AP-HP.
Hôpitaux universitaires
Henri-Mondor

srlf
SOCIÉTÉ
DE RÉANIMATION
DE LANGUE FRANÇAISE

TOUS ENSEMBLE · SOINS · PROGRÈS · BIENVEILLANCE · COMPÉTENCES · HUMANITÉ · NOUS SOMMES LA RÉANIMATION

Comment optimiser la ventilation mécanique?

Guillaume Carteaux

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CARMAS

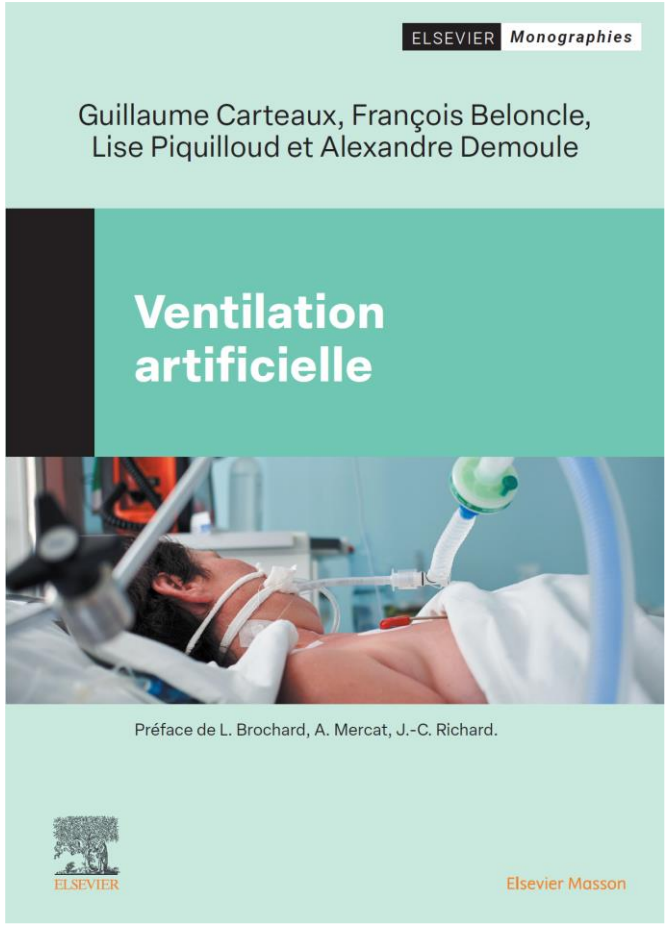
hmir Mondor

UNIVERSITÉ PARIS-EST CRÉTEIL VAL DE MARNE
UPEC

MOOC EIVASION

Liens d’intérêts

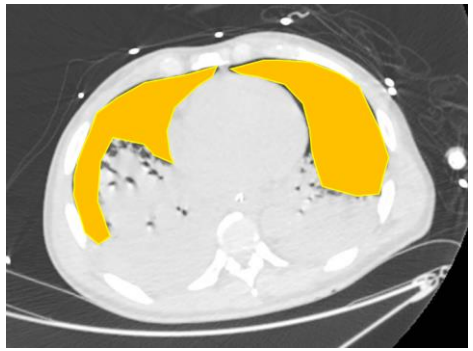
- Laboratoire (prêt de ventilateurs):
  - Fisher and Paykel
  - Medtronic
  - Air Liquide Medical Systems
- Conférencier:
  - Fisher and Paykel
  - Medtronic
  - Air Liquide Medical Systems
  - Dräger
  - GE Healthcare
- Honoraires pour activité de conseil:
  - Air Liquide Medical Systems
  - Löwenstein



Droits d’auteur: 1,75%

SDRA modéré à sévère

	SRLF (2018)	ATS (2023)	ESICM (2023)
Volume courant	6 ml/kg PPT	6 (4–8) ml/kg PPT	4 et 8 ml/kg PPT
Pplat	≤ 30 cmH_2O	≤ 30 cmH_2O	≤ 30 cmH_2O
PEEP	PEEP élevée (> 12 cmH_2O), si tolérance respiratoire et hémodynamique	PEEP élevée sans manœuvre de recrutement	Pas de recommandation
Manœuvres de recrutement	Non	Non	Non
Décubitus ventral	Si PaO_2/FiO_2 < 150	si PaO_2/FiO_2 < 100	Si PaO_2/FiO_2 < 150
Curarisation	Si PaO_2/FiO_2 < 150, max 48h	si PaO_2/FiO_2 < 100, précoce	Non systématique



The New England
Journal of Medicine

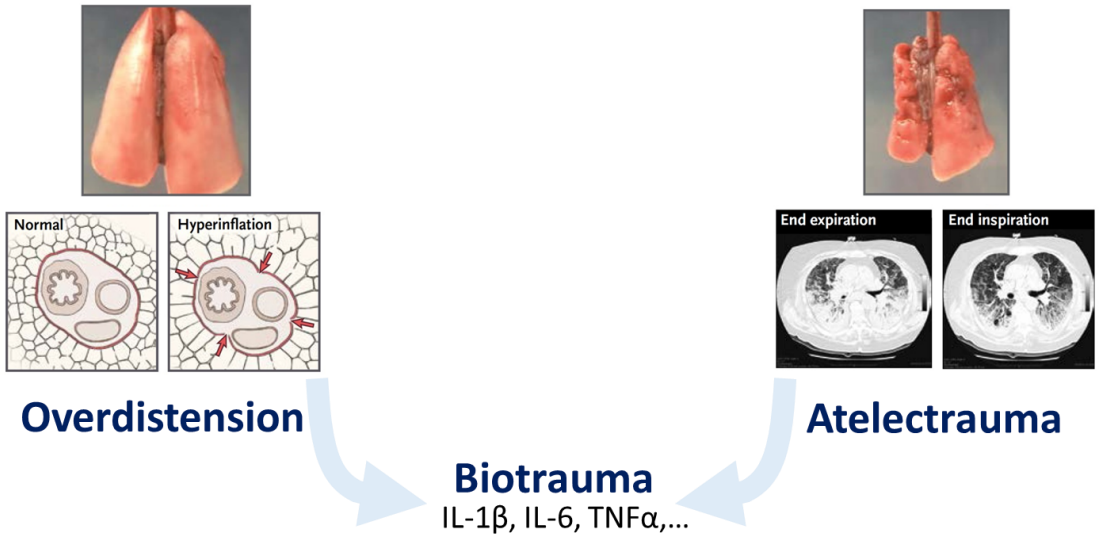
VOLUME 342 MAY 4, 2000 NUMBER 18

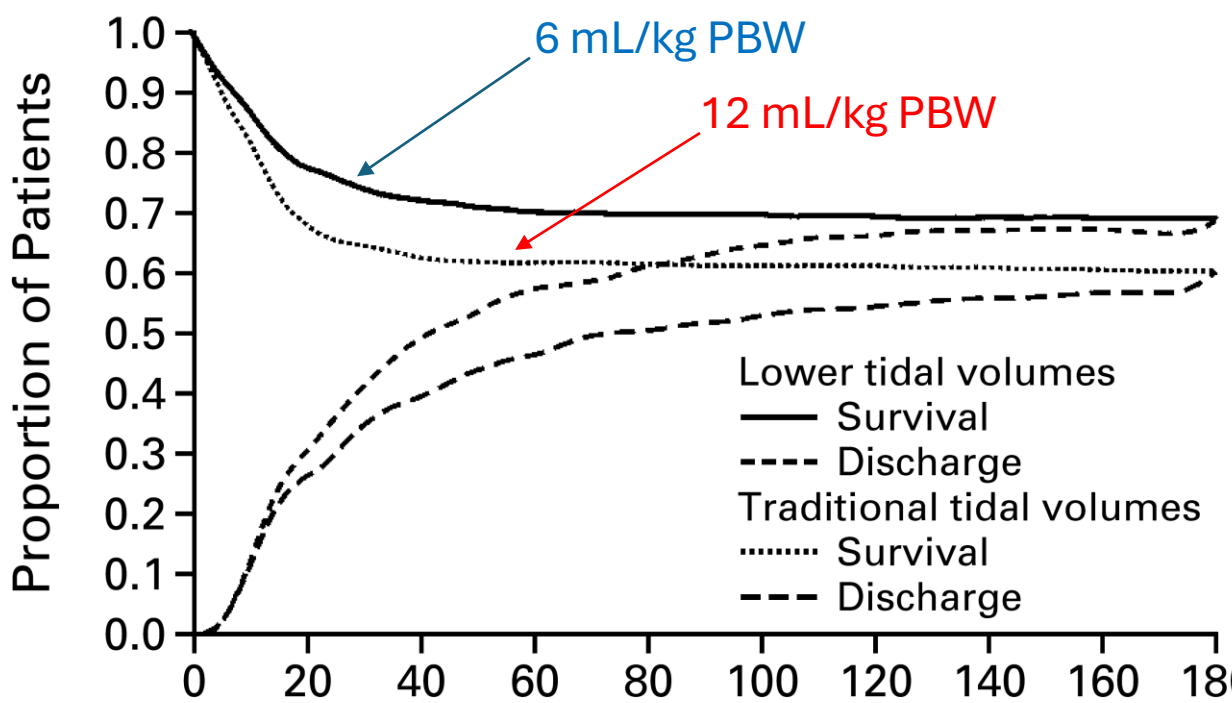
VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

VILI

Ventilator induced lung injury



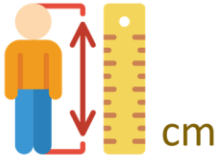


A Slutsky, M Ranieri. N Engl J Med 2013;369:2126-36.

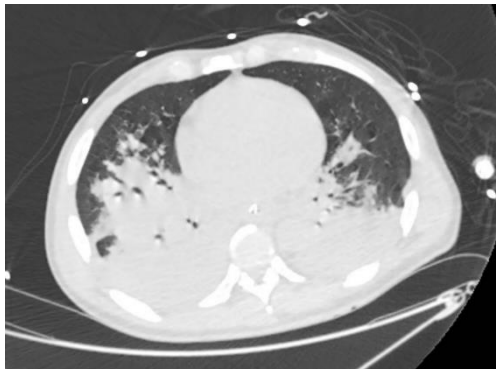
$$\frac{V_T}{PPT} \approx \frac{V_T}{\alpha(Taille\ du\ poumon\ sain)}$$

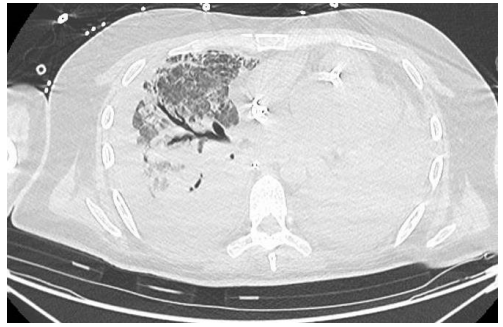
PPT = X + 0,91 (Taille – 152,4)

