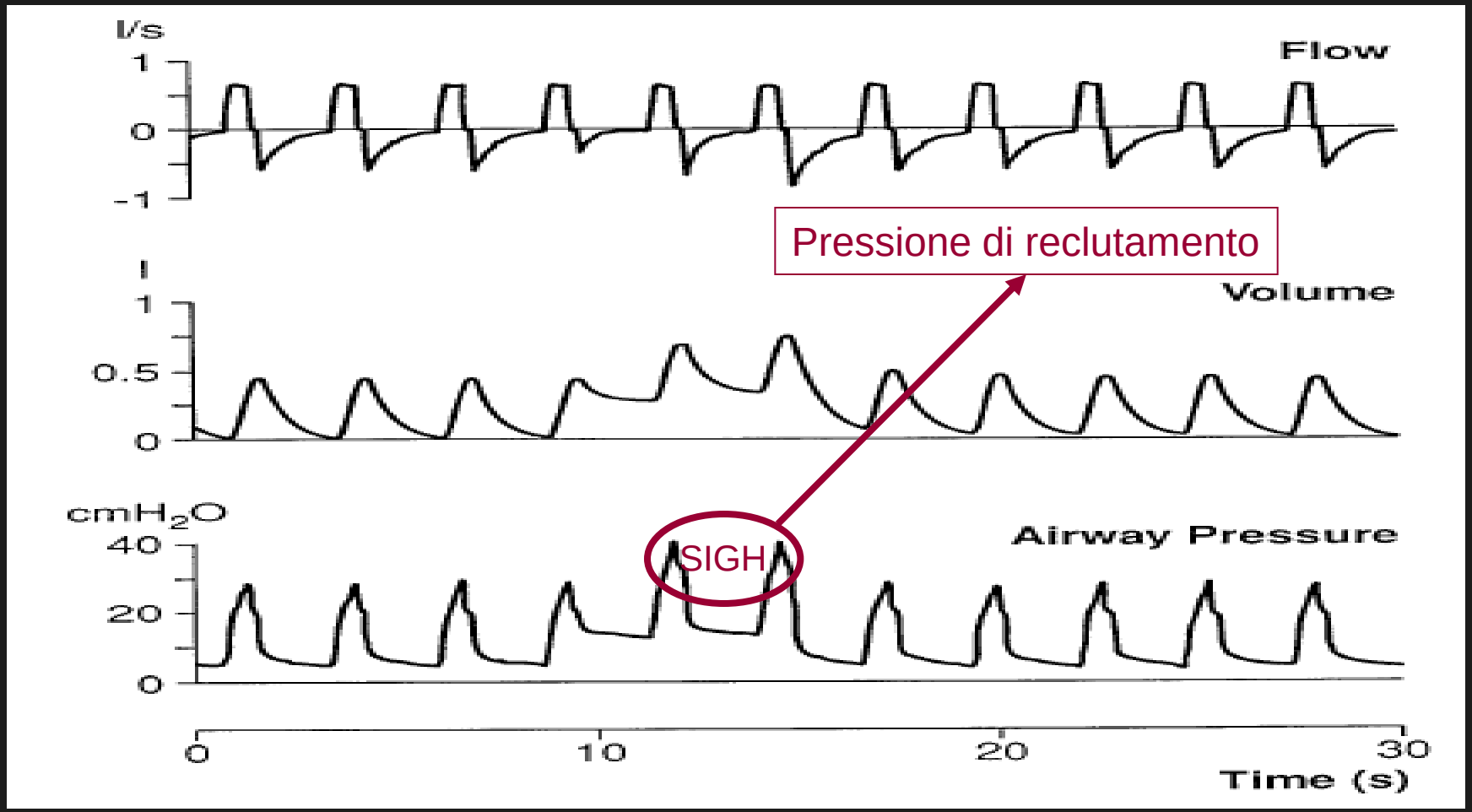
- ↑ ➲ Problema risolto !
  Era un'atelettasia
- ↑ e poi ↓ ➲ Ripeto e ↑ PEEP
- ± ➲ ↑ Pressione Rm's oppure **aspetto**

Quante RM's ?

- Pochissime se uso SIGH
- In Controllata e Assistita
- Che pressione ? ➲ quella di reclutamento
- A chi ? ➲ A quelli che reclutano

Effects of periodic lung recruitment maneuvers on gas exchange and respiratory mechanics in mechanically ventilated ARDS patients.

G. Foti, M.Cereda, M.E. Sparacino, L. De Marchi,F. Villa, A. Pesenti
Intensive Care Med (2000) 26: 501-507

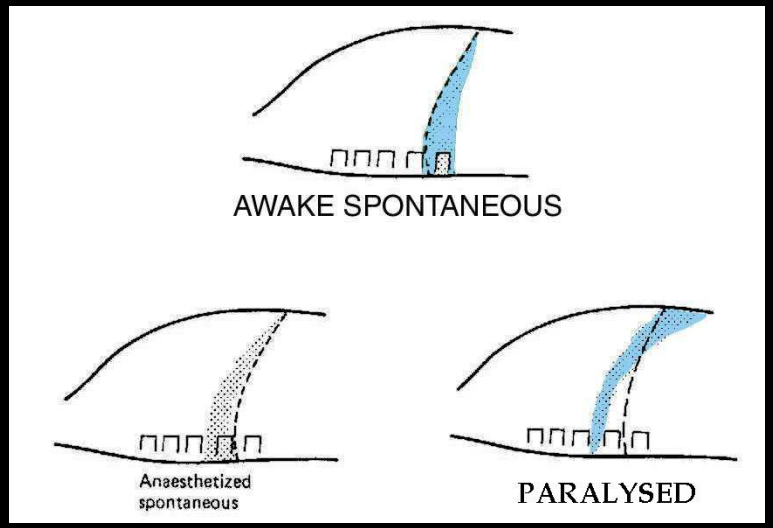


↑Oxygenation
↓ Qva/Qt

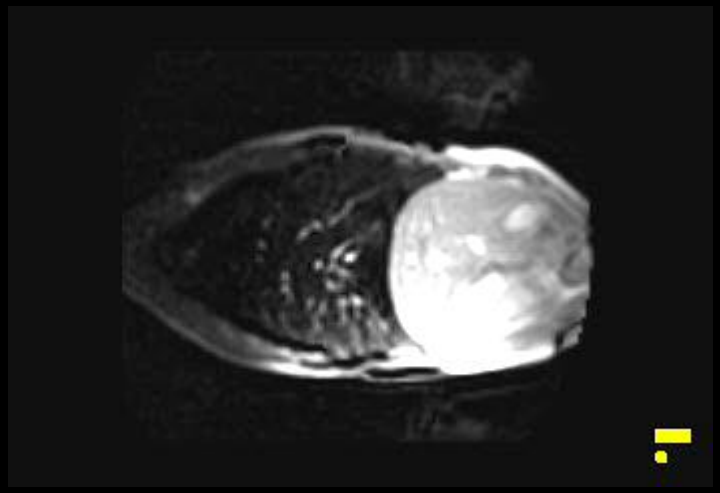
Perchè la Ventilazione Assistita?

- Reclutamento zone declivi
- Riduzione effetti emodinamici negativi
- Prevenzione atrofia da disuso dei muscoli respiratori
- Riduzione sedazione, stop curaro

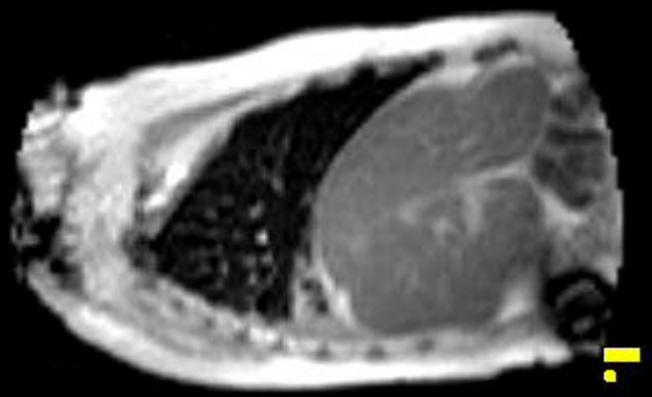
Effetti dell'attività diaframmatica sulla distribuzione della ventilazione



spontaneous breathing



controlled ventilation, NMBA

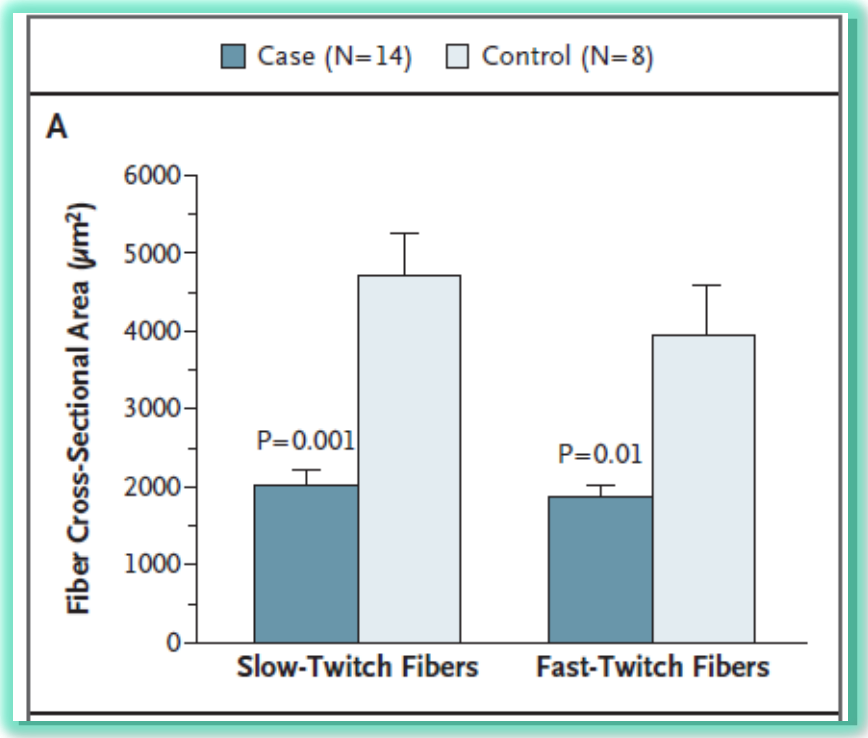


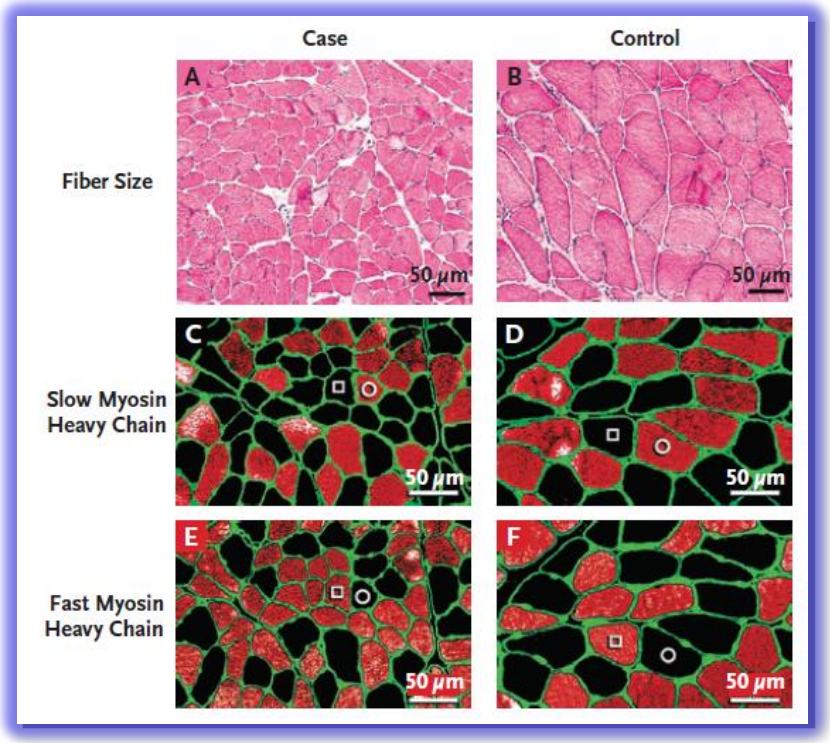
The NEW ENGLAND JOURNAL of MEDICINE

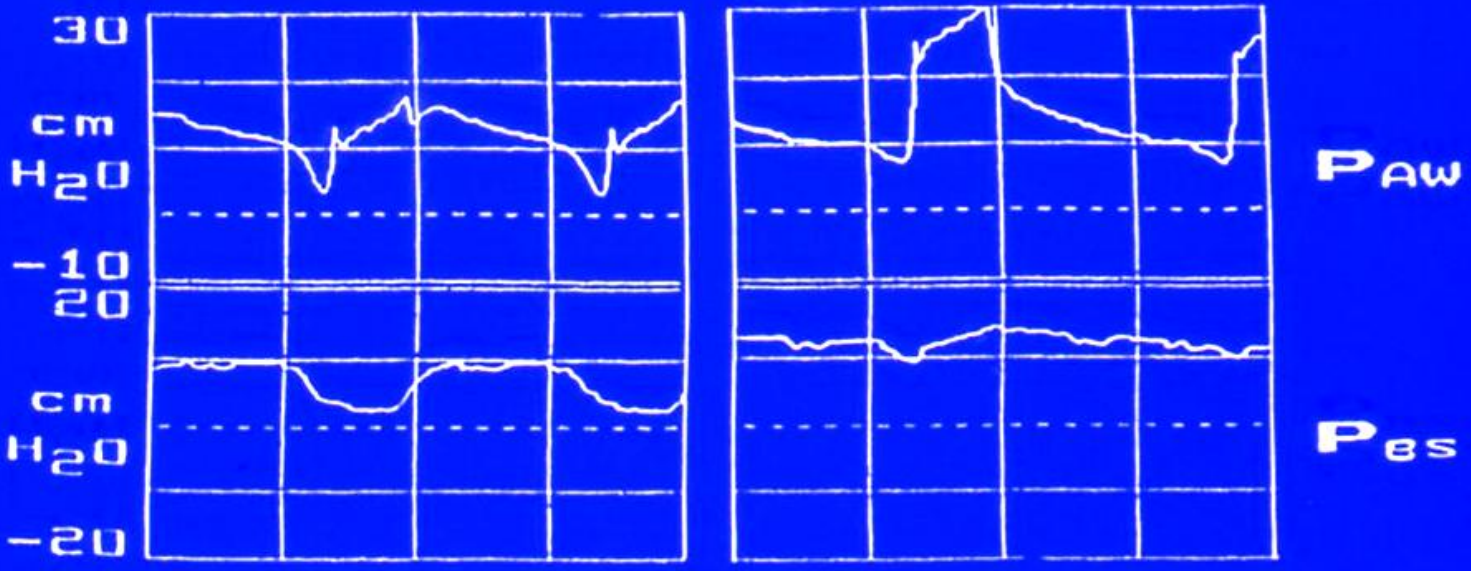
ESTABLISHED IN 1812 MARCH 27, 2008 VOL. 358 NO. 13