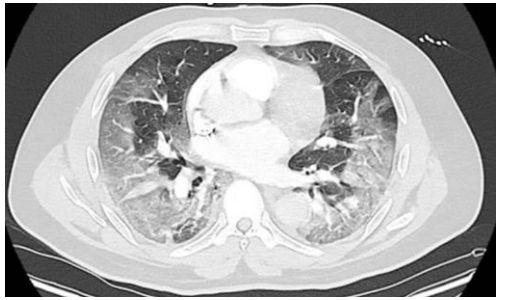
X = 45,5

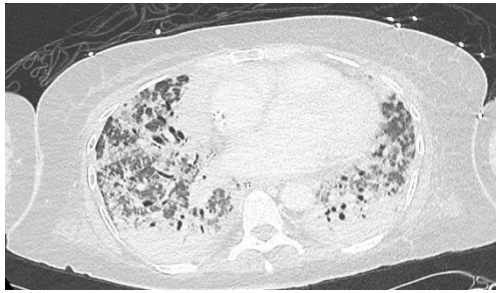


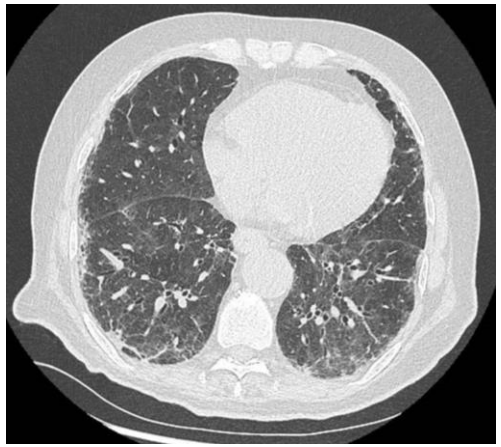
X = 50

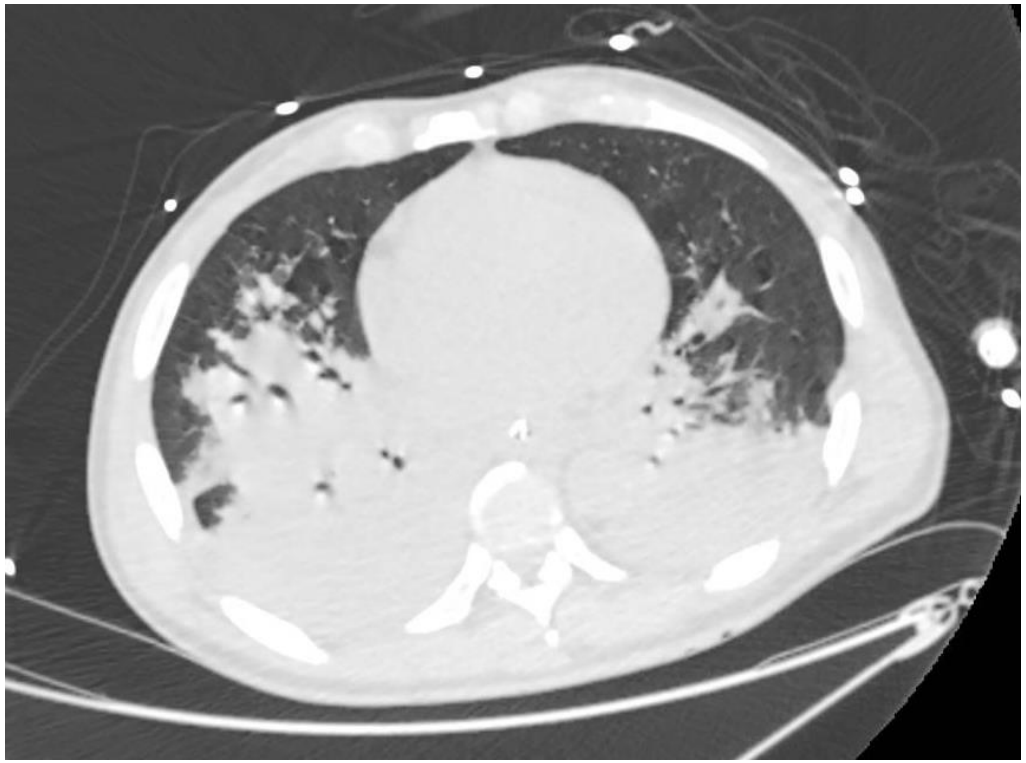


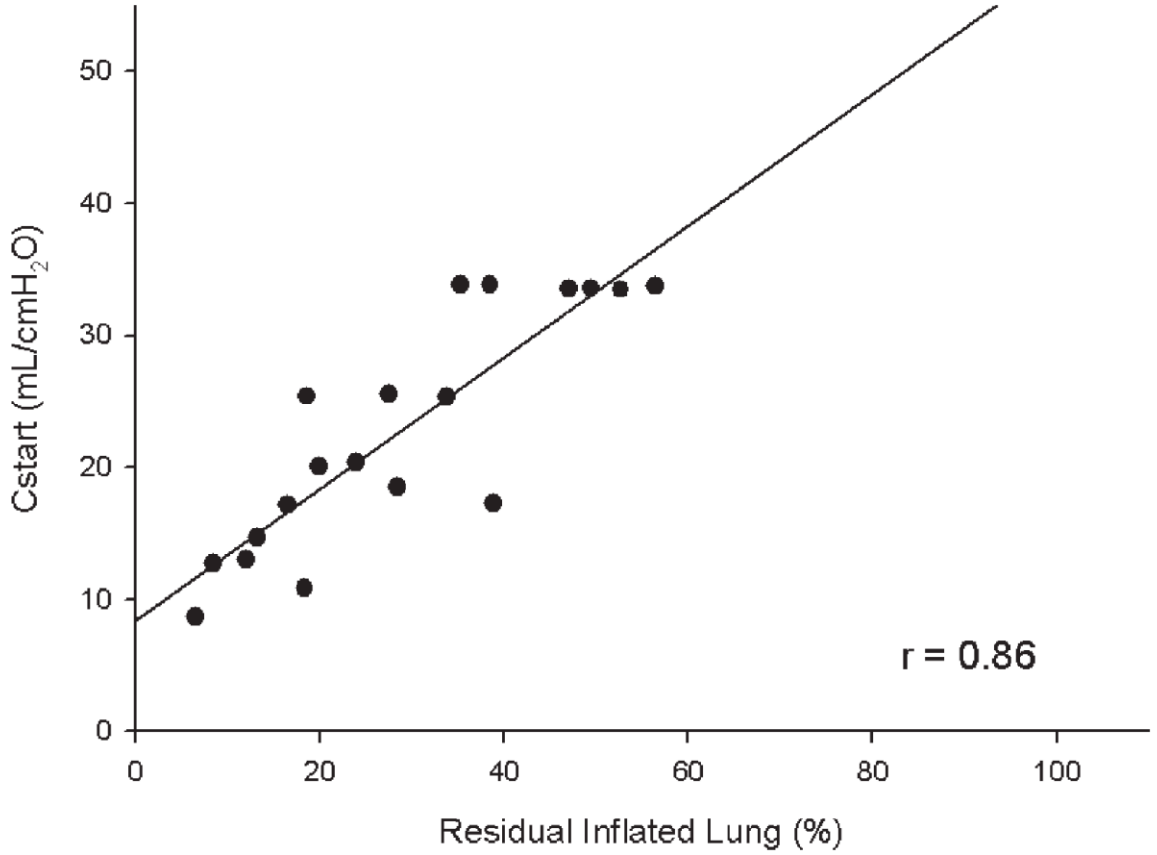










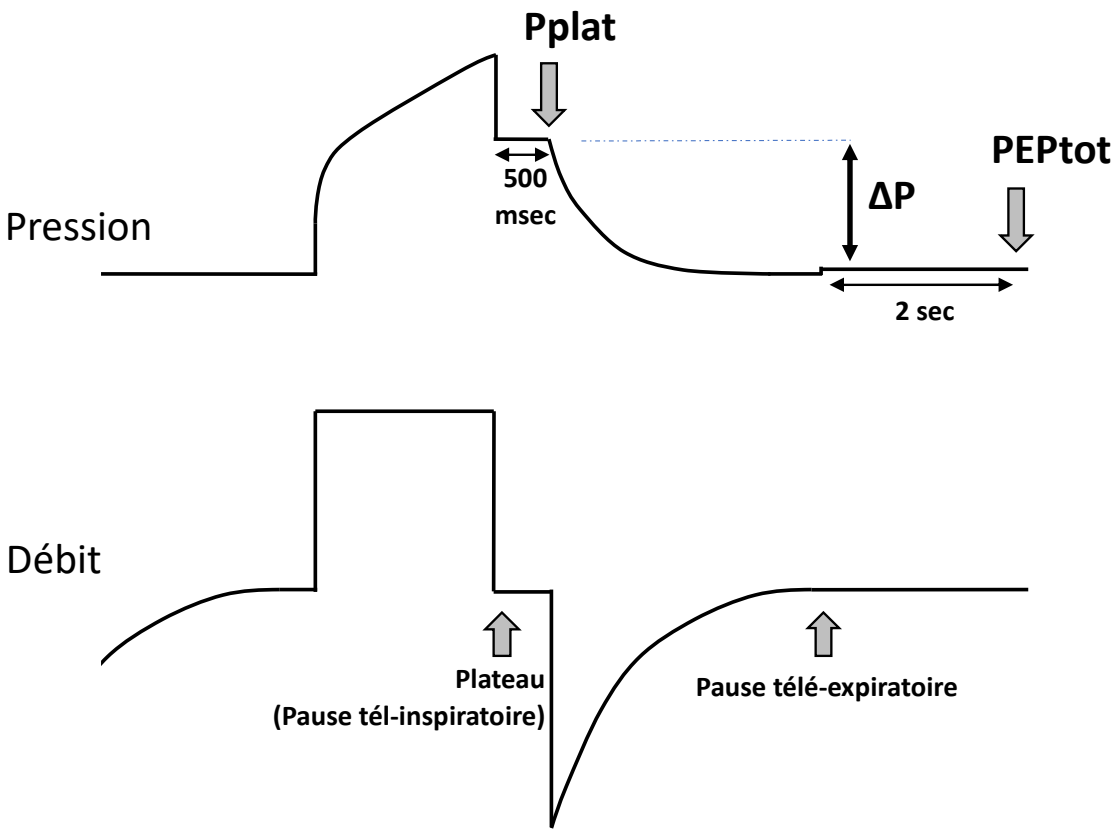


Compliance du système respiratoire = α EELV

$$C_{RS} = \frac{\Delta V}{\Delta P}$$

Gattinoni L, Pesenti A. *Intensive Care Med* 2005: The concept of « baby lung »

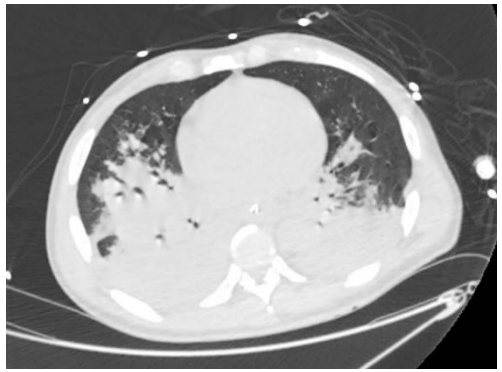
La PRESSION MOTRICE

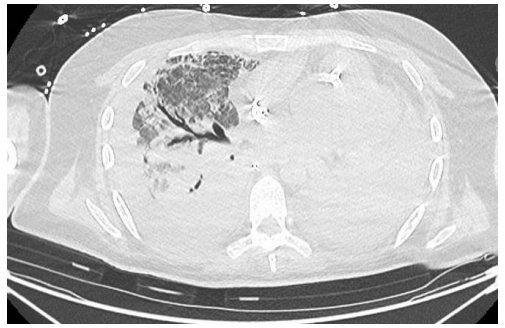


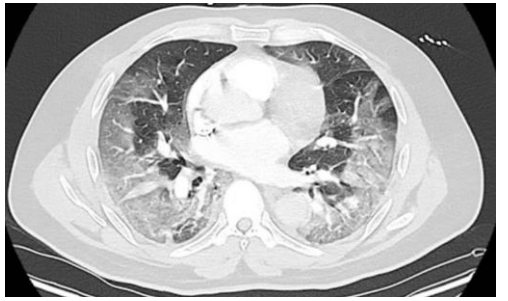
$$C_{RS} = \frac{V_T}{Pplat - PEEPtot}$$

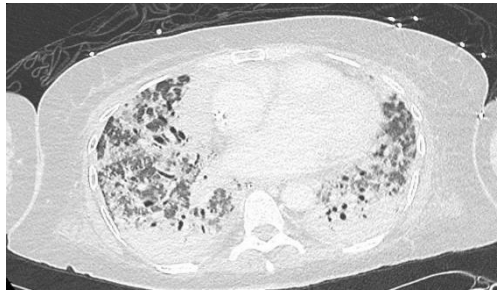
$$\Delta P = Pplat - PEEPtot = \frac{V_T}{C_{RS}}$$

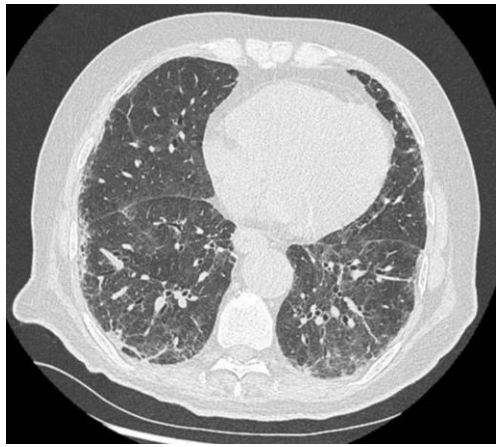
$$\Delta P = \frac{V_T}{C_{RS}} \approx \frac{V_T}{\alpha EELV} \approx strain$$



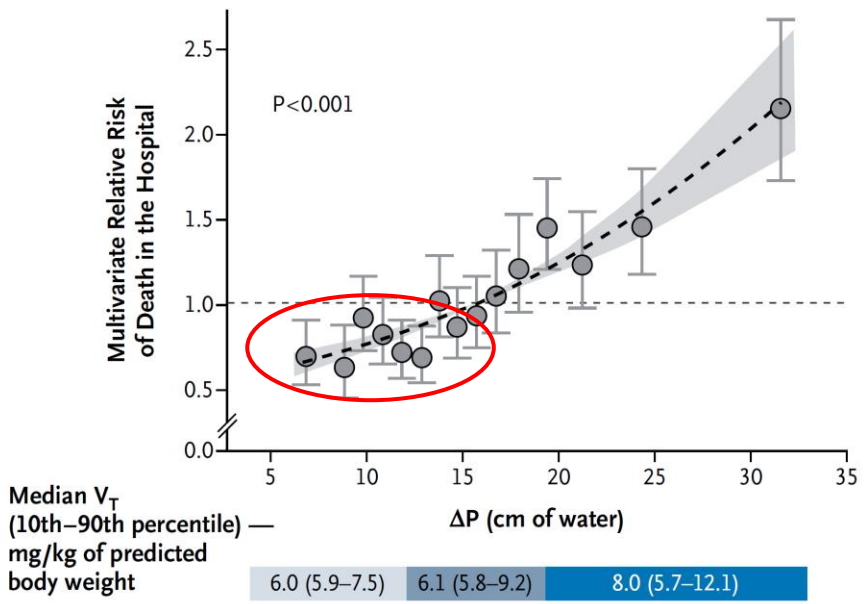








$$\Delta P < 15\ cm\ H_2O$$

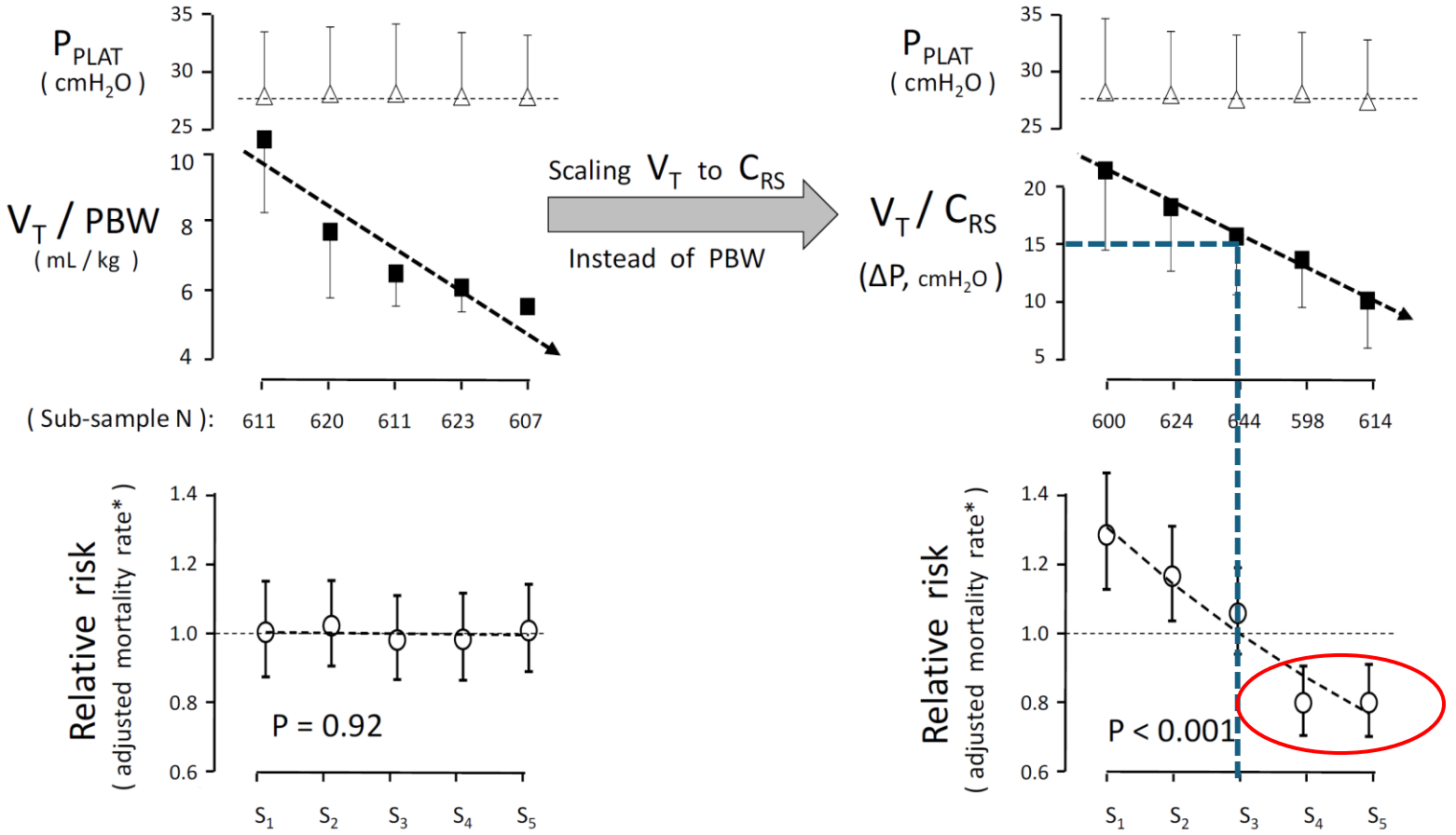


Resampling D

- matched P_{PLAT},
- decreasing ranks of V_T / PBW

Resampling E

- matched P_{PLAT},
- decreasing ranks of V_T / C_{RS} (=ΔP)