Rapid Disuse Atrophy of Diaphragm Fibers in Mechanically Ventilated Humans

Sanford Levine, M.D., Taitan Nguyen, B.S.E., Nyali Taylor, M.D., M.P.H., Michael E. Friscia, M.D., Murat T. Budak, M.D., Ph.D., Pamela Rothenberg, B.A., Jianliang Zhu, M.D., Rajeev Sachdeva, M.D., Seema Sonnad, Ph.D., Larry R. Kaiser, M.D., Neal A. Rubinstein, M.D., Ph.D., Scott K. Powers, Ph.D., Ed.D., and Joseph B. Shrager, M.D.



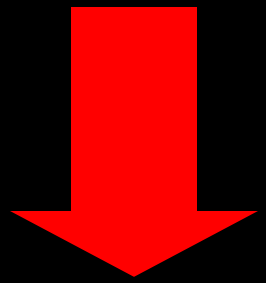




Is it Partial Ventilatory Support ?

Sim

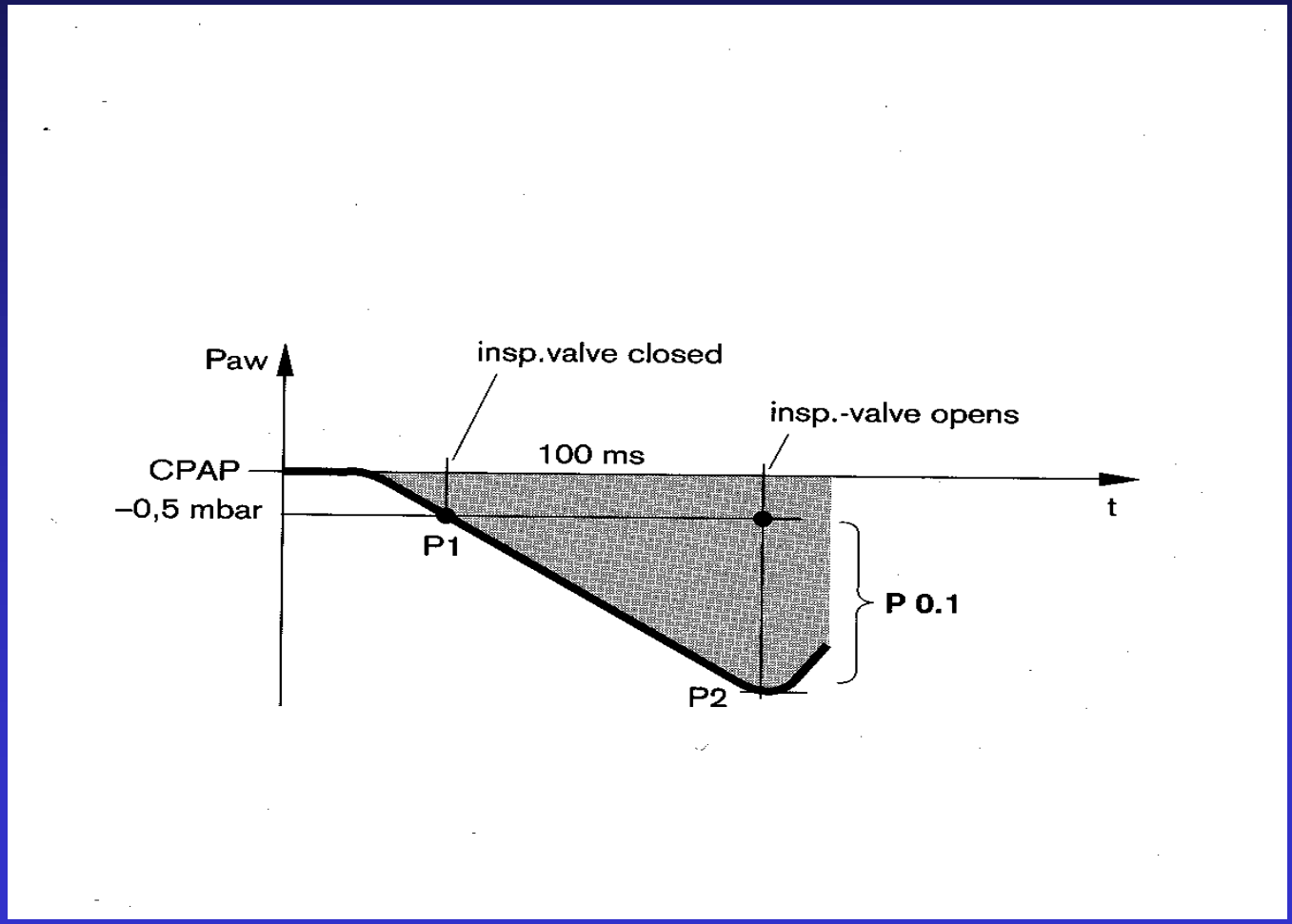
Come evitare sovrassistenza durante Pressure Support



“Finto PSV”

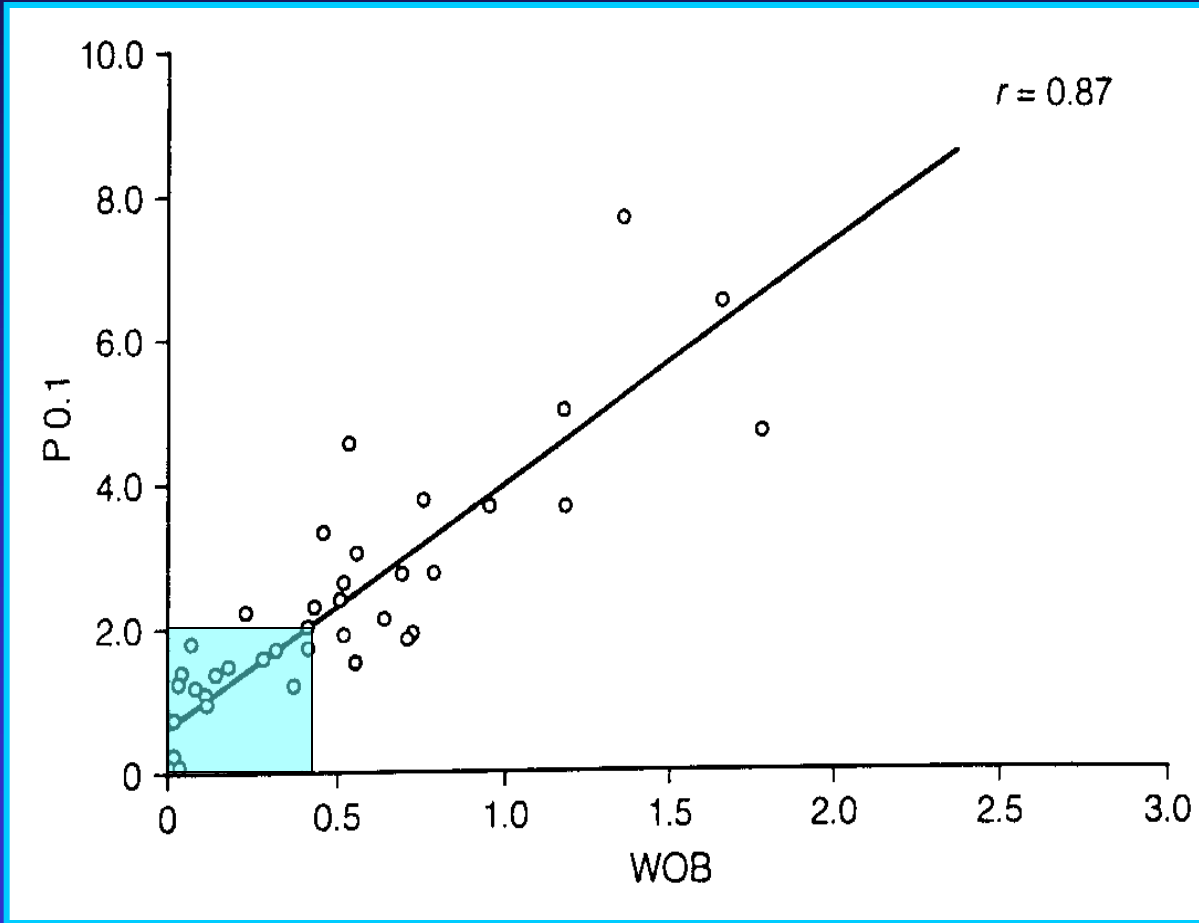
Pressione di occlusione (P0.1)

Pressione negativa generata dai muscoli inspiratori durante i primi 100 msec. del tentativo inspiratorio a vie aeree occluse, in assenza di flusso e variazioni di volume intratoracico