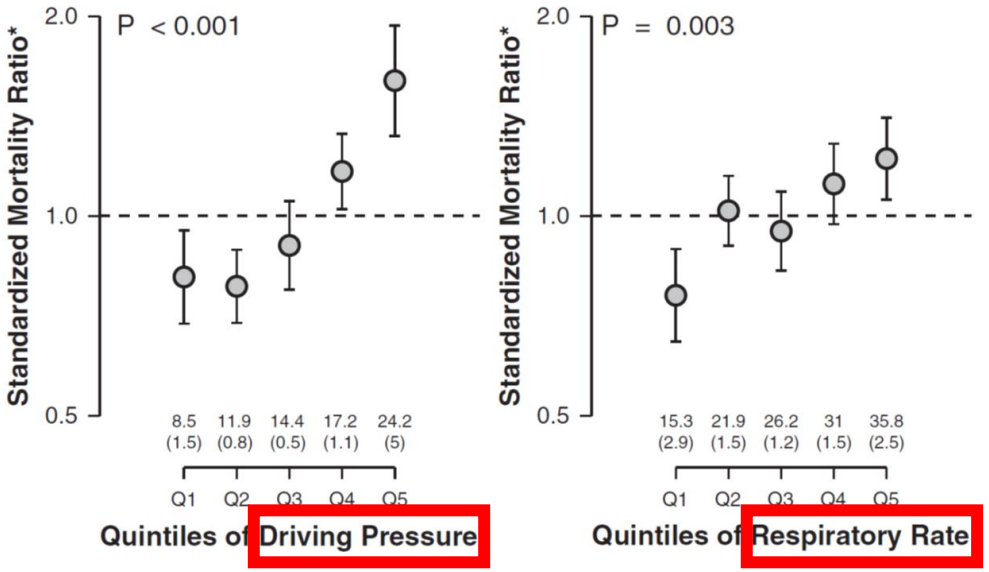


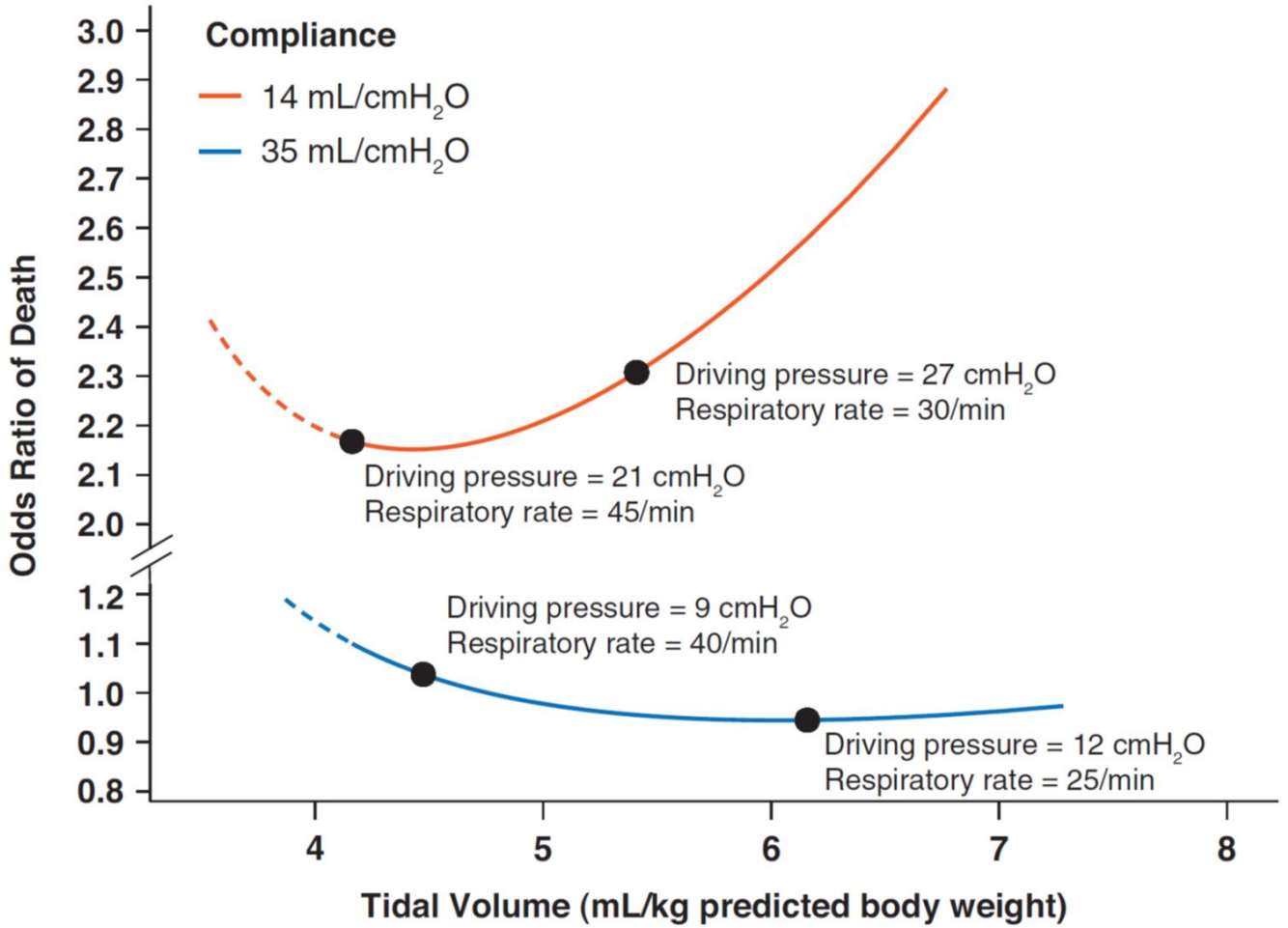
* : mortality rate adjusted for *age, APACHE/SAPS risk, arterial-pH, P/F ratio, and Trial* (Cox Proportional Hazard Regression)

Amato M et al. N Engl J Med 2015;372:747-755

Data:

6RCT
+
MIMIC-III





4 ΔP + RR

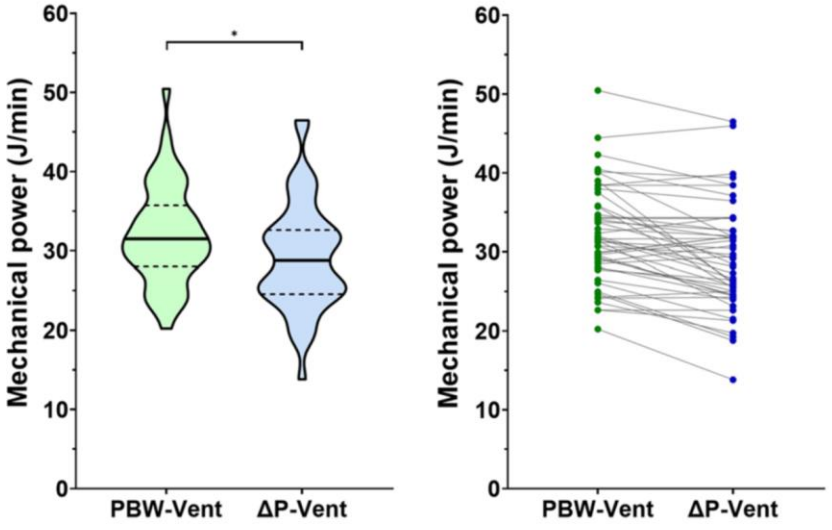
Costa E et al. Am J Respir Crit Care Med 2021;204:303-311

RESEARCH Open Access

Driving pressure-guided ventilation decreases the mechanical power compared to predicted body weight-guided ventilation in the Acute Respiratory Distress Syndrome

Anne-Fleur Haudebourg[1,2*], Samuel Tuffet[1,2,3], François Perier[1,2], Keyvan Razazi[1,2], Nicolas de Prost[1,2], Armand Mekontso Dessap[1,2] and Guillaume Carteaux[1,2,3]

Critical Care (2022) 26:185

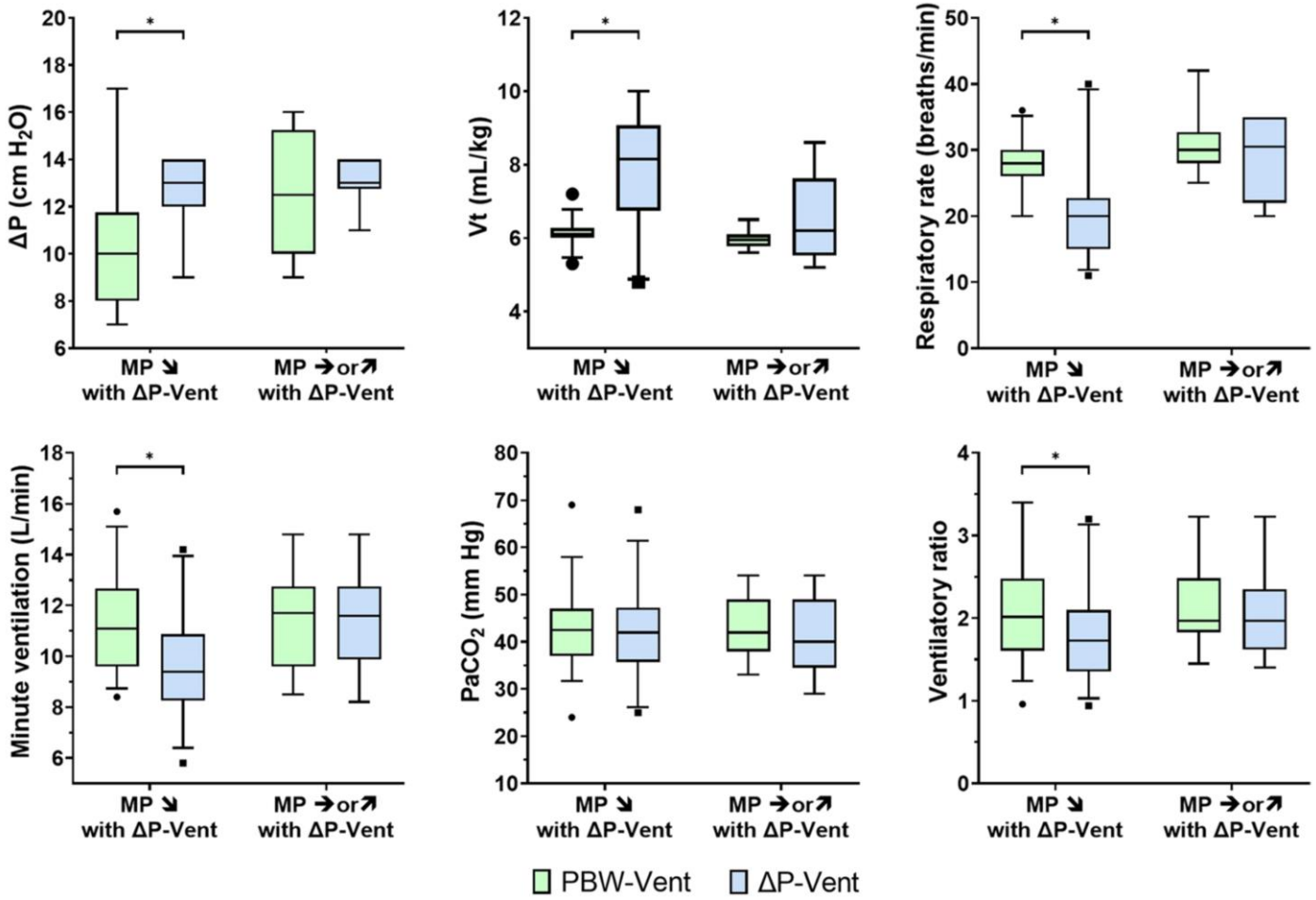


N = 50 SDRA modérés à sévères

Vt = 6 mL/kg PBW

Vt pour ΔP = 12-14 cm H_2O

FR ajustée pour $EtCO_2$ stable



Avec PBW-Vent (Vt = 6 mL/kg):

ΔP > 14 cm H_2O: 18%

ΔP 12-14 cm H_2O: 10%

ΔP < 12 cm H_2O: 72%

DRIVENT

Evaluation pré-randomization

Vt = 6 mL/kg
PEEP (PEEP/FiO_2 table)
Pplat < 30 cm H_2O

$12 \leq \Delta P \leq 14$ cmH_2O

Inclus non randomisé (10 à 25%)

$\Delta P < 12$ ou > 14 cmH_2O

randomisé

PBW-guided Vt

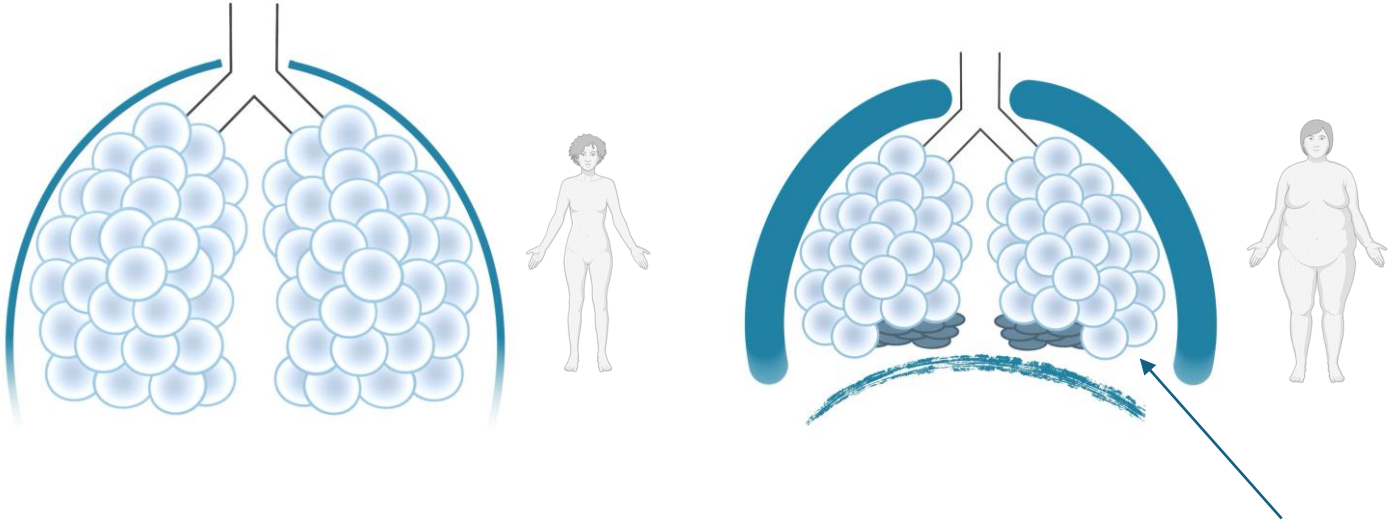
VAC:
Vt = 6 mL/kg PPT
PEEP selon PEEP/FiO_2
FR pour pH 7,30-7,45
Pplat < 30 (32 si obèse)

ΔP-guided Vt

VAC:
Vt pour cibler $12 \leq \Delta P \leq 14$ cmH_2O
PEEP selon PEEP/FiO_2
FR pour pH 7,30-7,45
Pplat < 30 (32 si obèse)

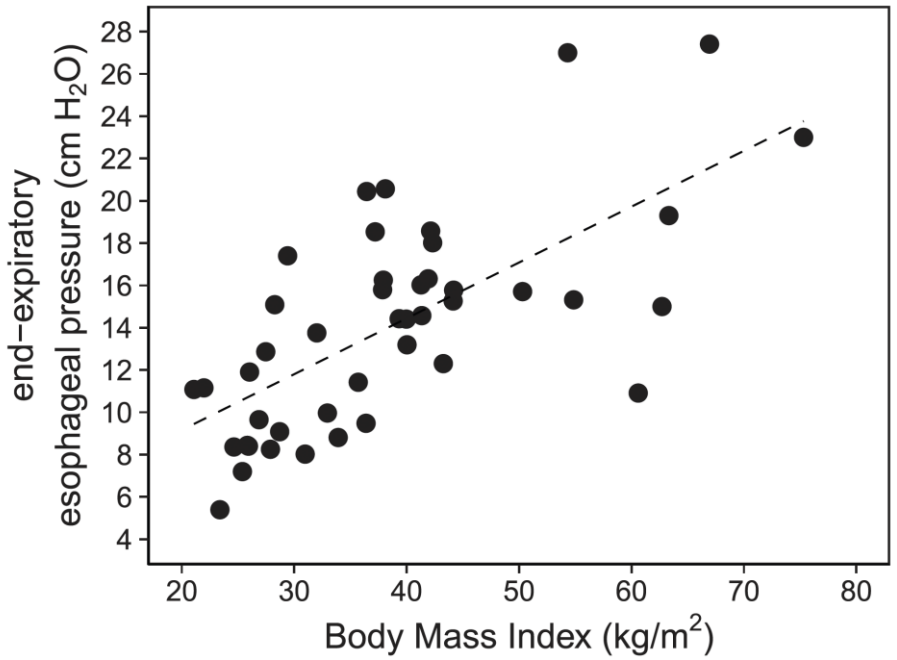
Recommandations pour DV, curares, ECMO

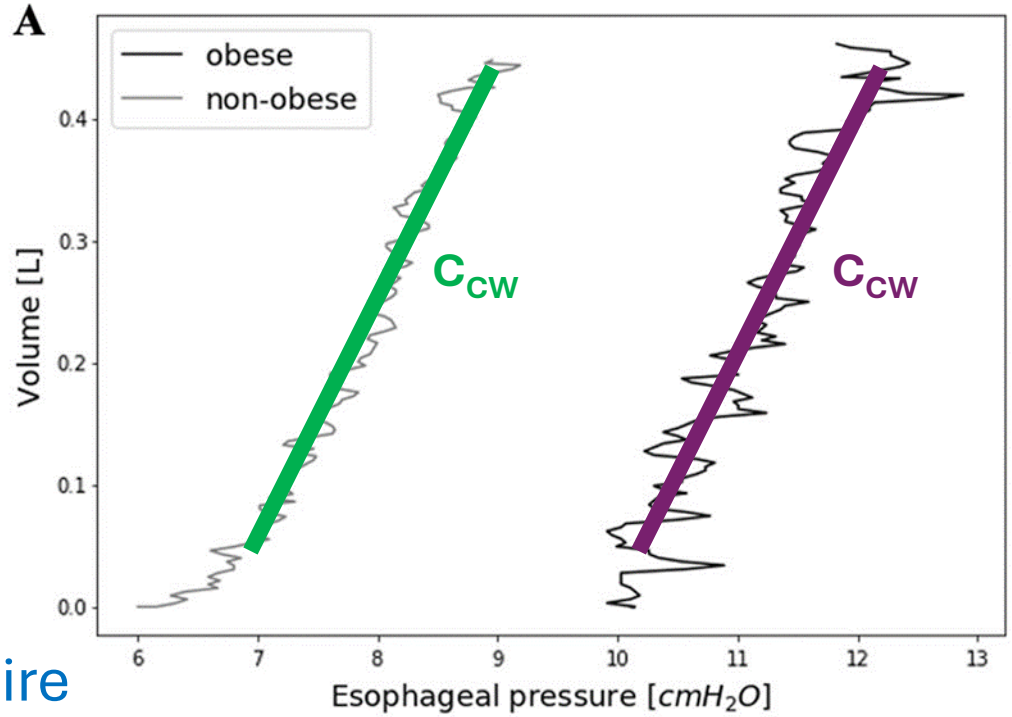
Standardisation switch vers VSAI pour le sevrage



↗ Pression pleurale

↘ Pression transpulmonaire





NON OBESE
End expiratory
pleural pressure

OBESE
End expiratory
pleural pressure

Coudroy R *et al*. *Anesthesiology* 2020

Beloncle F *et al*. *Crit Care* 2023

SDRA modéré à sévère

	SRLF (2018)	ATS (2023)	ESICM (2023)
Volume courant	6 ml/kg PPT	6 (4–8) ml/kg PPT	4 et 8 ml/kg PPT
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PEEP	PEEP élevée (> 12 cmH_2O), si tolérance respirartoire et hémodynamique	PEEP élevée sans manœuvre de recrutement	Pas de recommandation
Manœuvres de recrutement	Non	Non	Non
Décubitus ventral	Si PaO_2/FiO_2 < 150	si PaO_2/FiO_2 < 100	Si PaO_2/FiO_2 < 150
Curarisation	Si PaO_2/FiO_2 < 150, max 48h	si PaO_2/FiO_2 < 100, précoce	Non systématique

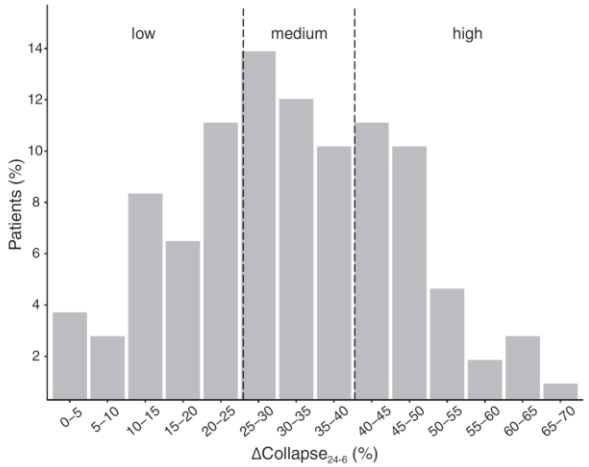
Lung Recruitment Assessed by Electrical Impedance Tomography (RECRUIT)

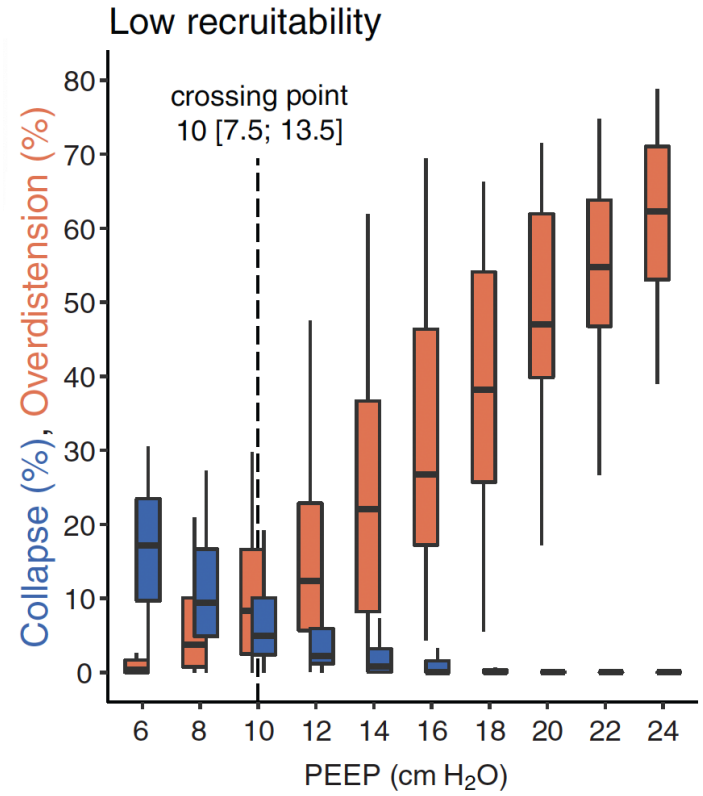
A Multicenter Study of COVID-19 Acute Respiratory Distress Syndrome

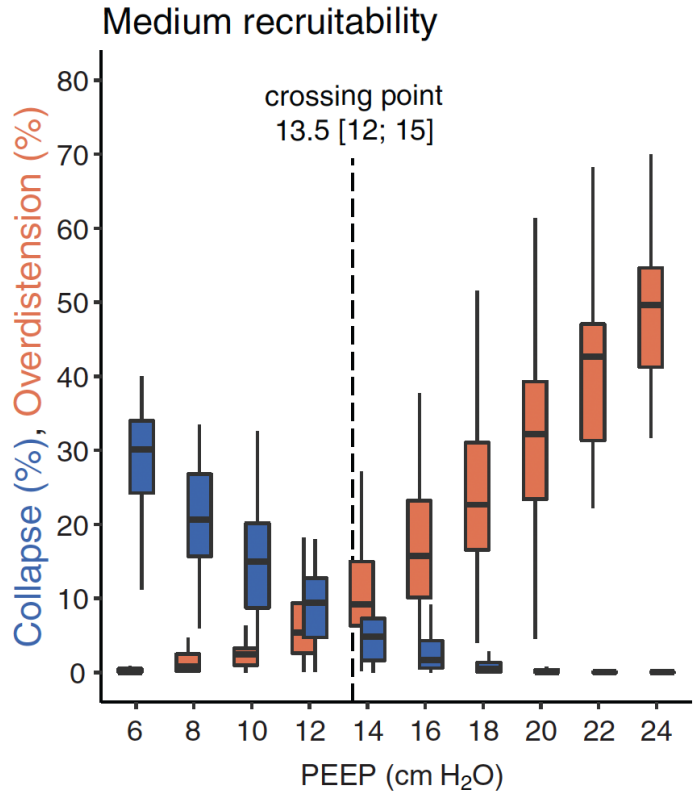
Annemijn H. Jonkman[1,2,3*], Glasiele C. Alcala[4*], Bertrand Pavlovsky[5,6], Oriol Roca[7,8], Savino Spadaro[9,10], Gaetano Scaramuzzo[9,10], Lu Chen[1,2], Jose Dianti[2,11], Mayson L. de A. Sousa[1,2,4], Michael C. Sklar[1,2], Thomas Piraino[1,2], Huiqing Ge[12], Guang-Qiang Chen[13], Jian-Xin Zhou[13], Jie Li[14], Ewan C. Goligher[2,11,15], Eduardo Costa[4], Jordi Mancebo[16†], Tommaso Mauri[17‡], Marcelo Amato[4‡], and Laurent J. Brochard[1,2‡]; for the Pleural Pressure Working Group (PLUG)

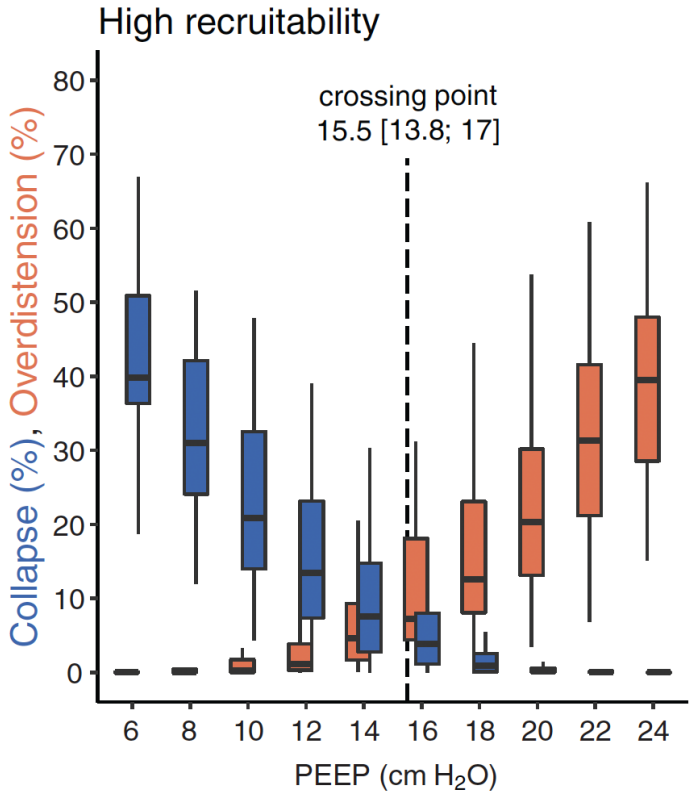
Am J Respir Crit Care Med Vol 208, Iss 1, pp 25–38, Jul 1, 2023