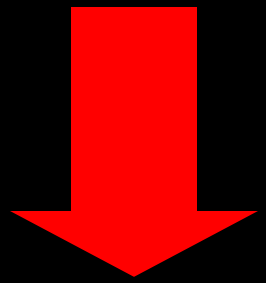


A. Alberti et al.

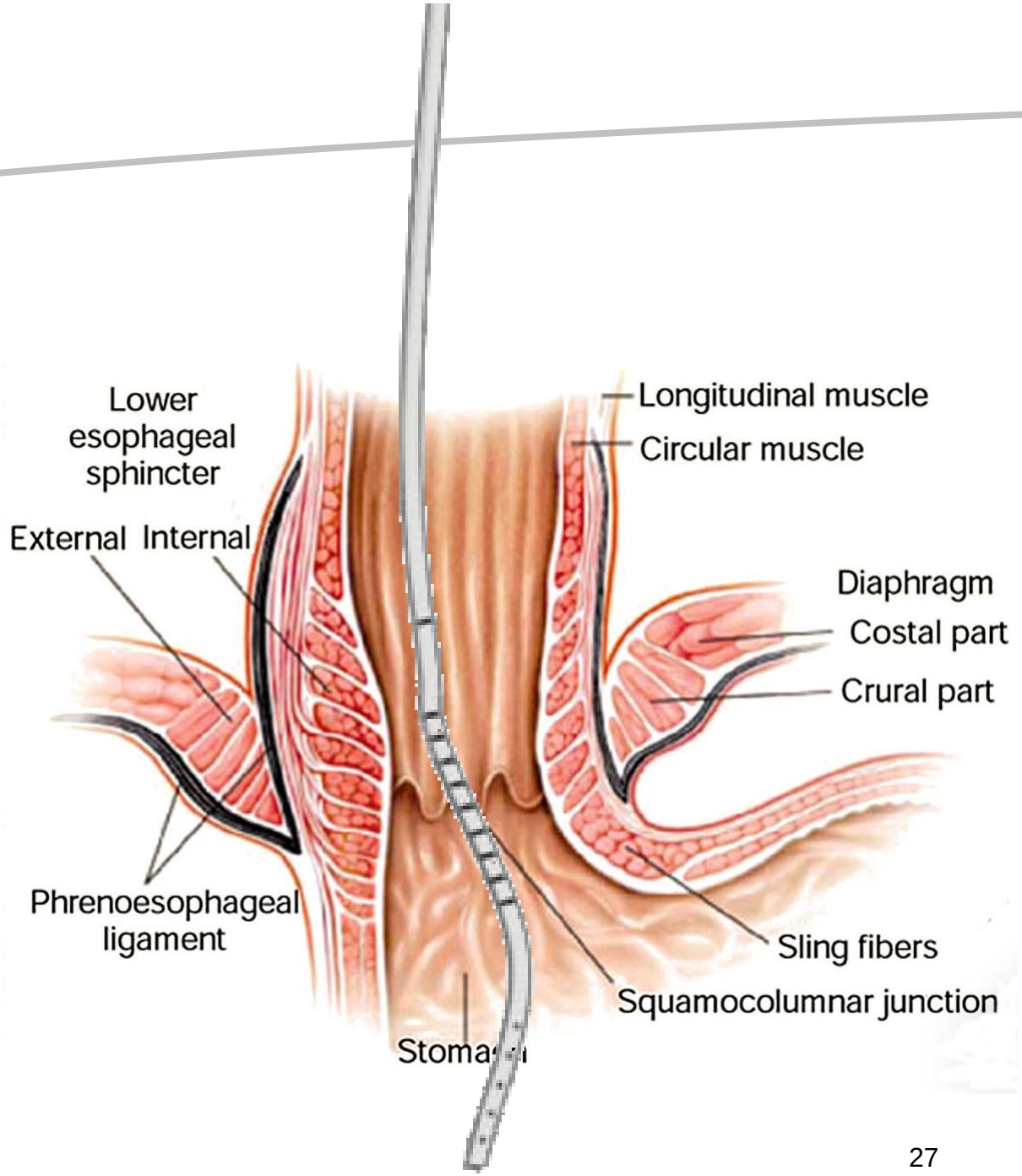
Intensive Care Med 1995



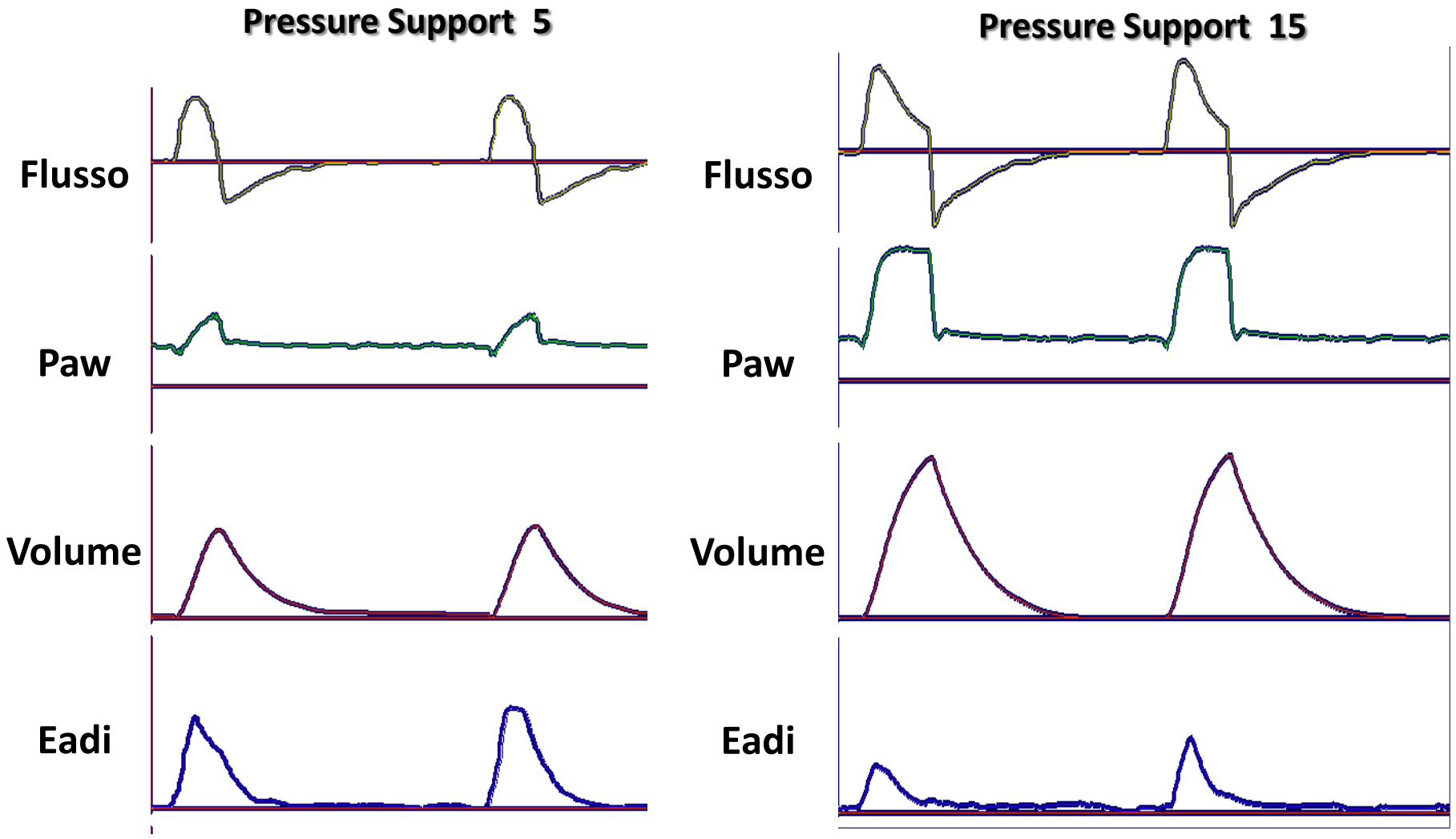
Come evitare sovrassistenza durante Pressure Support



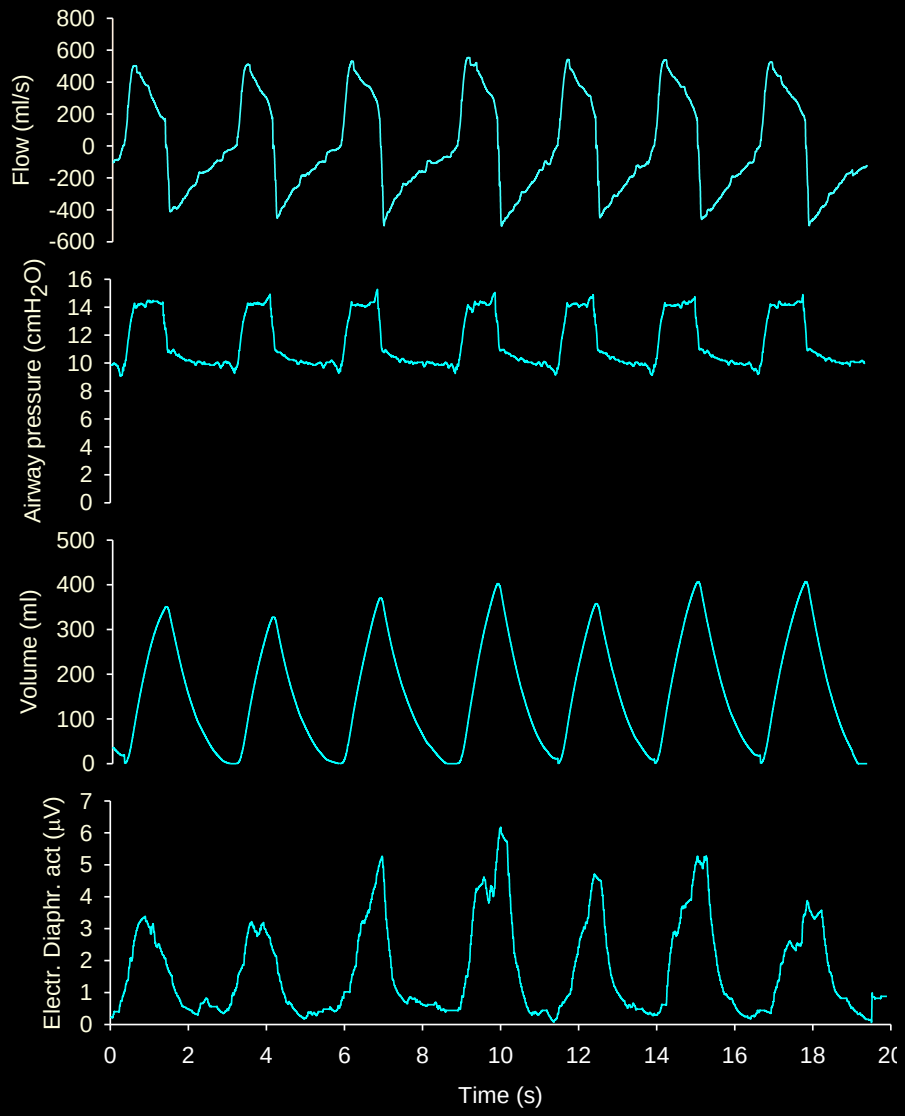
Edi


Lower
esophageal
sphincter
External
Internal
Longitudinal muscle
Circular muscle
Diaphragm
Costal part
Crural part
Phrenoesophageal
ligament
Sling fibers
Squamocolumnar junction

Paziente B


Pressure Support 5
Flusso
Paw
Volume
Eadi
Pressure Support 15
Flusso
Paw
Volume
Eadi

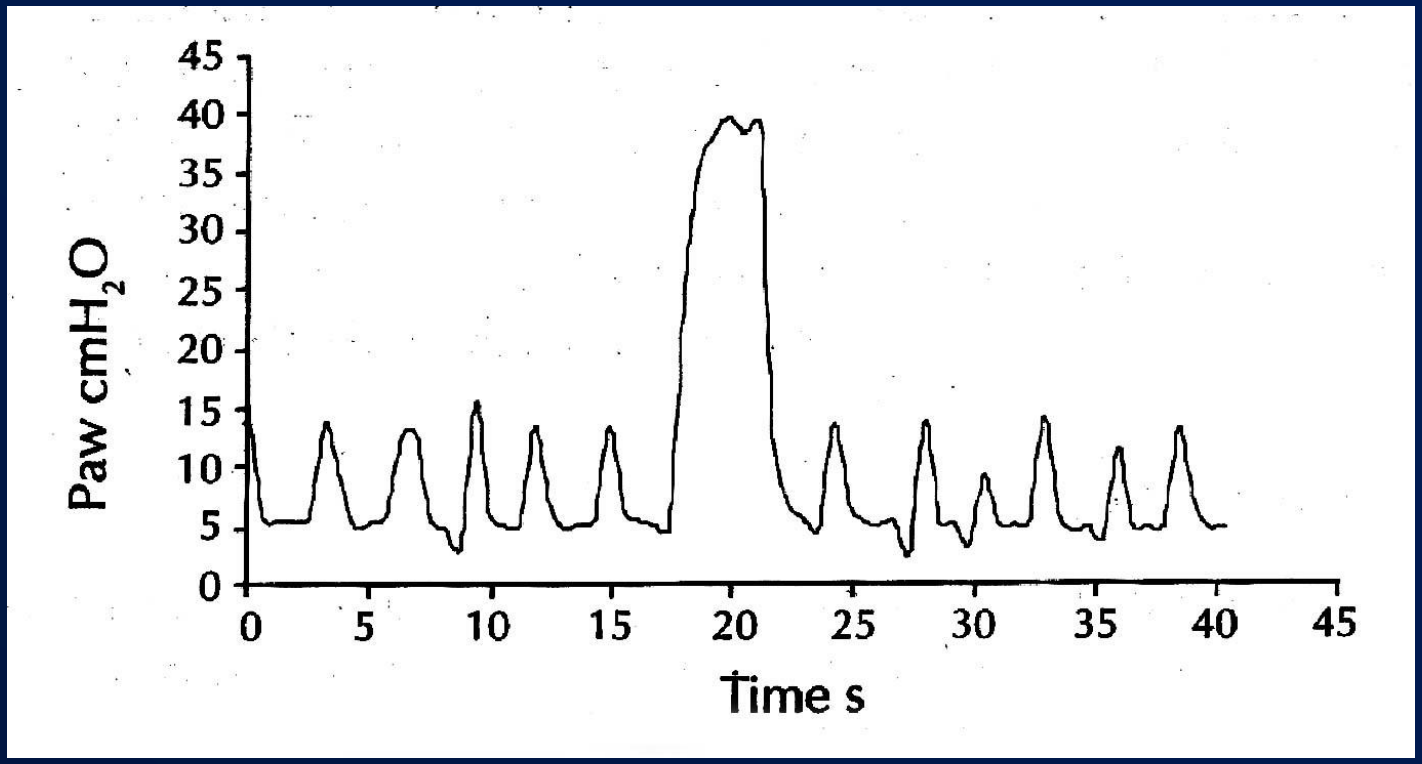
Pressure Support



PSV strategy: avoid overassistance

- **Po.1 > 2$_{cmH2O}$, Eadi active**
- **⇩PSV** ⇨ ⇧ Effort (Va/Q, atrophy, hemodymamics, etc.)
- **⇩TV** ⇨ Derecruitment ⇨ **Sigh**

SIGH durante PSV



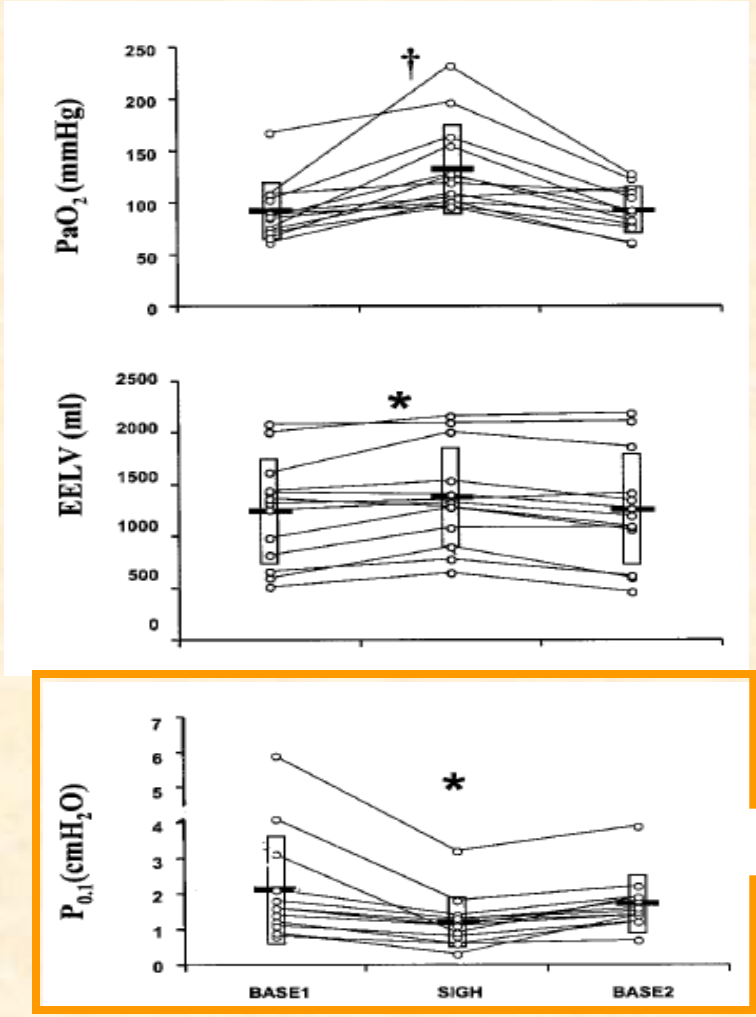
Set: BIPAP-ASB, Pmax 35-40

Ti 3-5 s.

Freq. 0.5-1 b.p.m.

Sigh Improves Gas Exchange and Lung Volume in Patients with Acute Respiratory Distress Syndrome Undergoing Pressure Support Ventilation

Nicolò Patroniti, M.D., Giuseppe Foti, M.D.,† Barbara Cortinovis, M.D.,‡ Elena Maggioni, M.D.,‡ Luca M. Bigatello, M.D.,§ Maurizio Cereda, M.D.,* Antonio Pesenti, M.D.||*



Sigh improves tollerance to spontaneous breathing

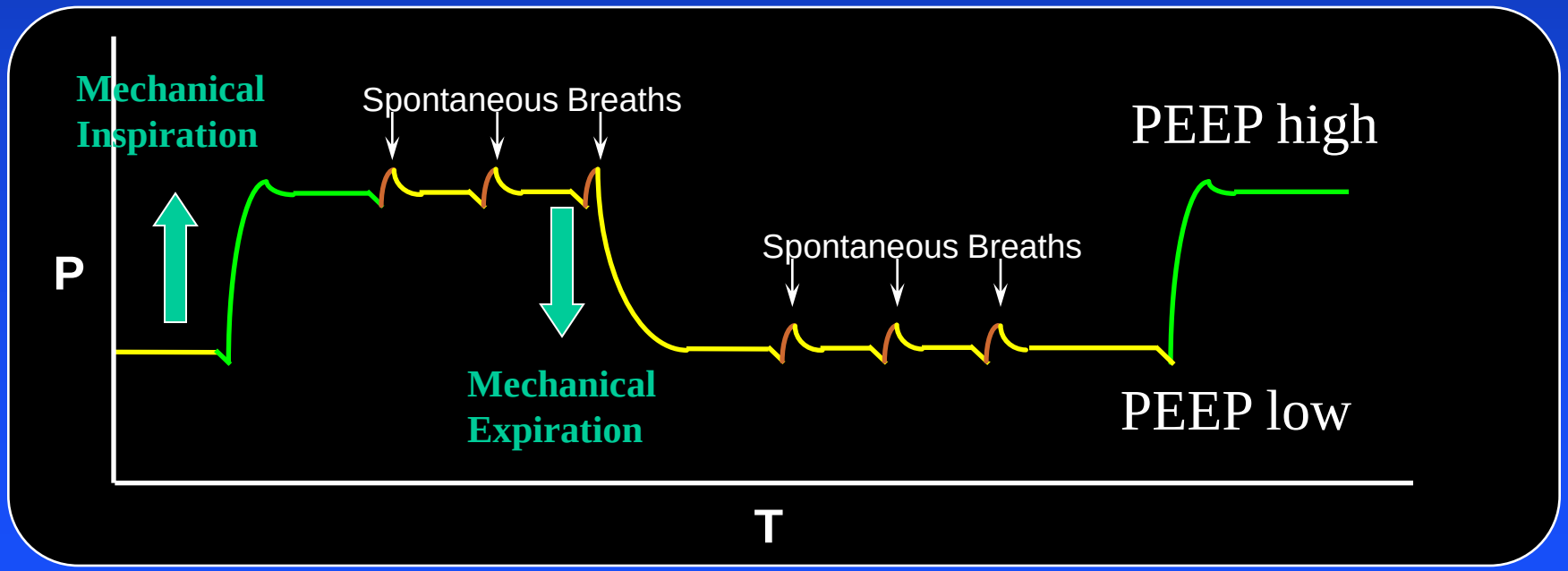
Anesthesiology, V 96, No 4, Apr 2002

Conclusioni

- Volumetrica/pressometrica durante ventilazione controllata
  - Non parliamone più !
- Usiamo TV bassi e Pplat < 30
  - No HME
- Ipossia
  - RM’s e PEEP adjustment
  - Sigh
- Usiamo Ventilazione assistita “vera”
  - Po.1,Eadi,NAVA, PSV+ Sigh

BiPAP, BiLevel, APRV, BiVent, etc.?

- Sono sostanzialmente differenti fa di loro
  - **NO !**
- Cosa sono ?
  - **CPAP fluttuante fra 2 livelli di PEEP**



Outcome results

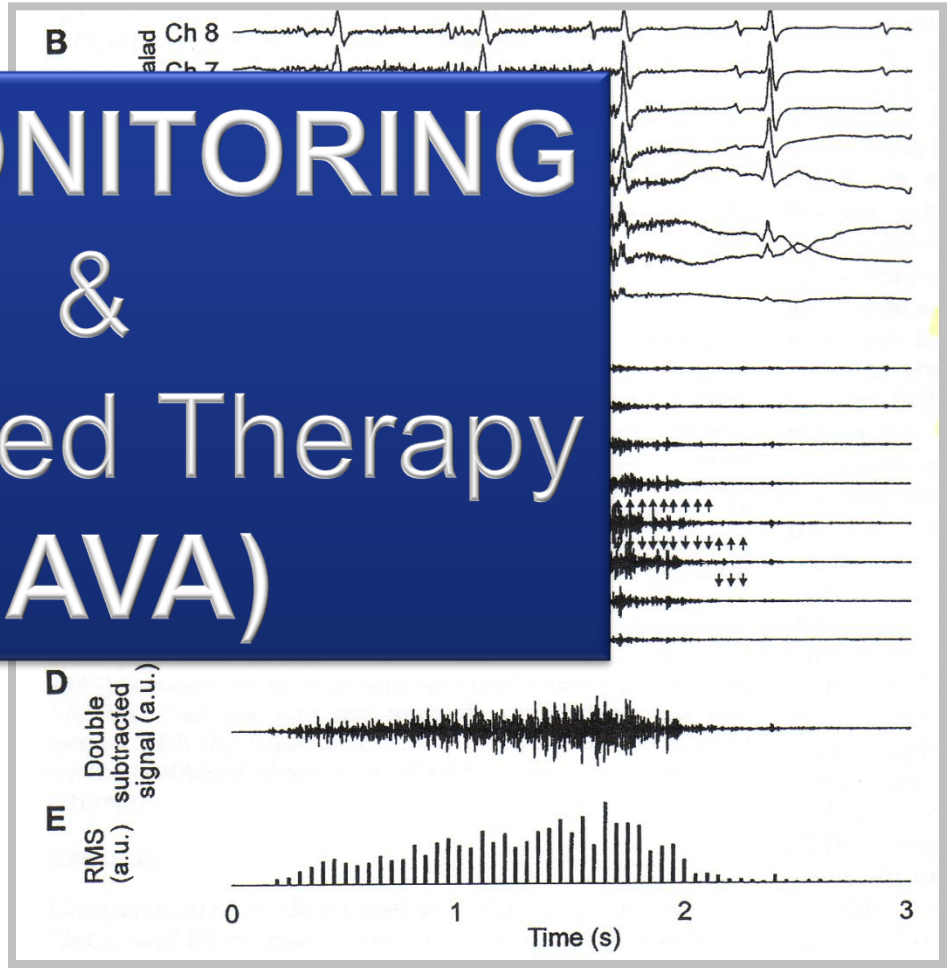
	BIPAP	PCV	p
N° pts.	15	15	
ARDS n (%)	3 (20)	11 (74)	0.015
Intubation (day)	18 ± 2	25 ± 2	0.011
ICU stay (day)	23 ± 2	30 ± 2	0.032

Putensen et al. AJRCCM 2001; 164, 43-49

MAQUET
GETINGE GROUP

SERVO-i receives s
from the Edi Cathet
filtering, uses the E
ventilatory monitori
regulation.

Edi MONITORING
&
Edi based Therapy
(NAVA)