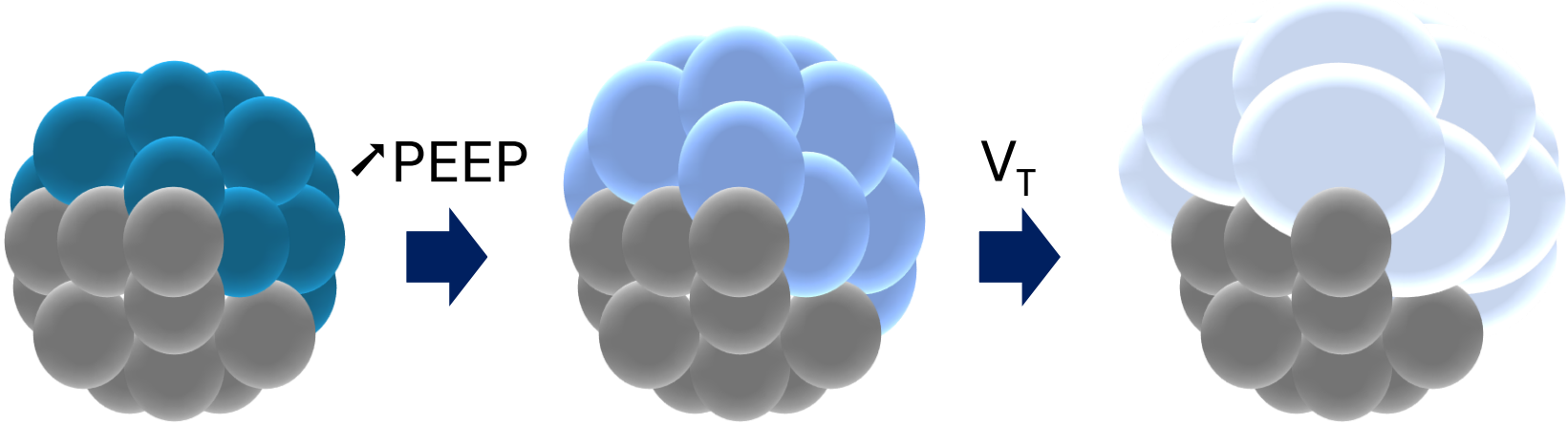
N = 108

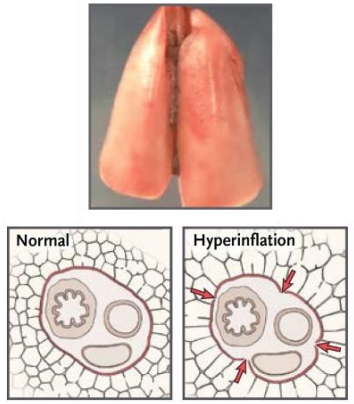






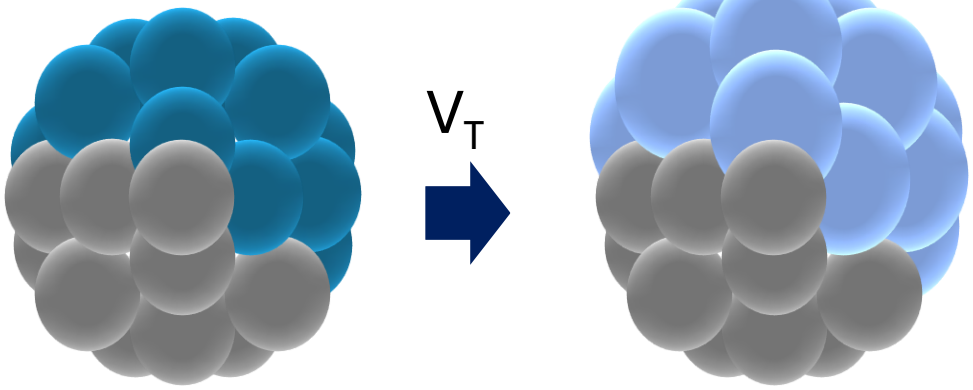




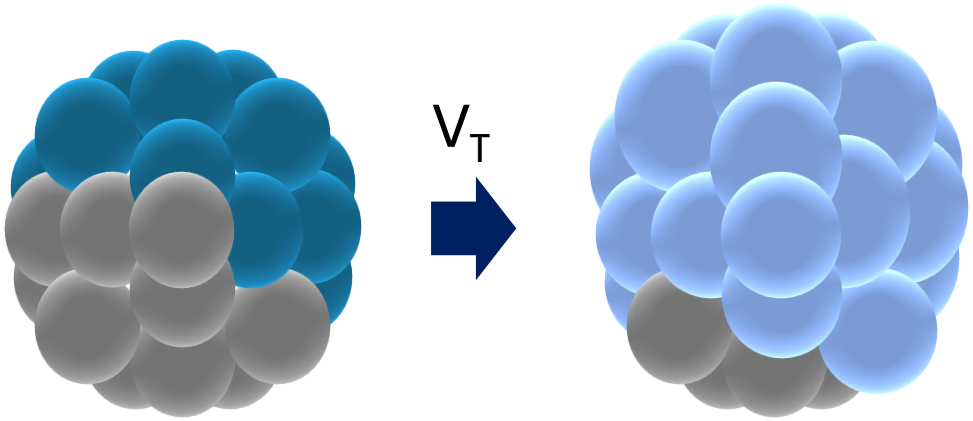


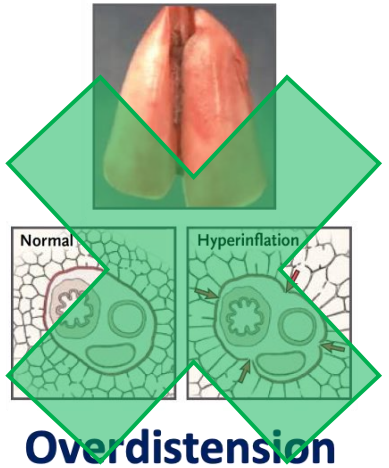
Overdistension

A Slutsky, M Ranieri. N Engl J Med 2013;369:2126-36

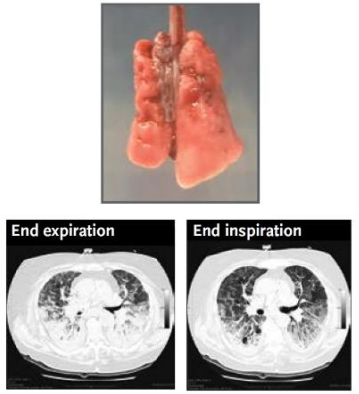


Low PEEP



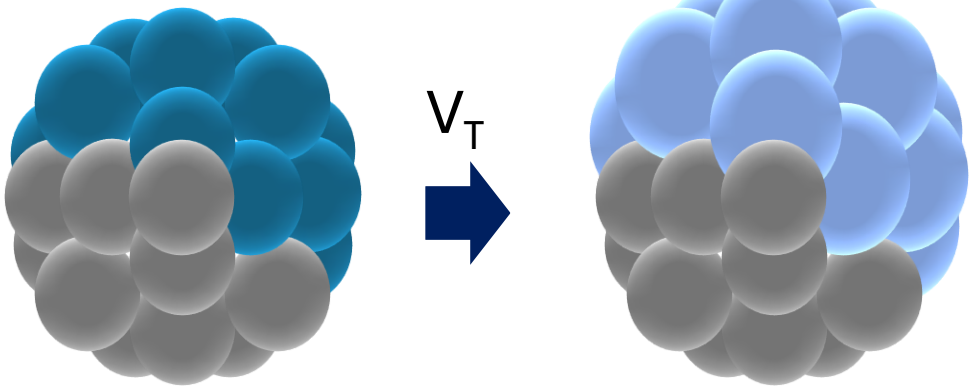


Overdistension

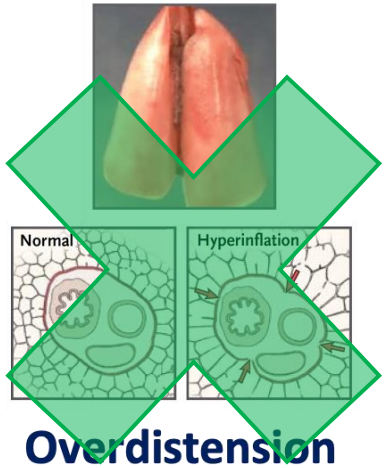


Atelectrauma

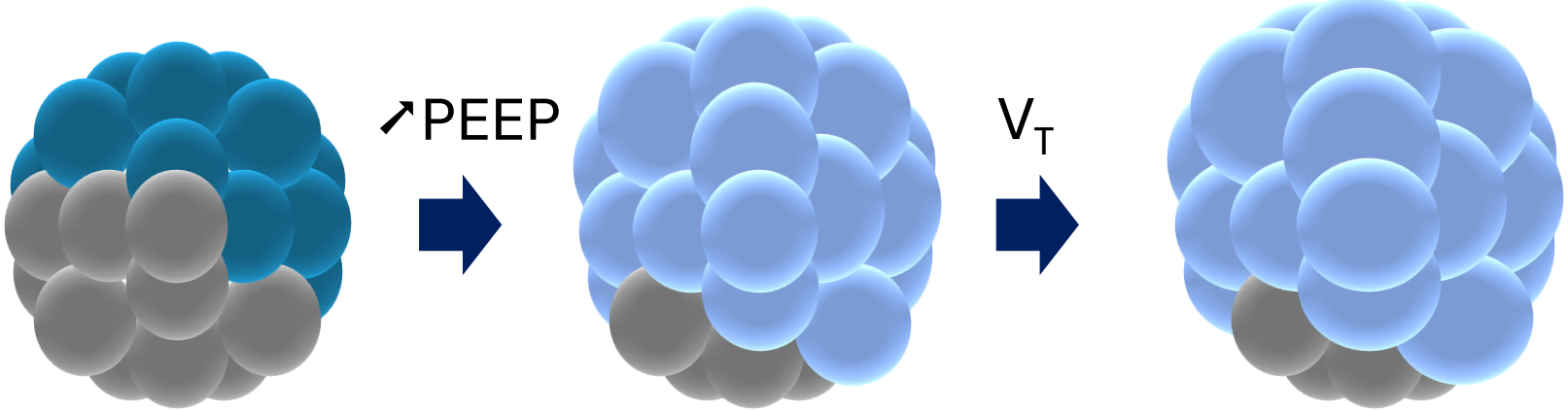
A Slutsky, M Ranieri. N Engl J Med 2013;369:2126-36



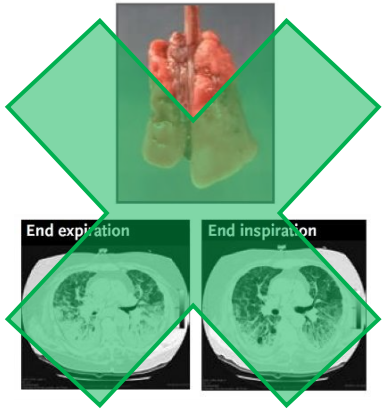
Low PEEP



Overdistension

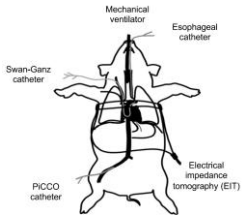


high PEEP



Atelectrauma

A Slutsky, M Ranieri. N Engl J Med 2013;369:2126-36



Severe and recruitable animal model of ARDS

Mortality = 0%

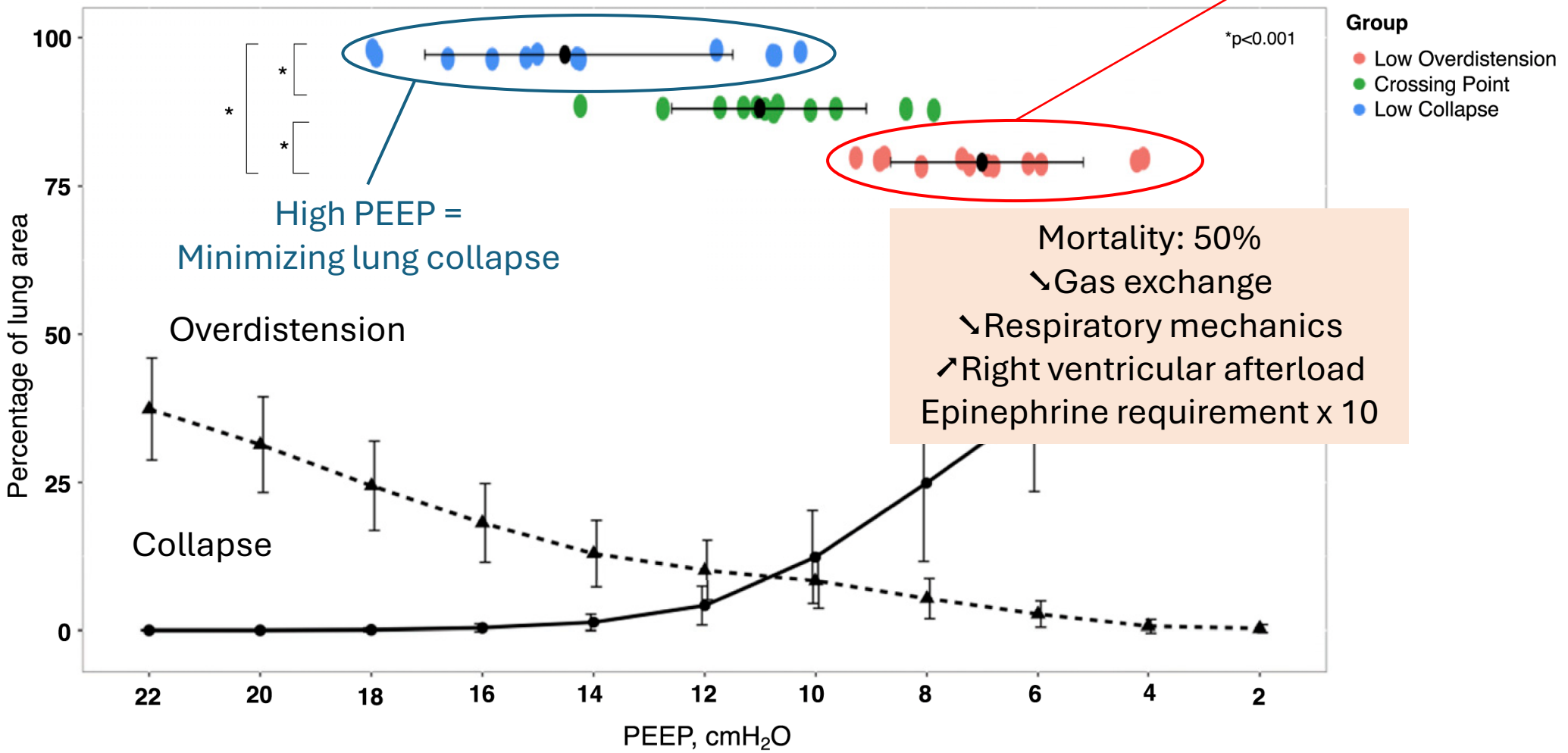
Low PEEP =
minimizing overdistension

High PEEP =
Minimizing lung collapse

Overdistension

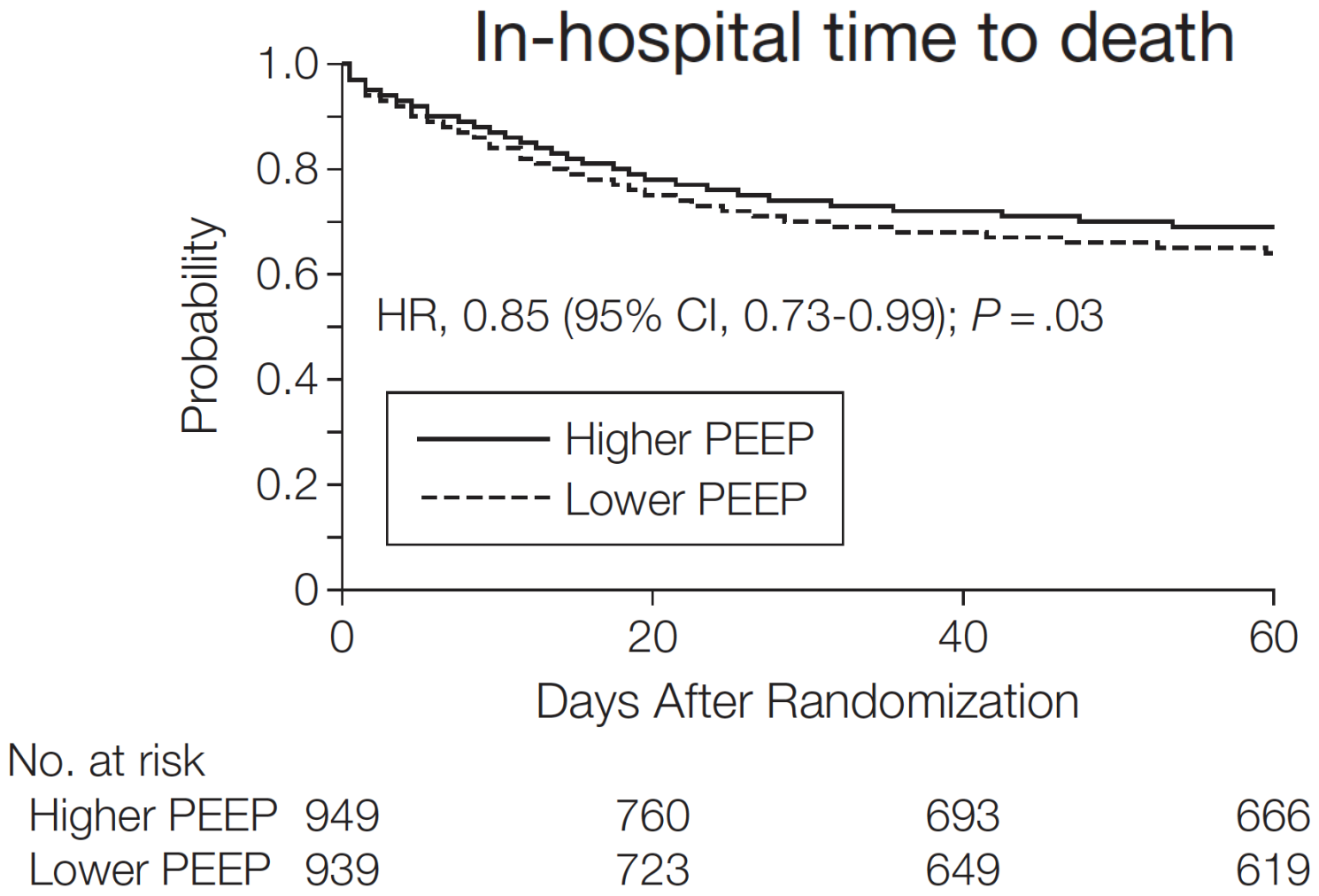
Collapse

Mortality: 50%
↘Gas exchange
↘Respiratory mechanics
↗Right ventricular afterload
Epinephrine requirement x 10