Recruitment manoeuvre and anesthesia

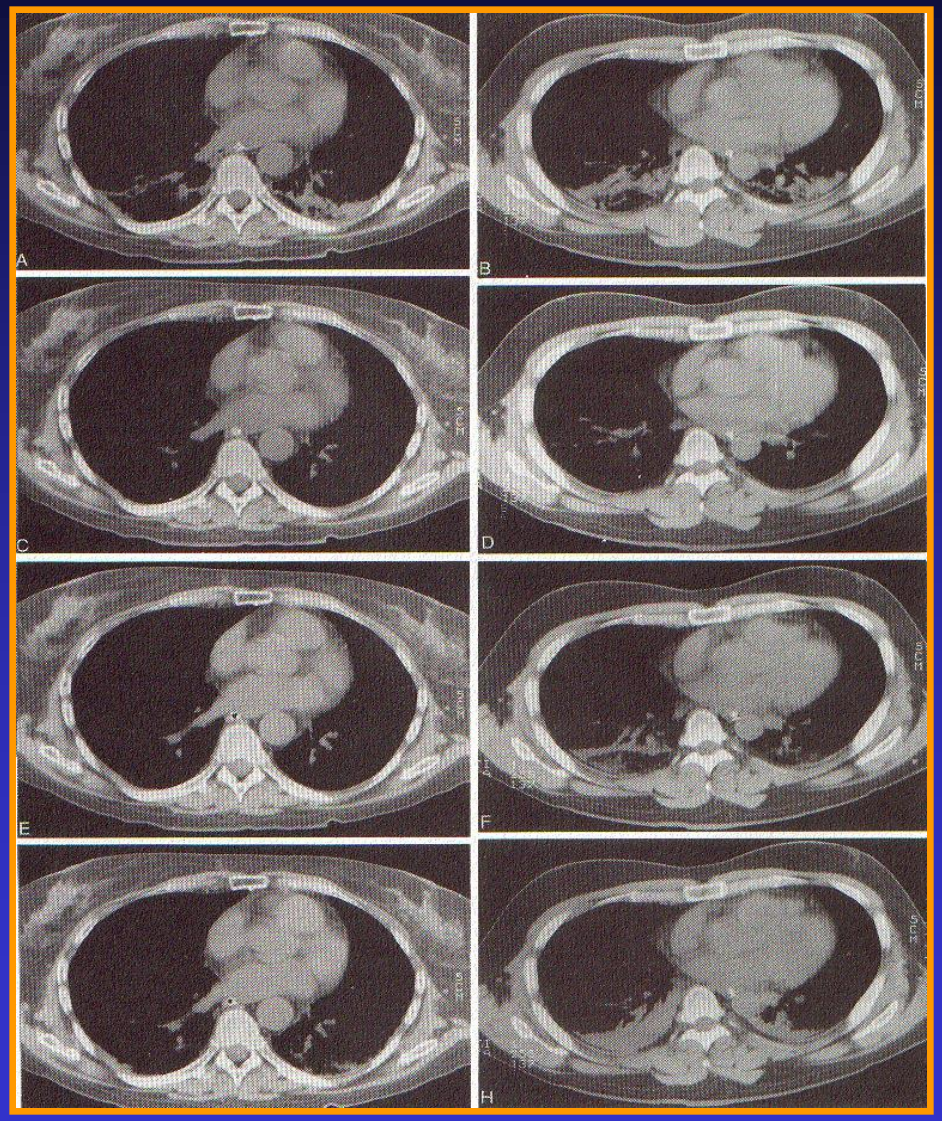
FiO2 0.4 FiO2 1

Post induction

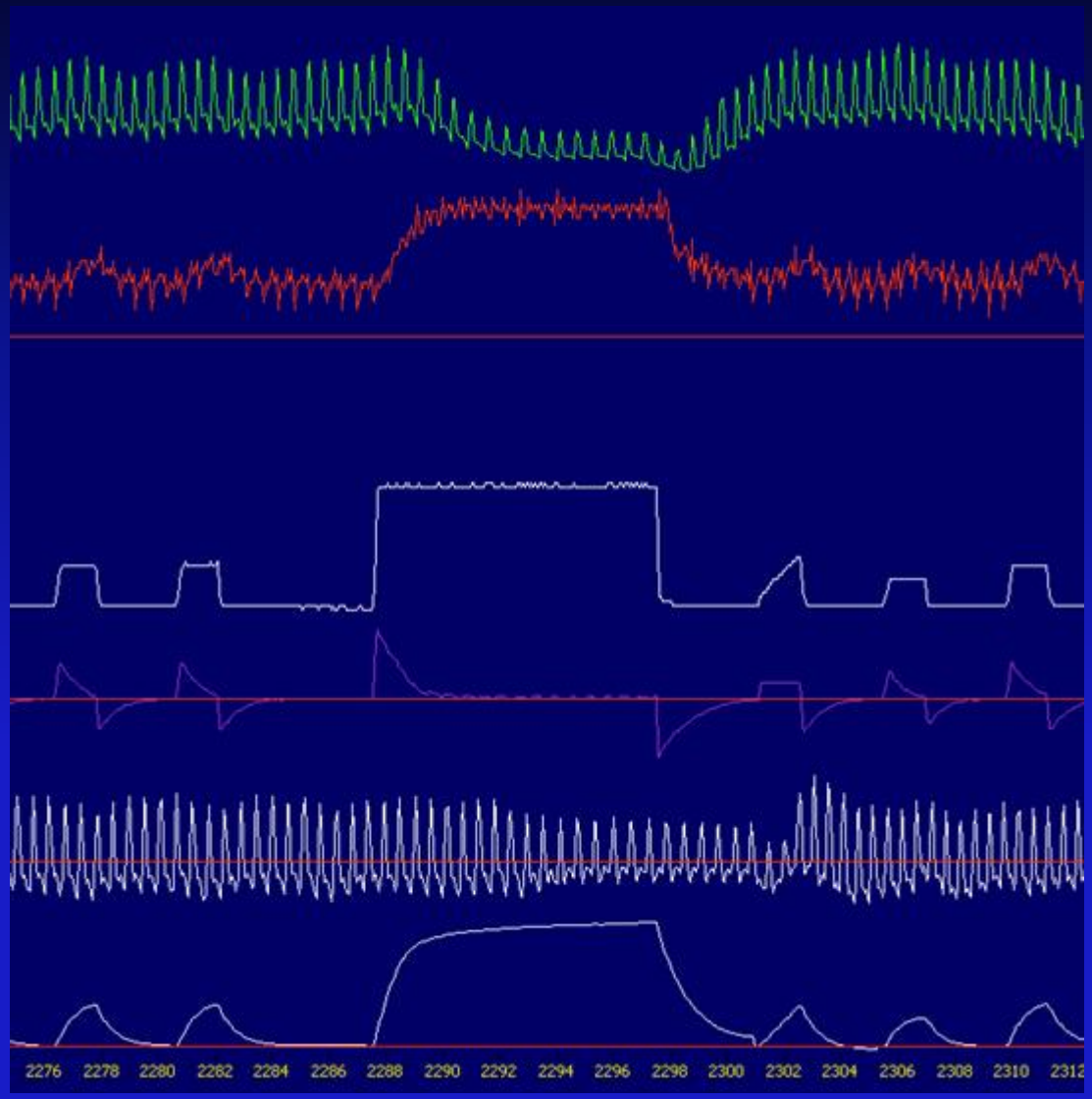
Post recruitment

5’

45’



RMs and hemodynamics



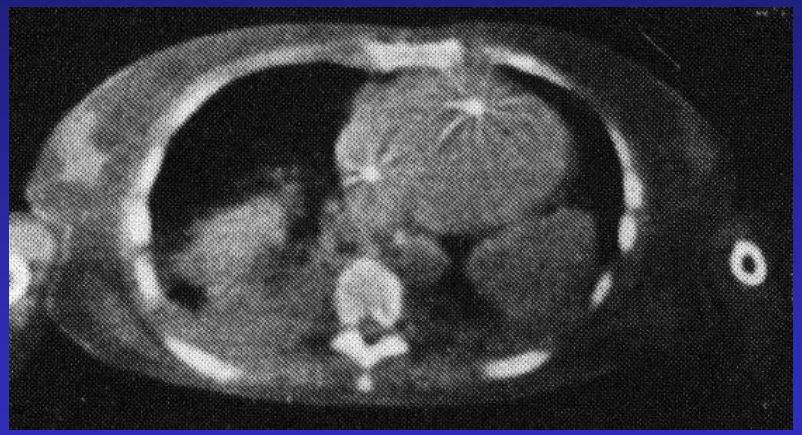
Corrispettivo TAC dell'Rx

PEEP

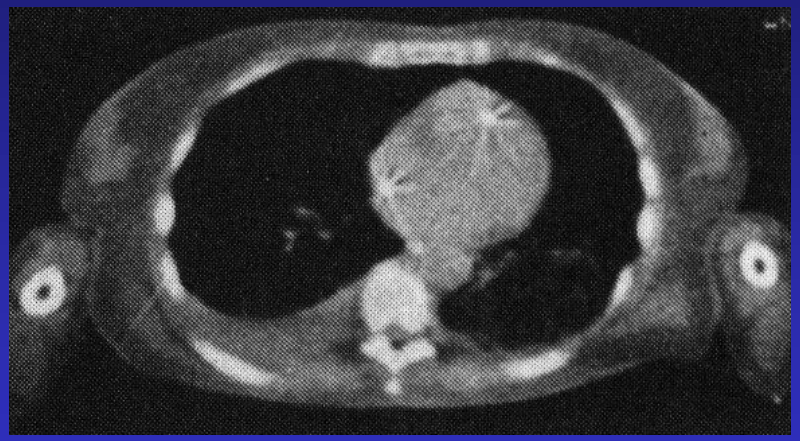
(Positive End Expiratory Pressure)

e

Reclutamento alveolare



PEEP = 5



PEEP = 15

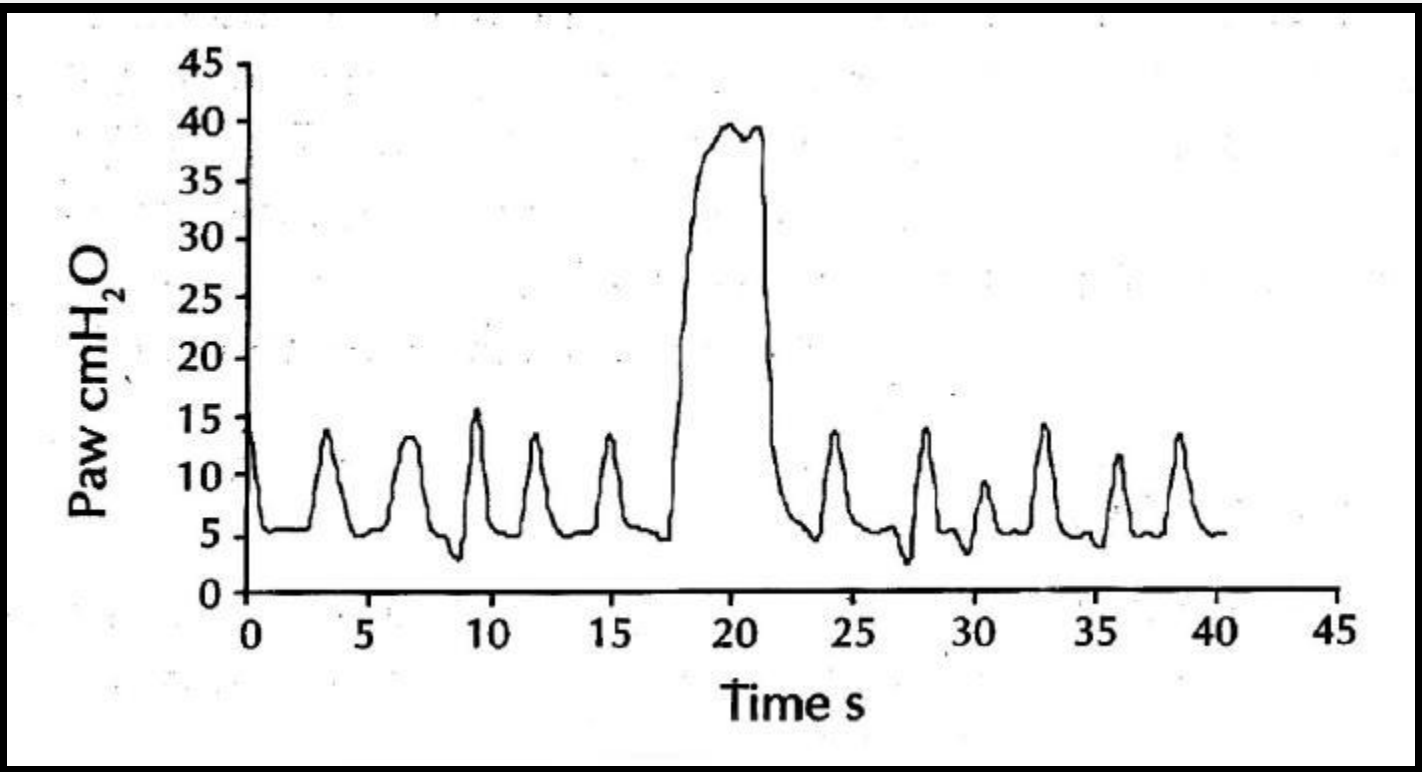
Sim

Manovra di Reclutamento

- **Pressione = 35-50 cmH_2O**
- **Durata = 20-40$_{sec}$, 1-3 $_{manovre}$**
- **Modalità: CPAP, APRV**
- **Check:**
  - **Pressione Arteriosa** ***(durante)***
  - **SpO_2, PaO_2** ***(dopo 1-5')***
- **Se miglioramento transitorio ➔ ↑ PEEP**

Sigh Improves Gas Exchange and Lung Volume in Patients with Acute Respiratory Distress Syndrome Undergoing Pressure Support Ventilation

Nicolò Patroniti, M.D., Giuseppe Foti, M.D.,† Barbara Cortinovis, M.D.,‡ Elena Maggioni, M.D.,‡ Luca M. Bigatello, M.D.,§ Maurizio Cereda, M.D.,* Antonio Pesenti, M.D.||*



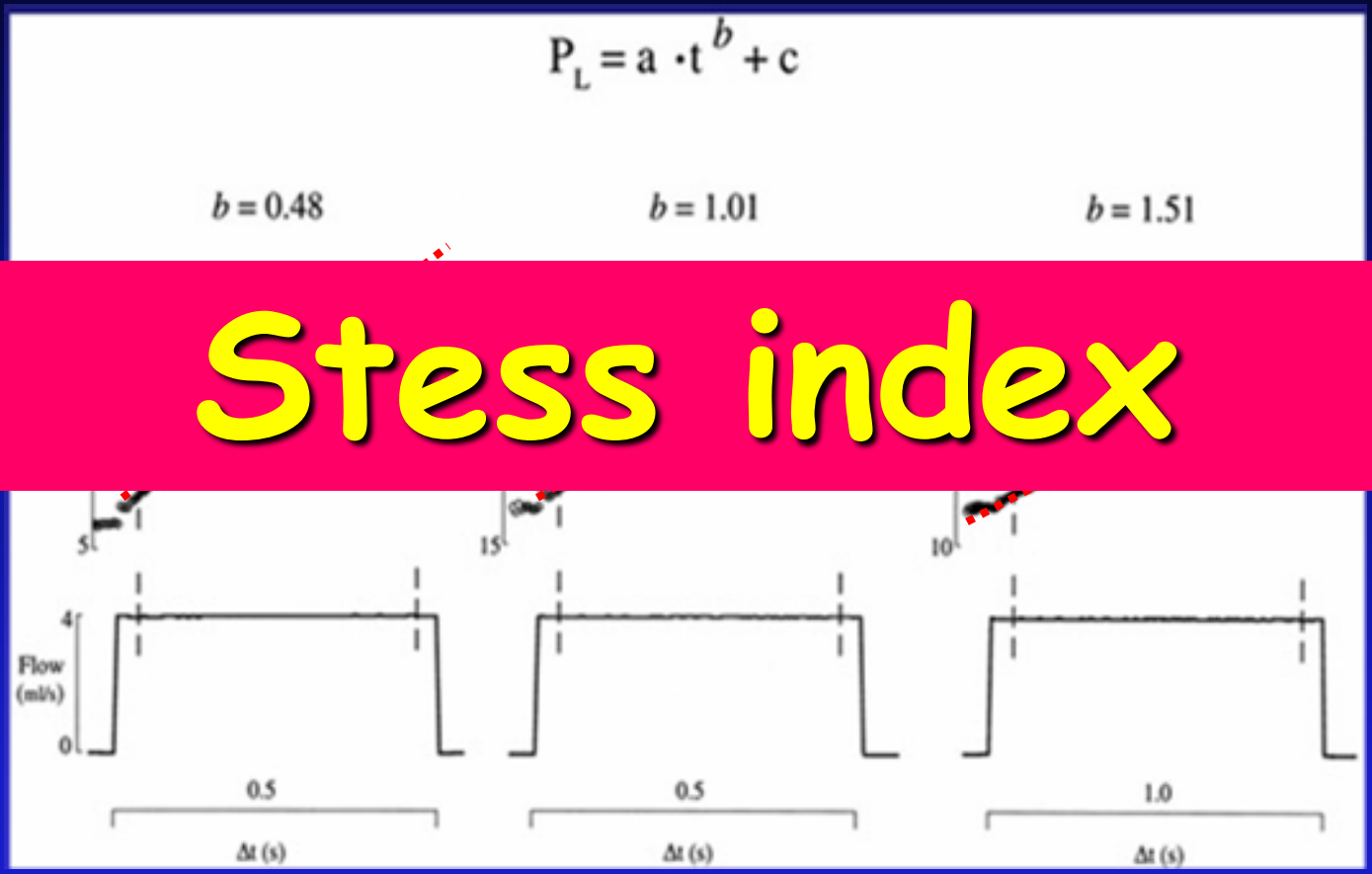
Set: BIPAP+PSV, Pmax = 35-40$_{cmH2O}$

Ti = 3-5 s.

RR_{BIPAP} = 0.5-1 b.p.m.

Anesthesiology, V 96, No 4, Apr 2002

Altra strategia per vedere sovradistensione senza PV curve



Stess index

Mettere il pz in ventilazione a volume controllato e valutare la linea di pressione per avere una idea su che punto della curva PV si trova

Ranieri et al. Anesthesiology 2000; 93(5):1320-8

Vantaggi PCV vs VCV

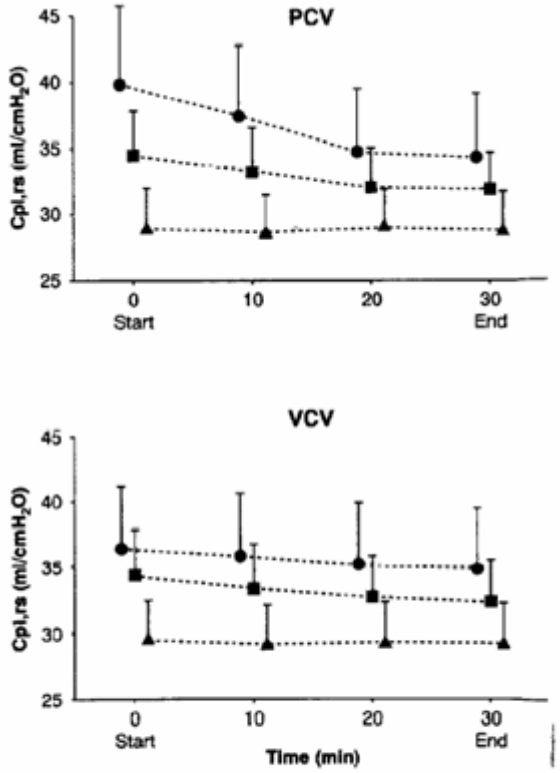


FIGURE 1. Respiratory system compliance (Cpl,rs) during pressure-controlled ventilation (PCV) and during volume-controlled ventilation (VCV) periods at PEEP 5 (circles), 10 (squares), and 15 (triangles) cm H_2O. Data are expressed as mean±SEM. Statistical comparisons are reported in Tables 2 and 3.

Table 4—*Gas Exchange Data at the End of PCV and VCV Periods*

	PEEP, cm H_2O		
	5	10	15
PaO_2, mm Hg			
PCV*	87.3±26.4	124.0±44.1	195.4±93.5
VCV*	82.4±29.8	130.2±42.2	215.7±66.3
$PaCO_2$, mm Hg			
PCV*	56.8±13.2	53.9±9.7	51.8±11.5†
VCV	57.9±14.9	55.4±12.2	55.9±15.22

51.8±11.5†

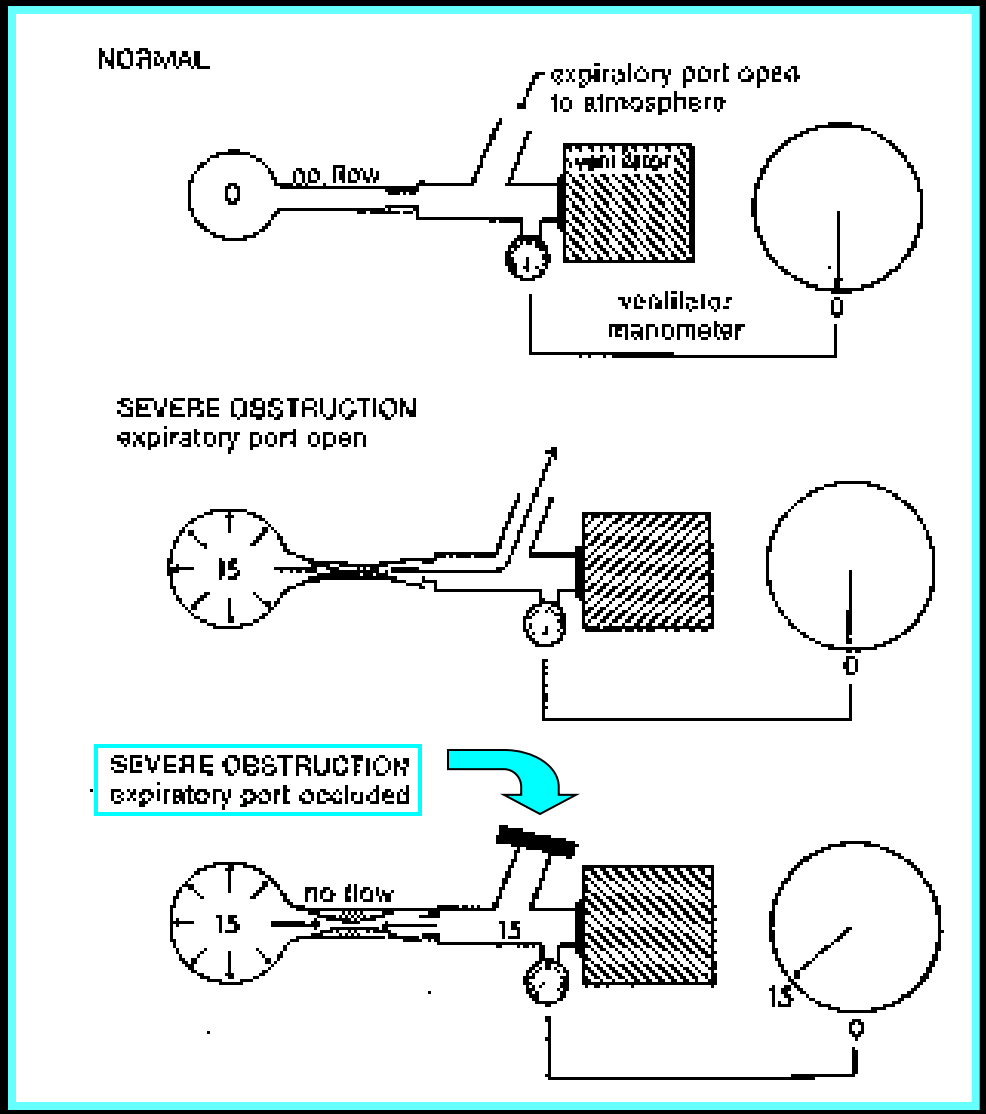
55.9±15.22

Positive End-Expiratory Pressure Prevents the Loss of Respiratory Compliance During Low Tidal Volume Ventilation in Acute Lung Injury Patients*

Maurizio Cereda, MD; Giuseppe Foti, MD; Guido Musch, MD; Maria Elena Sparacino, MD; and Antonio Pesenti, MD

OCCLUSIONE DI FINE ESPIRAZIONE

per smascherare PEEPi



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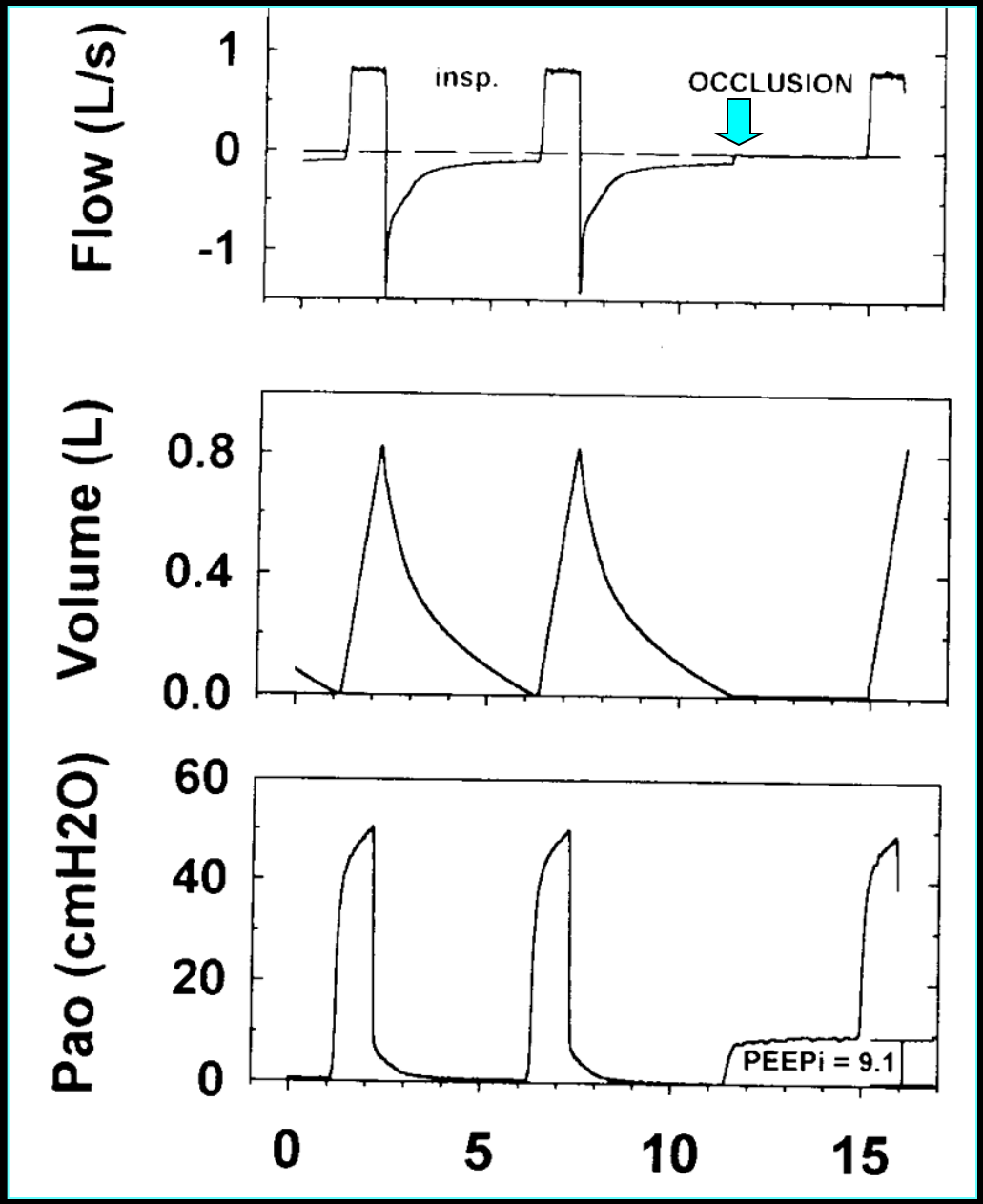

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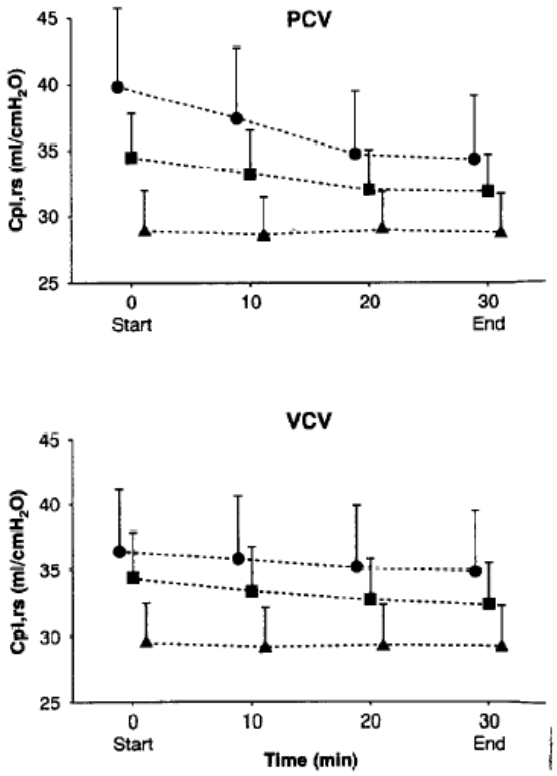


FIGURE 1. Respiratory system compliance (Cpl,rs) during pressure-controlled ventilation (PCV) and during volume-controlled ventilation (VCV) periods at PEEP 5 (circles), 10 (squares), and 15 (triangles) cm H_2O. Data are expressed as mean±SEM. Statistical comparisons are reported in Tables 2 and 3.

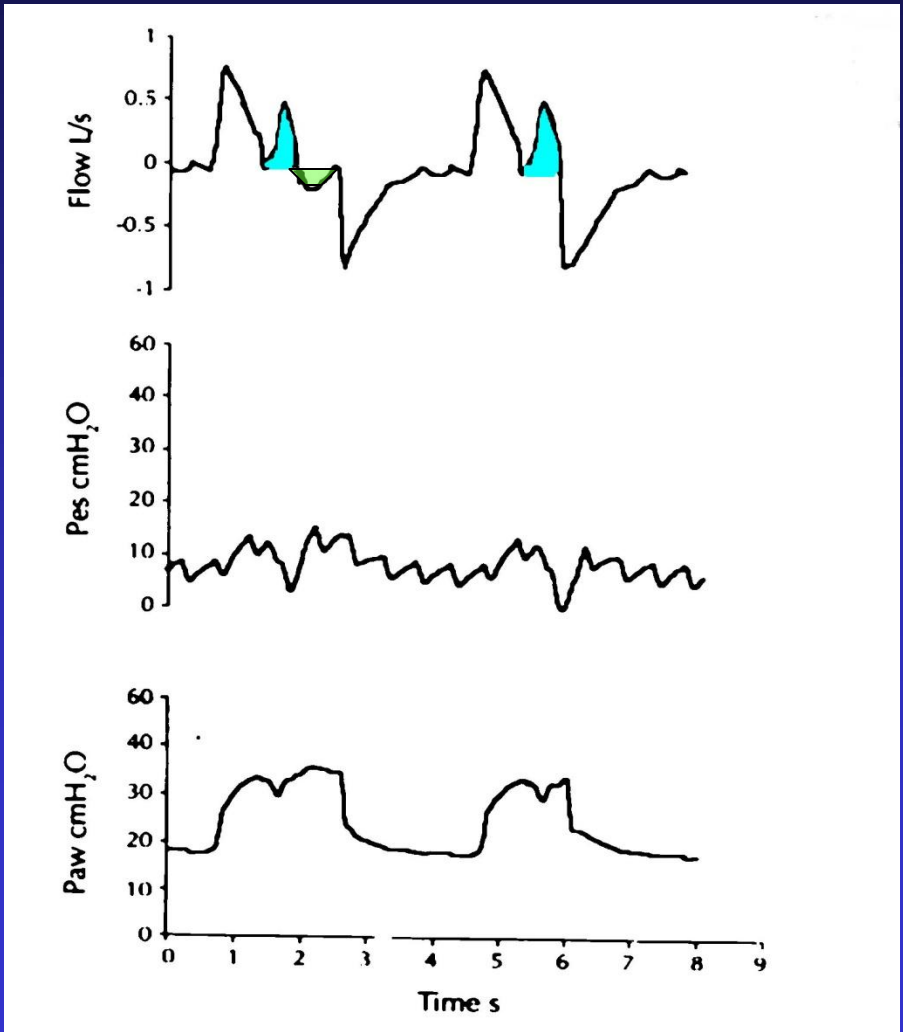
Table 4—*Gas Exchange Data at the End of PCV and VCV Periods*