MLA Sousa *et al. Am J Respir Crit Care Med 2024*

PaO2/FiO2 ≤ 200 mm Hg



Briel M *et al*. *JAMA* 2010

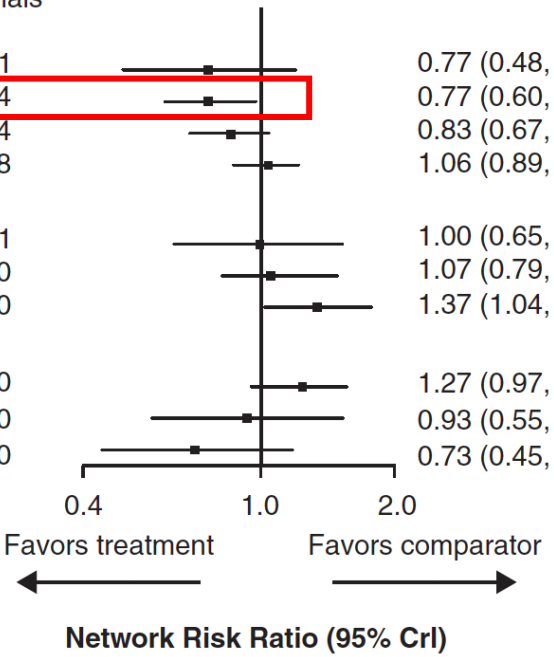
Association of Positive End-Expiratory Pressure and Lung Recruitment Selection Strategies with Mortality in Acute Respiratory Distress Syndrome

A Systematic Review and Network Meta-analysis

Jose Dianti[1,2], Manuel Tisminetzky[1,2], Bruno L. Ferreyro[1,2,3], Marina Englesakis[4], Lorenzo Del Sorbo[1,2,5], Sachin Sud[6], Daniel Talmor[7], Lorenzo Ball[8], Maureen Meade[9,10], Carol Hodgson[11,12], Jeremy R. Beitler[13], Sarina Sahetya[14], Alistair Nichol[11,15,16], Eddy Fan[1,2,3,5,17,18,19], Bram Rochwerg[9,10], Laurent Brochard[2,20], Arthur S. Slutsky[2,20], Niall D. Ferguson[1,2,3,5,18,19], Ary Serpa Neto[10,21,22], Neill K. J. Adhikari[2,3,23], Federico Angriman[2,3,23*], and Ewan C. Goligher[1,2,5,17,18*]

Am J Respir Crit Care Med Vol 205, Iss 11, pp 1300–1310, Jun 1, 2022

	Direct comparisons		Network Risk Ratio (95% CrI)	Absolute risk difference (95% CrI)	Posterior probabilities			Certainty
	Patients	Trials			RR < 1.0	RR > 1.0	ARR > 1%	
vs. Lower PEEP strategy								
Pes-guided	49	1	0.77 (0.48, 1.22)	–0.09 (–0.21, 0.09)	0.87	0.13	0.84	Moderate
Higher PEEP without LRM	1,162	4	0.77 (0.60, 0.96)	–0.09 (–0.16, –0.01)	0.99	0.01	0.98	High
Higher PEEP with brief LRM	1,335	4	0.83 (0.67, 1.02)	–0.07 (–0.13, 0.01)	0.96	0.04	0.94	Moderate
Higher PEEP with prolonged LRM	1,900	8	1.06 (0.89, 1.22)	0.02 (–0.04, 0.09)	0.23	0.77	0.15	Low
vs. Higher PEEP without LRM strategy								
Pes-guided	200	1	1.00 (0.65, 1.54)	0.00 (–0.11, 0.16)	0.50	0.50	0.44	Moderate
Higher PEEP with brief LRM	0	0	1.07 (0.79, 1.48)	0.02 (–0.08, 0.12)	0.32	0.68	0.25	Low
Higher PEEP with prolonged LRM	0	0	1.37 (1.04, 1.81)	0.11 (0.01, 0.21)	0.01	0.99	0.01	Moderate
Additional comparisons								
Higher PEEP with prolonged vs. brief LRM	0	0	1.27 (0.97, 1.64)	0.09 (–0.01, 0.18)	0.04	0.96	0.03	Low
Pes-guided vs. Higher PEEP with brief LRM	0	0	0.93 (0.55, 1.54)	–0.02 (–0.16, 0.17)	0.61	0.39	0.57	Low
Pes-guided vs. Higher PEEP with prolonged LRM	0	0	0.73 (0.45, 1.19)	–0.11 (–0.25, 0.08)	0.90	0.10	0.88	Low



Association of Positive End-Expiratory Pressure and Lung Recruitment Selection Strategies with Mortality in Acute Respiratory Distress Syndrome

A Systematic Review and Network Meta-analysis

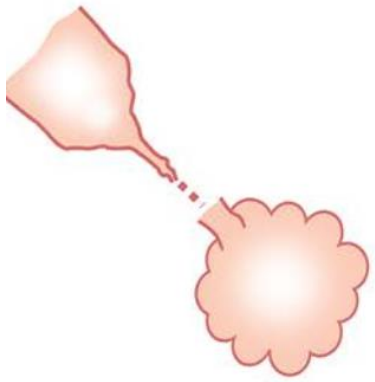
Jose Dianti[1,2], Manuel Tisminetzky[1,2], Bruno L. Ferreyro[1,2,3], Marina Englesakis[4], Lorenzo Del Sorbo[1,2,5], Sachin Sud[6], Daniel Talmor[7], Lorenzo Ball[8], Maureen Meade[9,10], Carol Hodgson[11,12], Jeremy R. Beitler[13], Sarina Sahetya[14], Alistair Nichol[11,15,16], Eddy Fan[1,2,3,5,17,18,19], Bram Rochwerg[9,10], Laurent Brochard[2,20], Arthur S. Slutsky[2,20], Niall D. Ferguson[1,2,3,5,18,19], Ary Serpa Neto[10,21,22], Neill K. J. Adhikari[2,3,23], Federico Angriman[2,3,23*], and Ewan C. Goligher[1,2,5,17,18*]

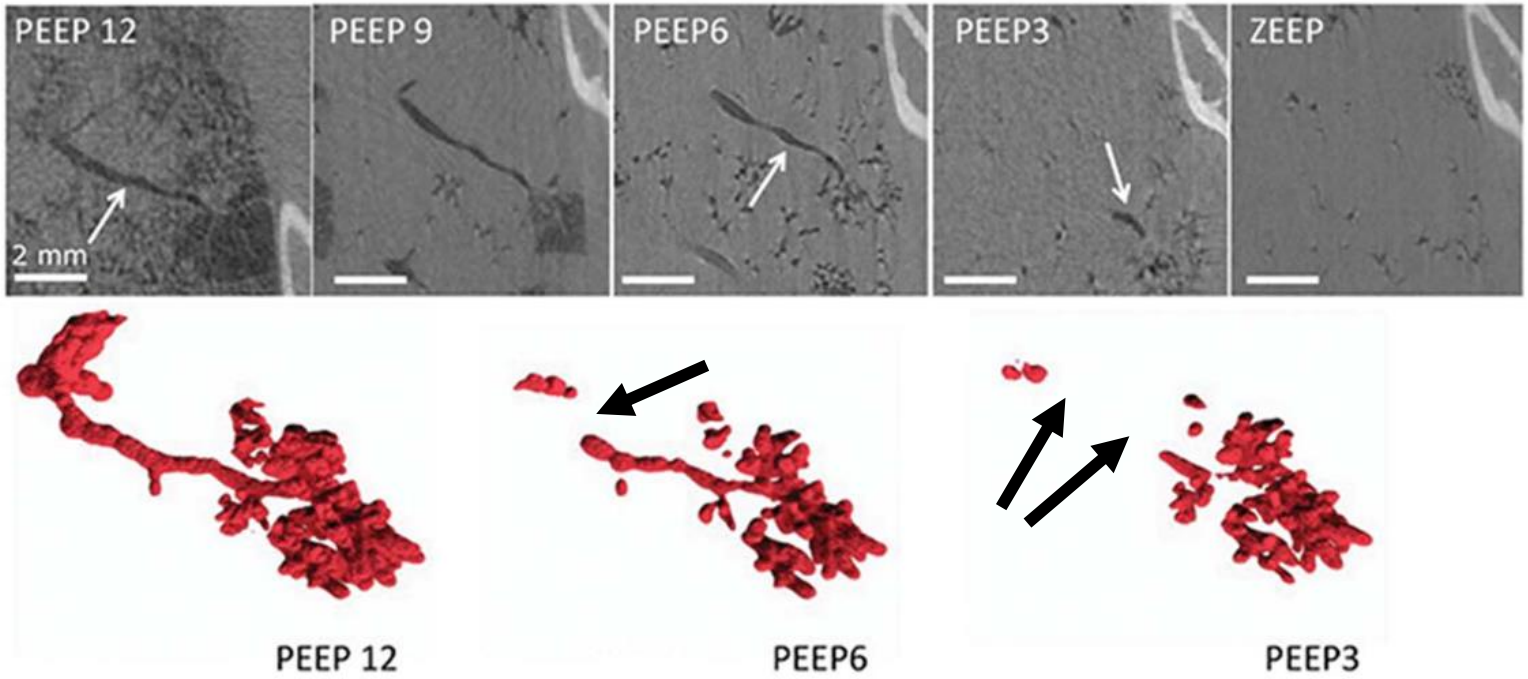
Am J Respir Crit Care Med Vol 205, Iss 11, pp 1300–1310, Jun 1, 2022

Certainty of evidence	Ranking category	Intervention	Reference	Risk ratio (95% CrI)	Posterior probability of benefit
High confidence (Moderate to high certainty)	*Probably **more** effective than lower PEEP*	Higher PEEP without LRM	Lower PEEP	0.77 (0.60 – 0.96)	99%
	*Probably **more** effective than lower PEEP*	Higher PEEP with brief LRM	Lower PEEP	0.83 (0.67 – 1.02)	96%
	*May result in **little or no difference** in outcome in comparison to lower PEEP*	Pes-guided	Lower PEEP	0.77 (0.48 – 1.22)	87%
	*Probably **harmful** compared to higher PEEP without LRM*	Higher PEEP with prolonged LRM	Higher PEEP without LRM	1.37 (1.04 – 1.81)	1%
Low confidence (Low certainty)	*May result in **little or no difference** in outcome in comparison to lower PEEP*	Higher PEEP with prolonged LRM	Lower PEEP	1.06 (0.89 – 1.22)	23%
	*May result in **little or no difference** in outcome in comparison to higher PEEP without LRM*	Higher PEEP with brief LRM	Higher PEEP without LRM	1.07 (0.79 – 1.48)	32%

Are the airways open?

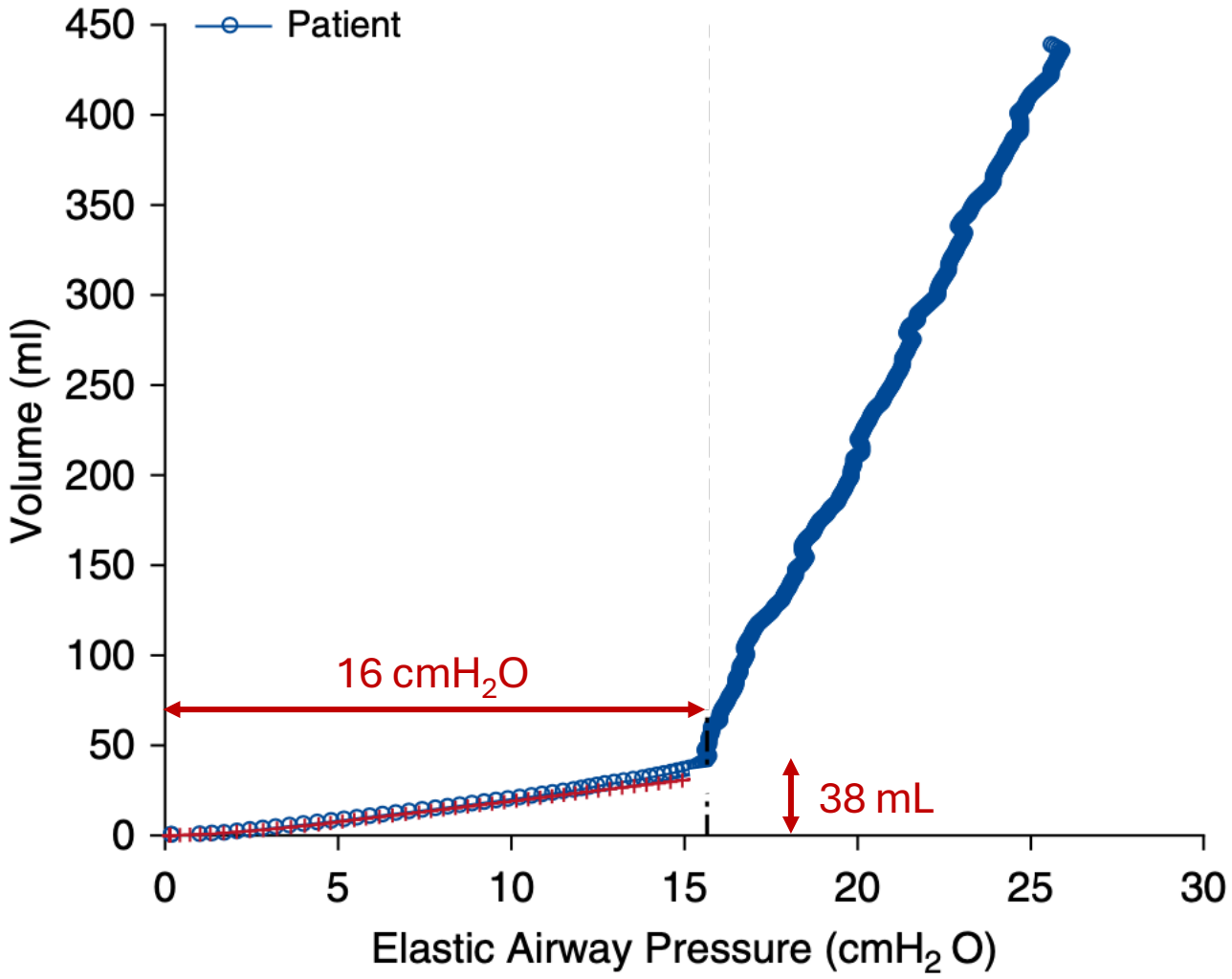
High-resolution synchrotron phase-contrast CT





Broche *et al, Crit Care Med*, 2019

PV curve and Airway Opening Pressure (AOP)

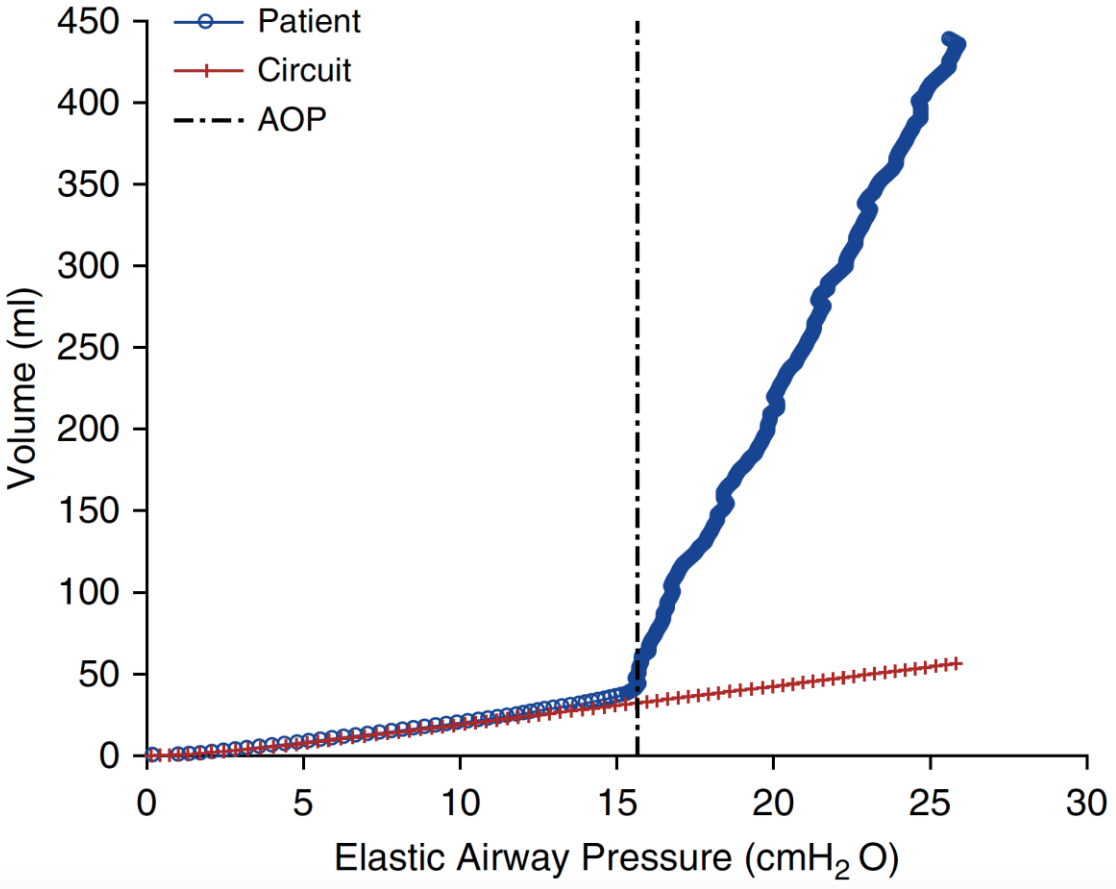


2.4 mL/cmH_2O

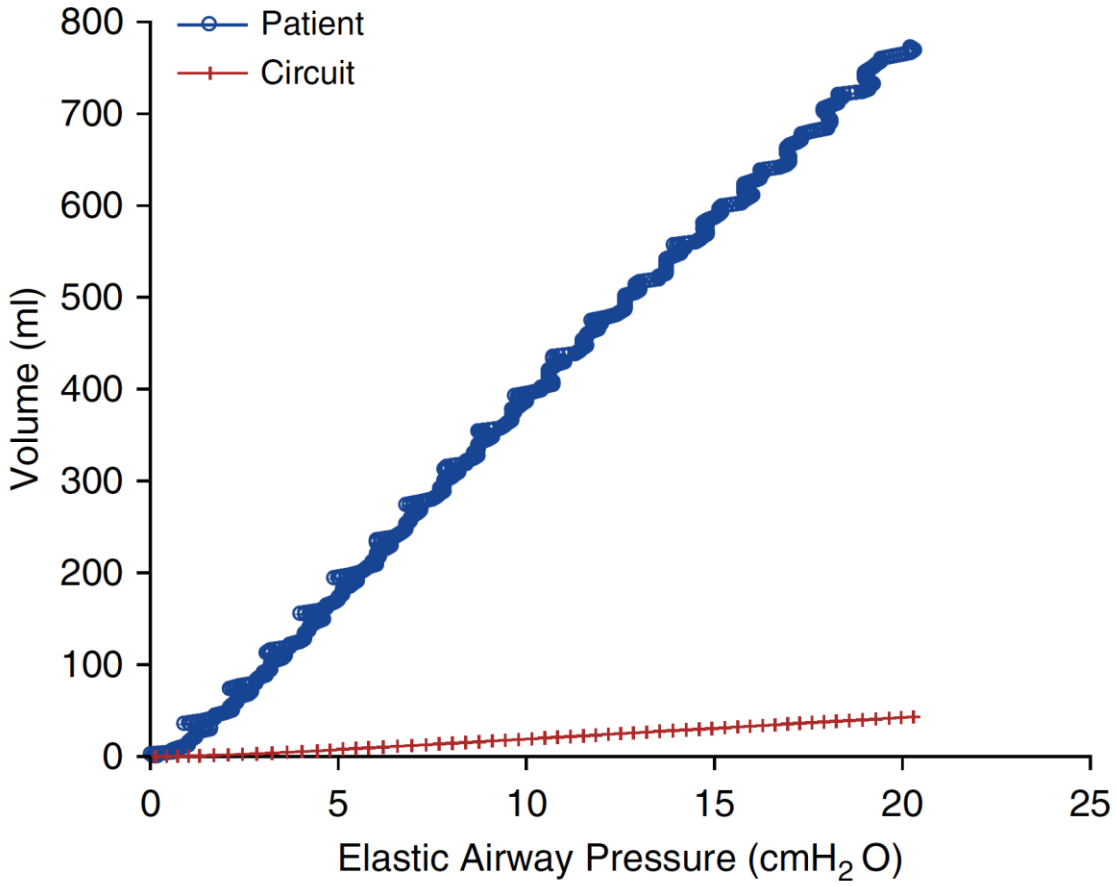
Circuit's compliance

Chen *et al. Am J Respir Crit Care Med* 2017

Airway closure

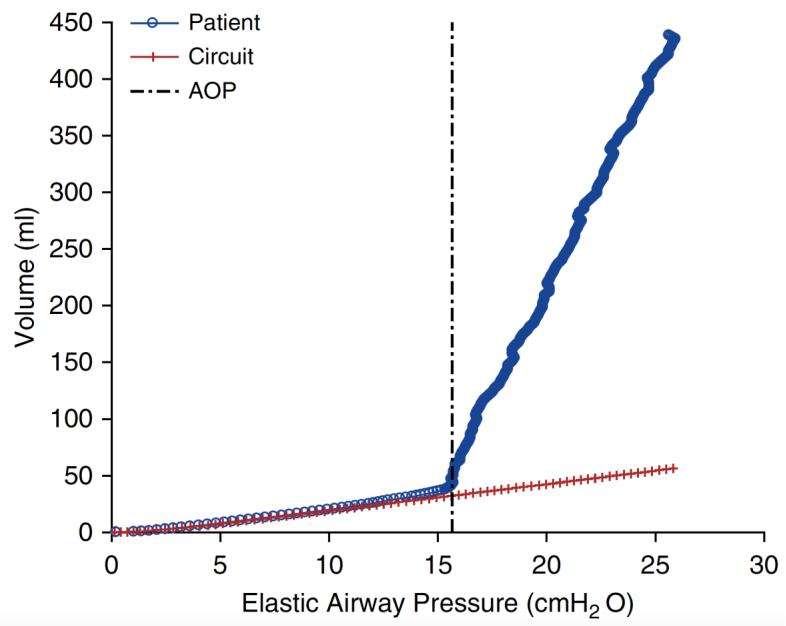


No airway closure

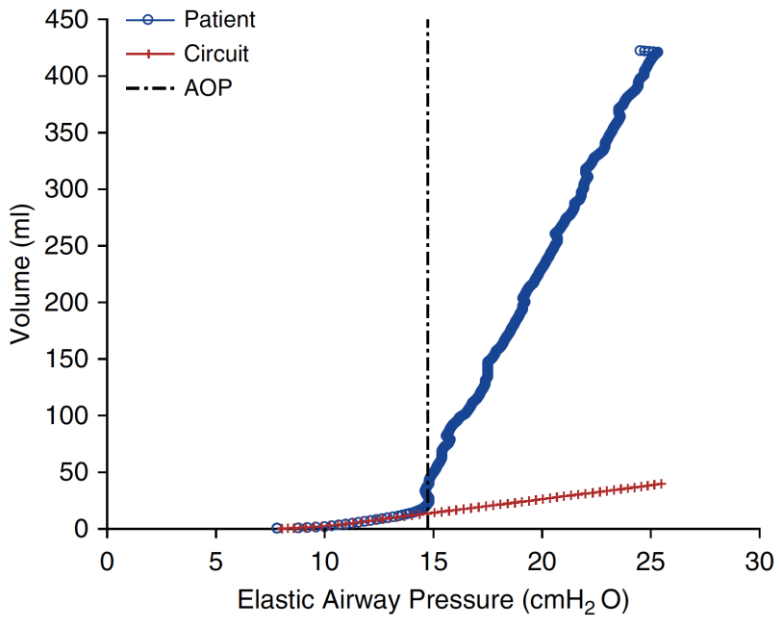


Chen *et al. Am J Respir Crit Care Med* 2017

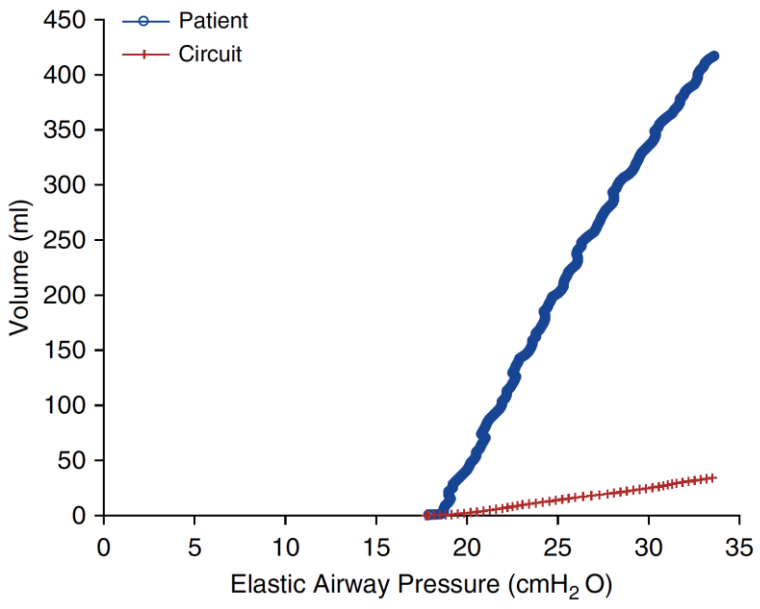
Airway closure and airway opening pressure



ZEEP



PEEP = 8 cm H_2O



PEEP = 16 cm H_2O

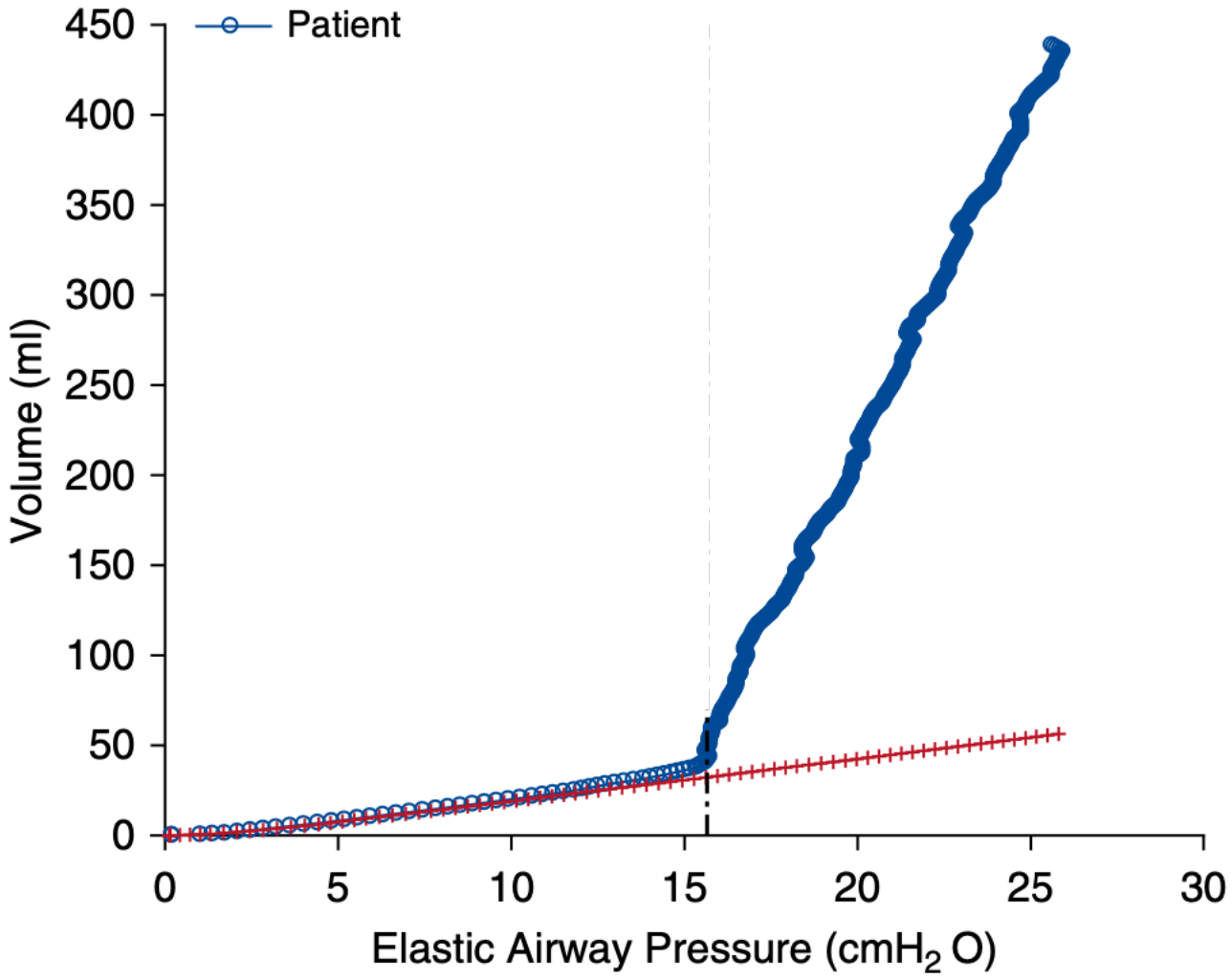
Chen *et al. Am J Respir Crit Care Med* 2017

Airway closure: a common phenomenon?