	PEEP, cm H_2O		
	5	10	15
PaO_2, mm Hg			
PCV*	87.3±26.4	124.0±44.1	195.4±93.5
VCV*	82.4±29.8	130.2±42.2	215.7±66.3
$PaCO_2$, mm Hg			
PCV*	56.8±13.2	53.9±9.7	51.8±11.5†
VCV	57.9±14.9	55.4±12.2	55.9±15.22

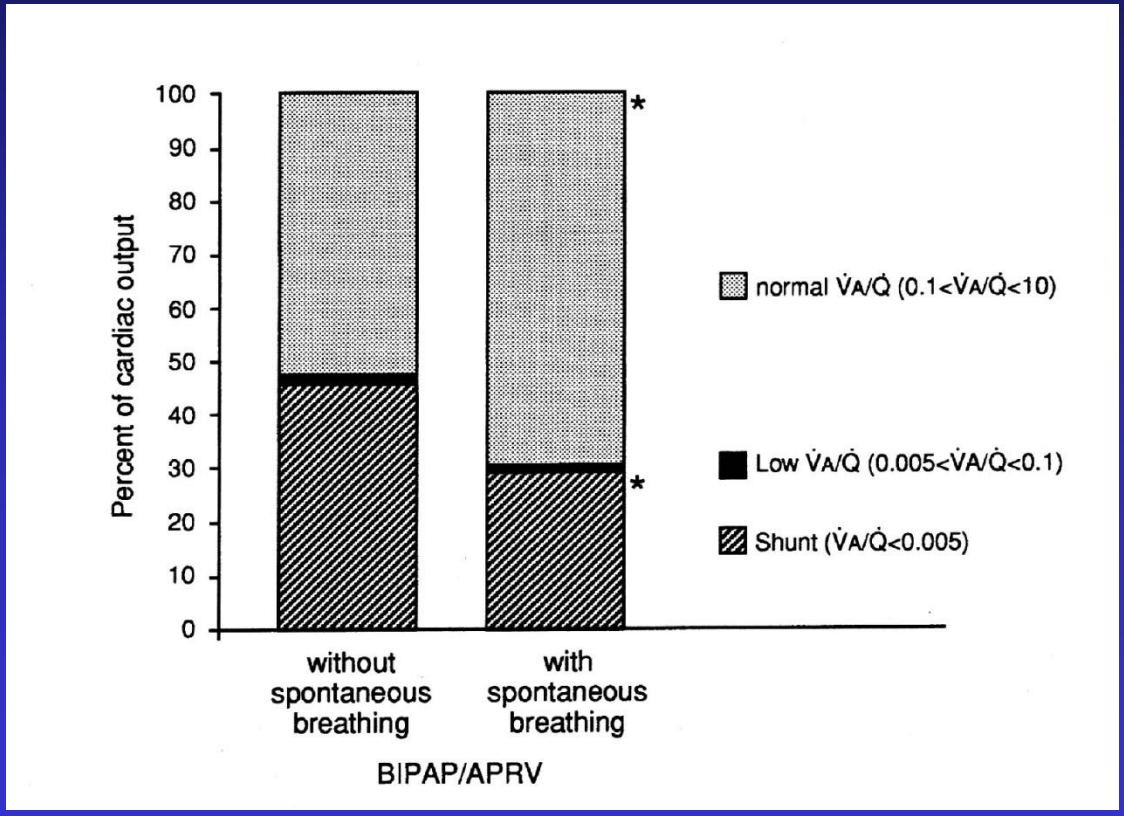
51.8±11.5†

55.9±15.22

BIPAP
e
Respiro Spontaneo

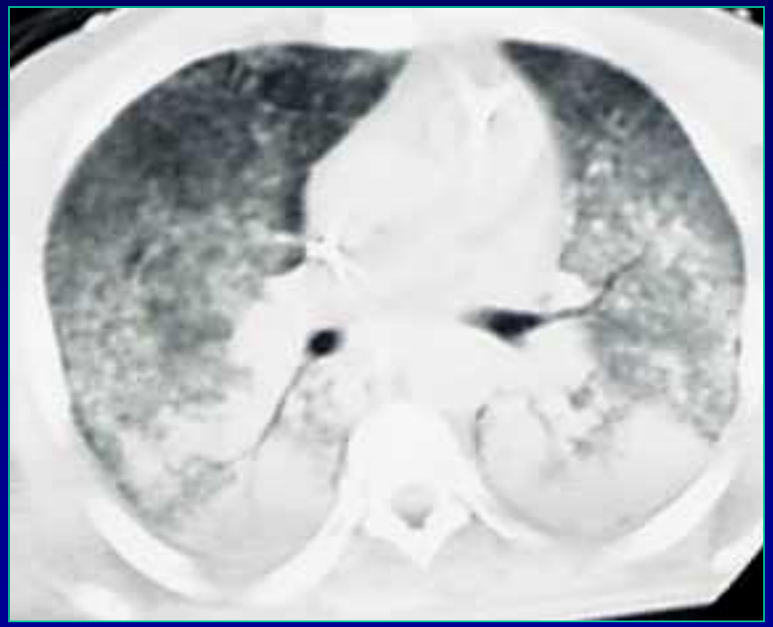


BIPAP: effetti sullo scambio gassoso

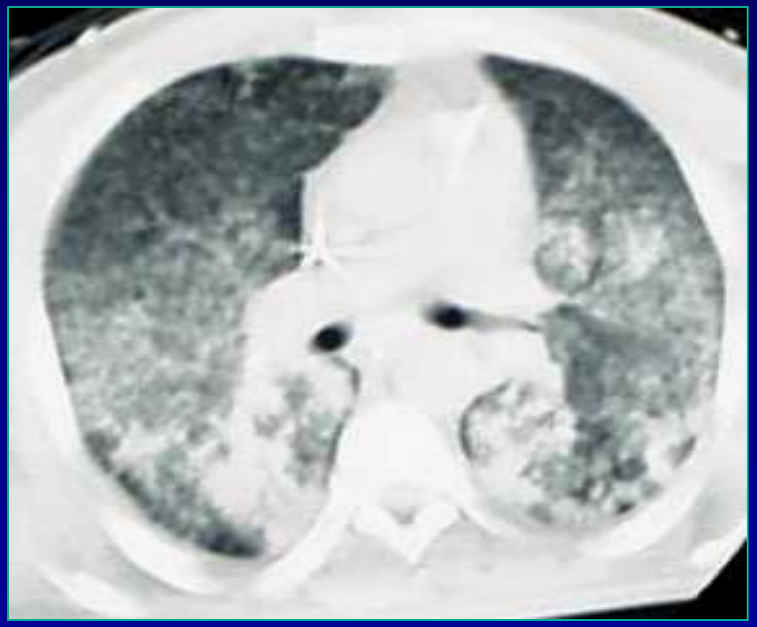


Putensen et al. AJRCCM 1994; 150:101-108

Total vs. Partial ventilatory Support



Controlled MechanicalVentilation

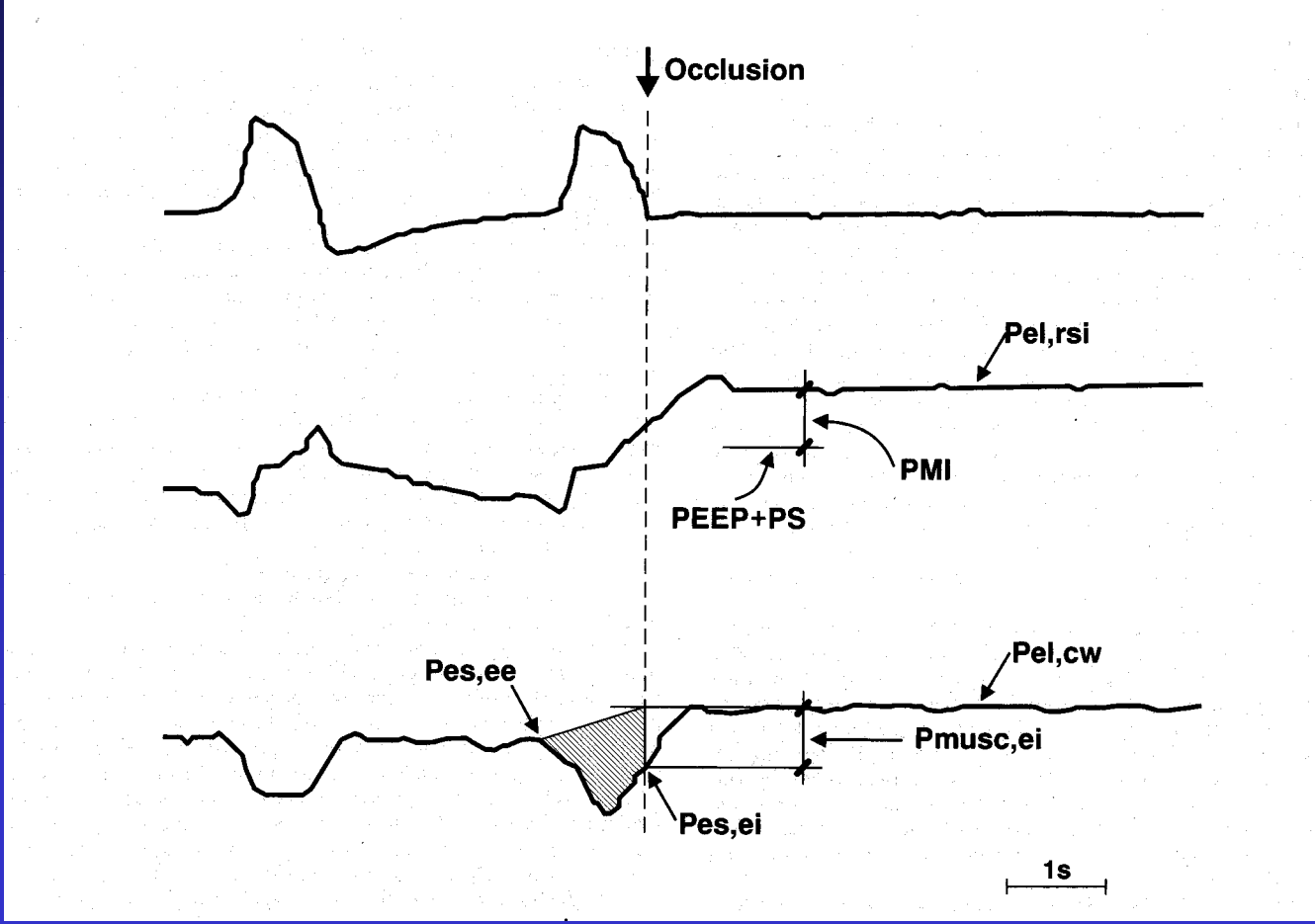


Partial Ventilatory Support

End Inspiratory occlusion:

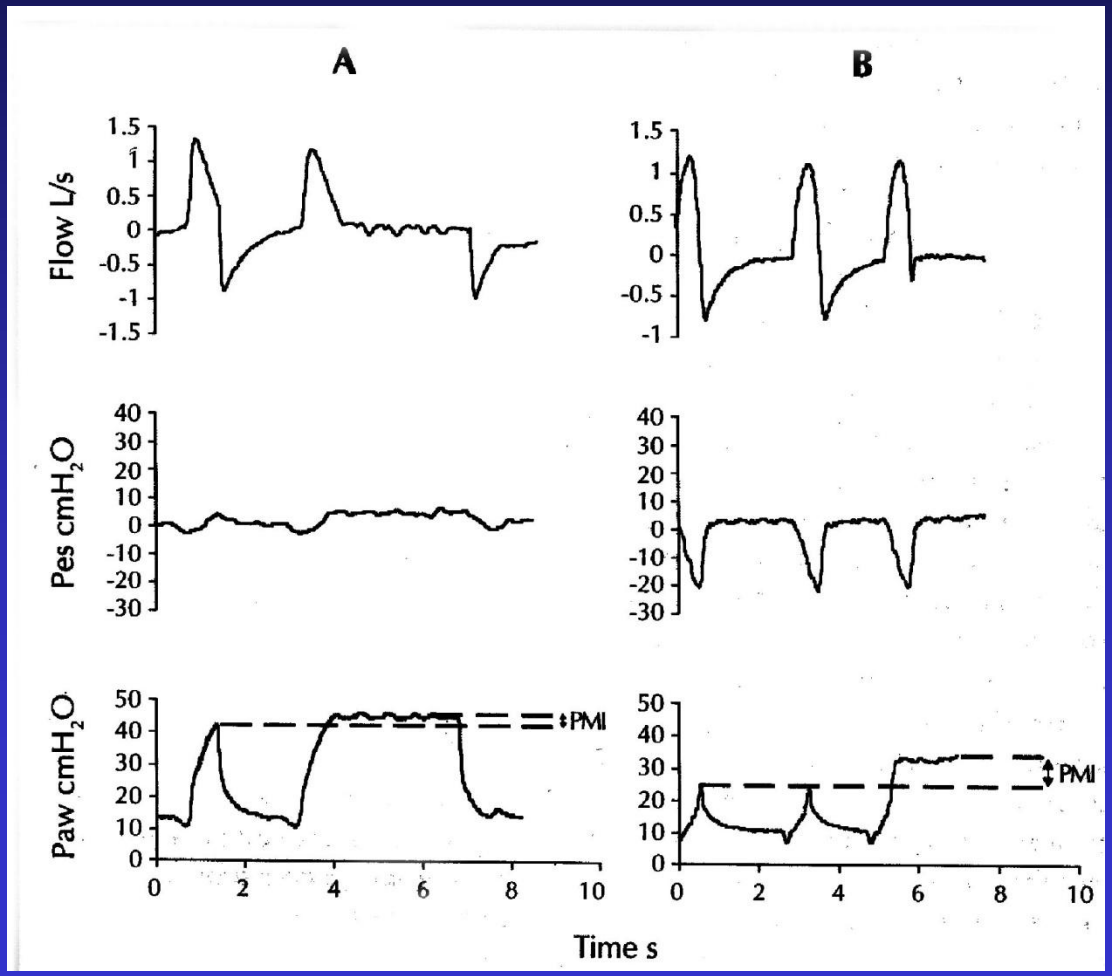
$PMI = Pel,_{rsi} - (PEEP+PS)$

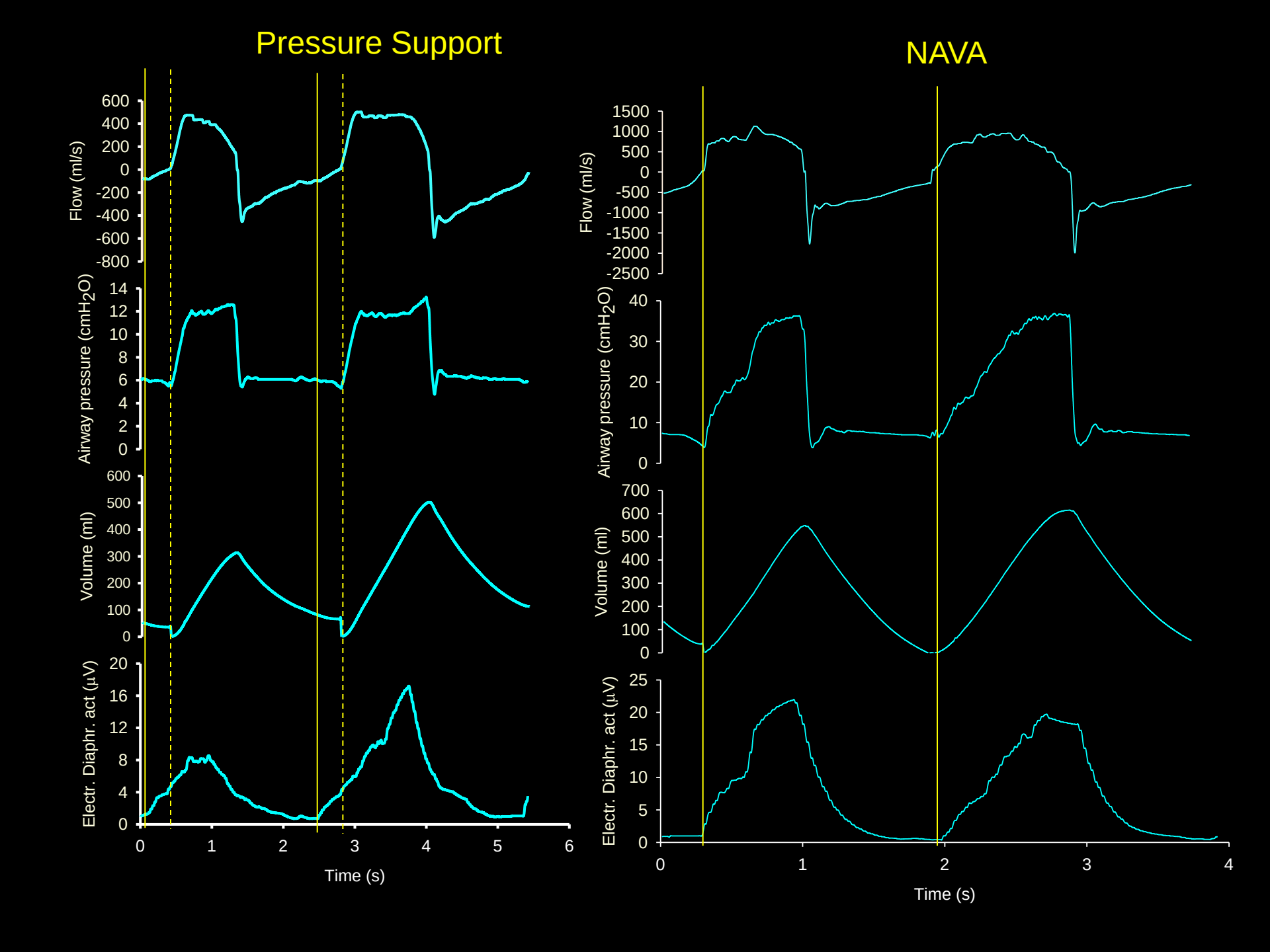
PMI = PMuscIndex



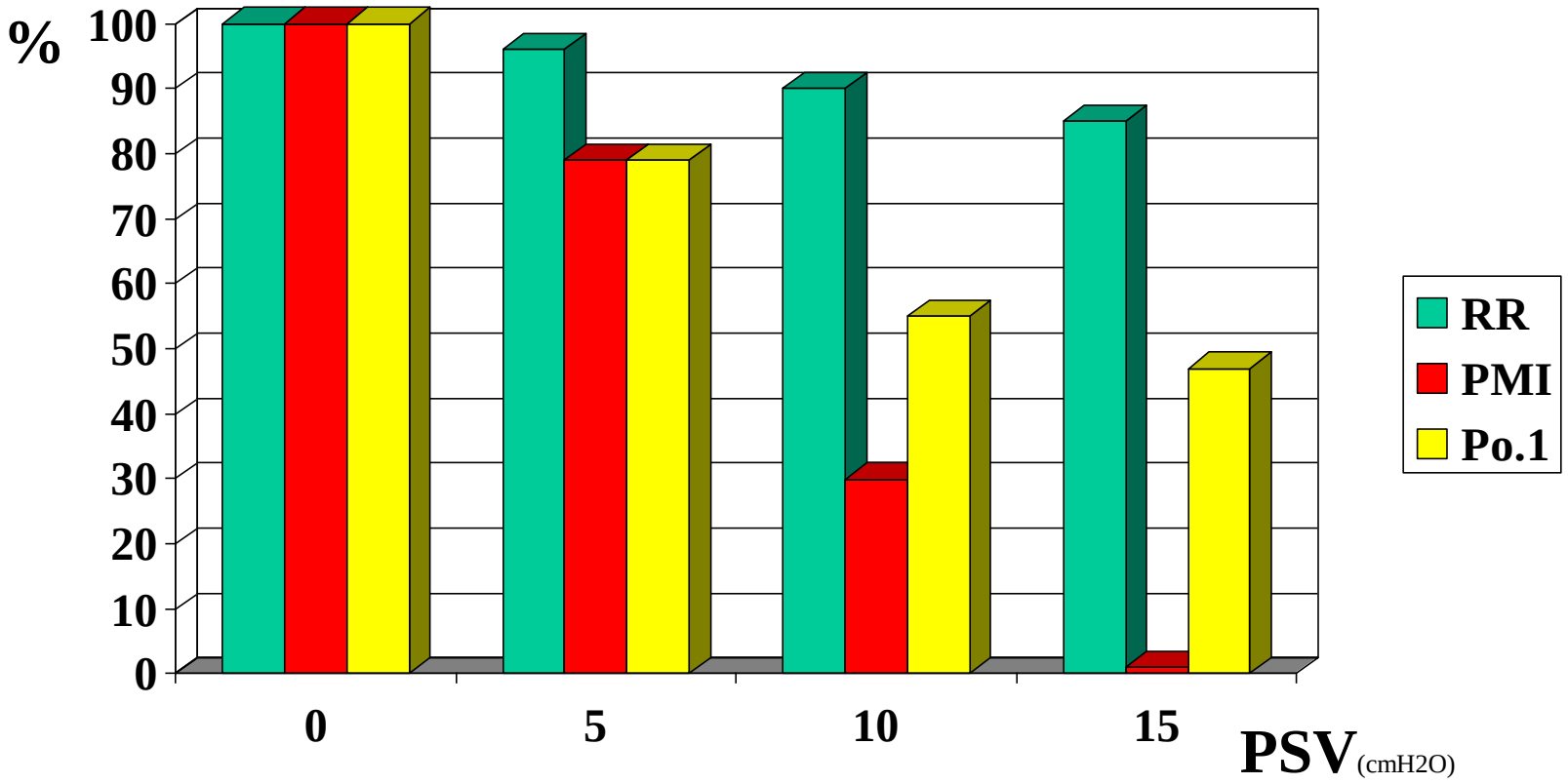
End Inspiratory occlusion:

- Low PMI & low effort (A)
- High PMI & high effort (B)




Pressure Support
NAVA
Flow (ml/s)
Airway pressure (cmH2O)
Volume (ml)
Electr. Diaphr. act (µV)
Time (s)

Indicatori di sforzo inspiratorio durante PSV



PMI e Po.1 riflettono meglio di RR le variazioni di sforzo indotte da PSV

Dynamics of re-expansion of atelectasis during general anesthesia

Rothen HU,Neuman p, Berglund J, Valtaysson J,Magnusson a and Hedenstierna G.
British J of Anesthesia (1999):82, 4, 551-6

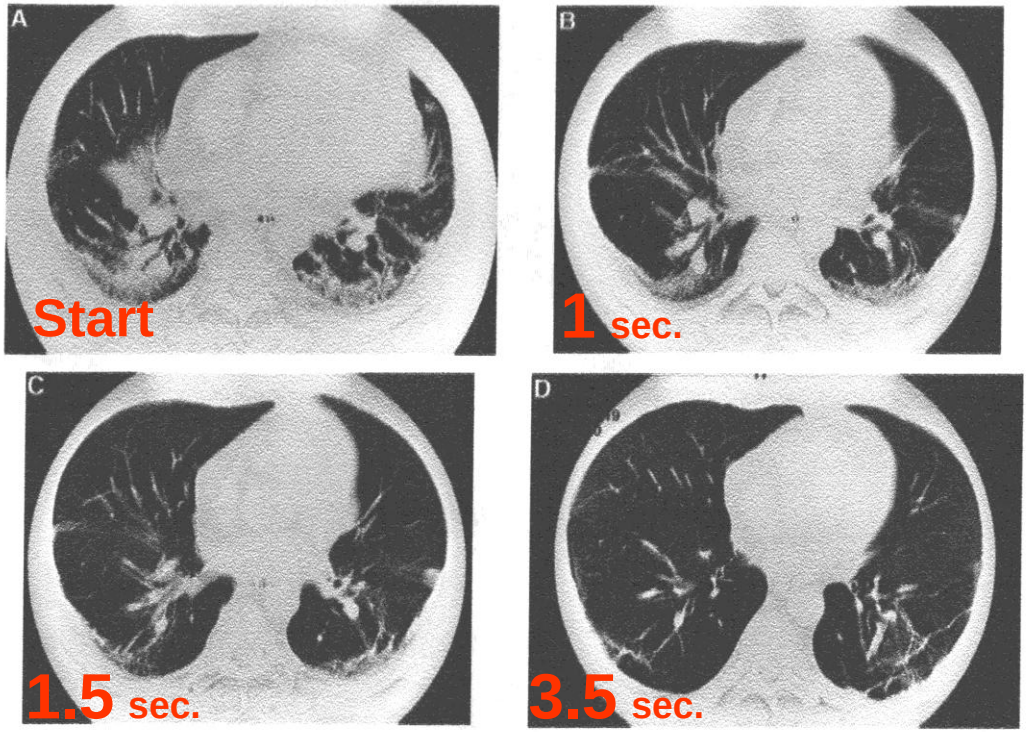


Fig 2 CT scan during the VC manoeuvre. A=At start of VC manoeuvre; B=1 s after the start of the VC manoeuvre; C=1.5 s after the start of the VC manoeuvre; and D=3.5 s after the start of the VC manoeuvre.

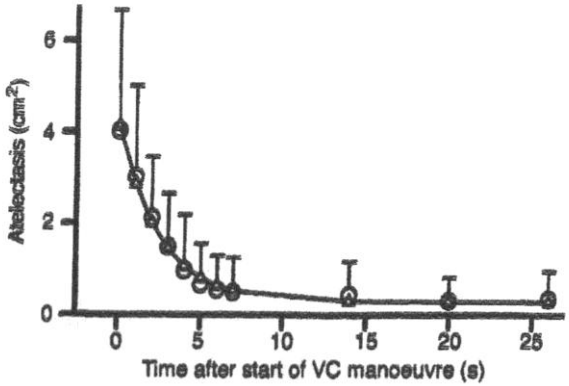


Fig 1 Atelectasis before and during the VC manoeuvre. Mean values (○) and SD (error bars) are shown. Also shown is a curve with negative exponential decay, fitted to individual data (△), connected by a line. For further details, see text.

L'insufflazione deve durare almeno 3 sec.
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