51 ARDS patients	Pooled Cohort (n = 51)	Body Mass Index < 30 kg/m² (n = 18)	Body Mass Index ≥ 30 and < 40 kg/m² (n = 16)	Body Mass Index ≥ 40 kg/m² (n = 17)	*P* Value
PEEP set, cm H_2O	5 (5–6)	5 (5–5)	5 (5–8)	5 (5–5)	0.219
Low-flow inflation pressure–volume curve					
Complete airway closure, n (%)	21 (41%)	4 (22%)	6 (38%)	11 (65%)	0.036
Airway opening pressure, cm H_2O	9.6 (8.5–13.2)	9.7 (9.2–12.2)	12.5 (7.5–16.7)	9.6 (8.8–10.7)	0.836

Guérin *J Appl Physiol* 2020
Coudroy *Anesthesiology* 2020

How to measure AOP?

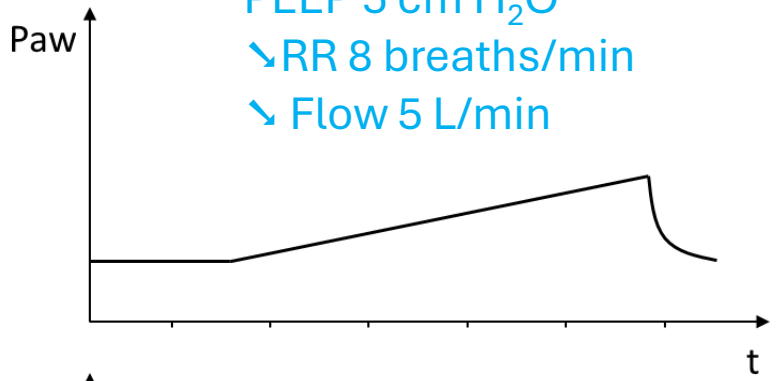


Chen *et al*. *Am J Respir Crit Care Med* 2017

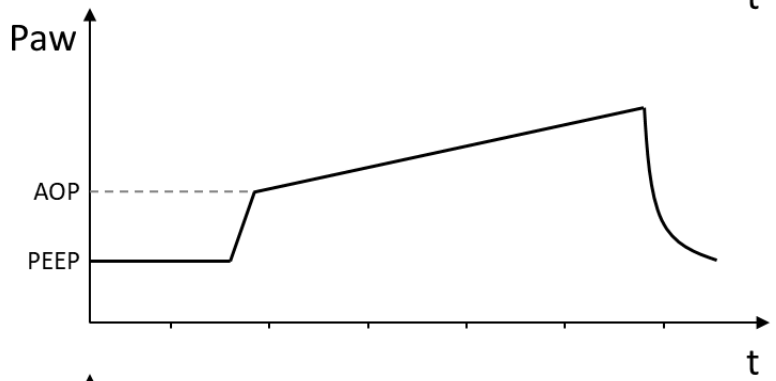
Low flow insufflation

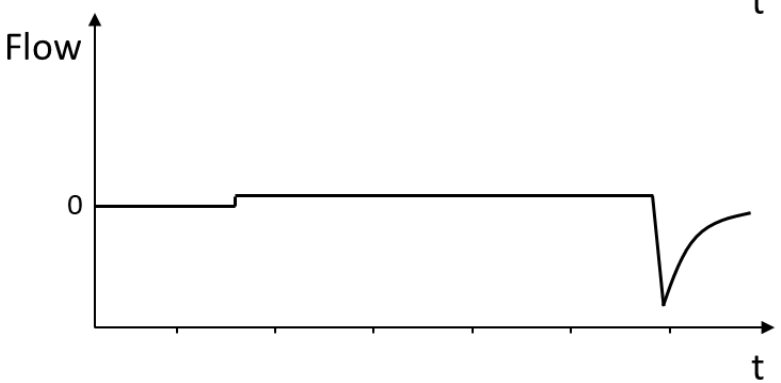
PEEP 5 cm H_2O
↘RR 8 breaths/min
↘ Flow 5 L/min

No AOP



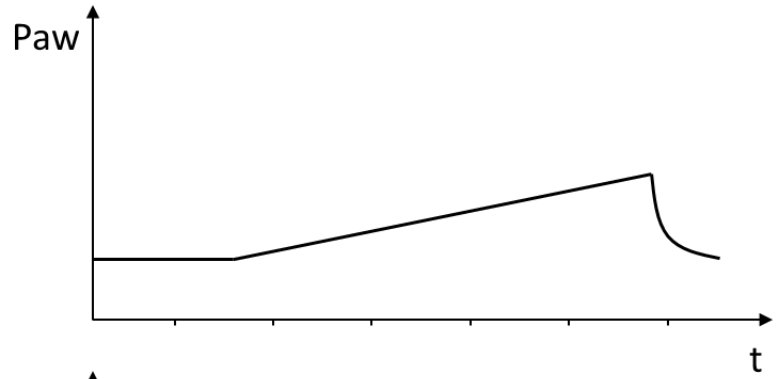
AOP



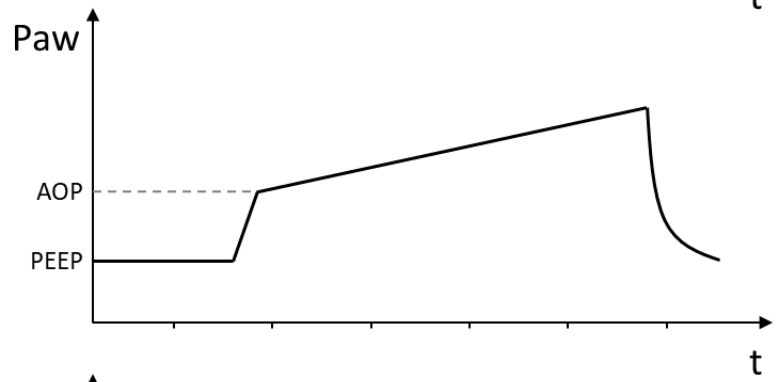


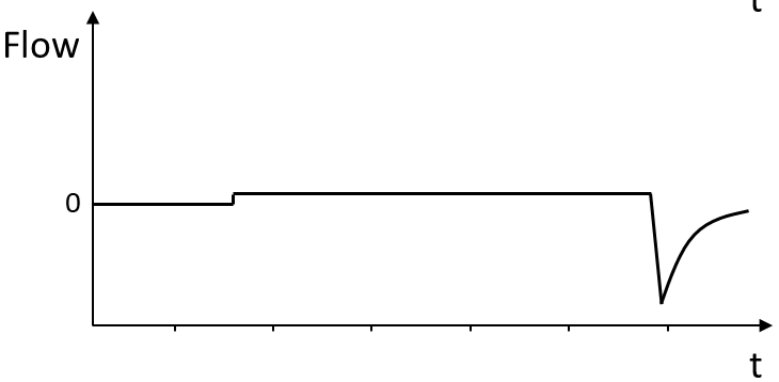
Low flow insufflation

No AOP



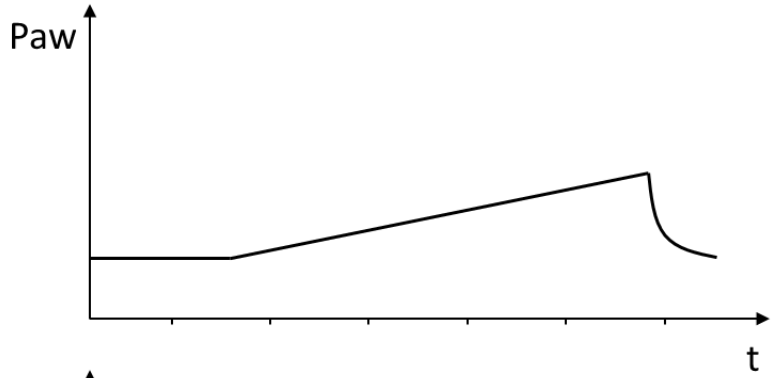
AOP





Low flow insufflation

No AOP



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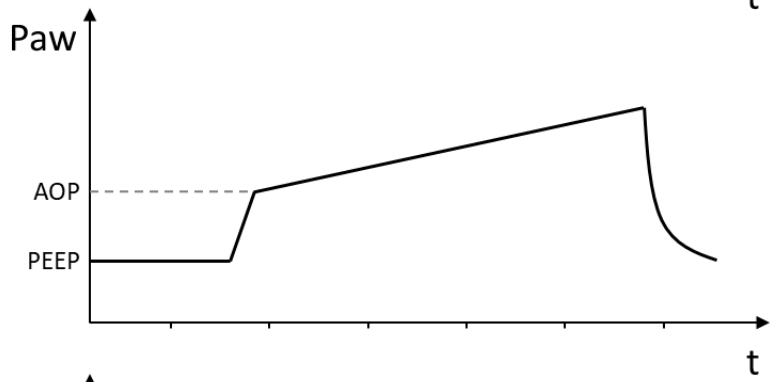
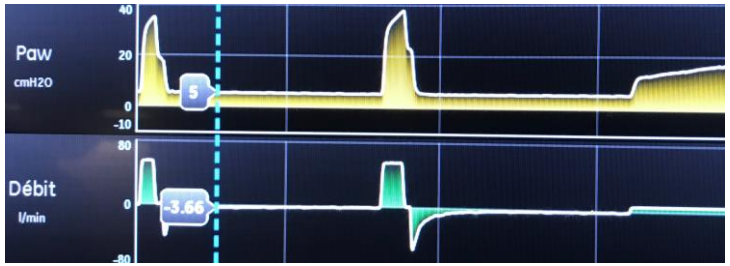
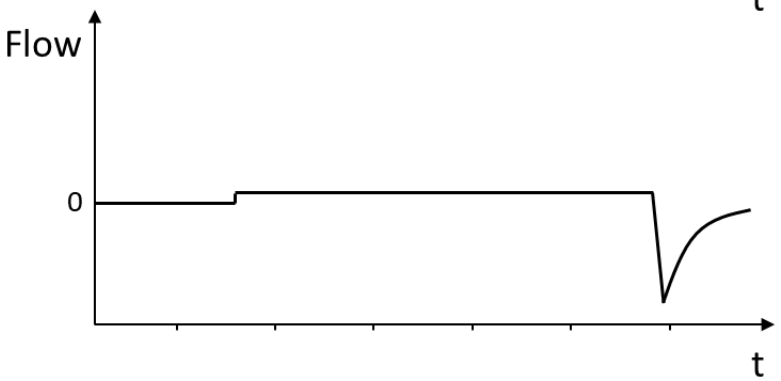
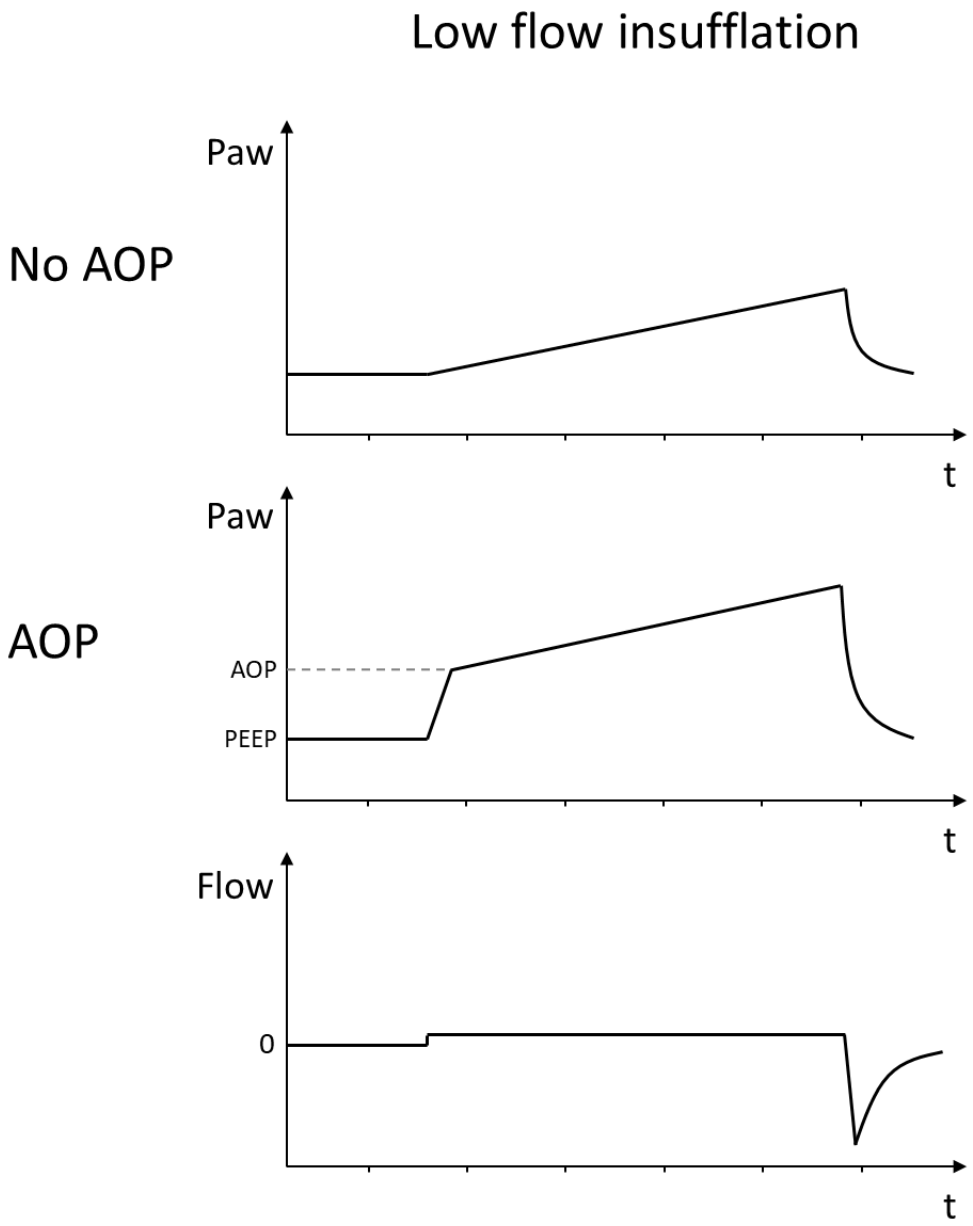






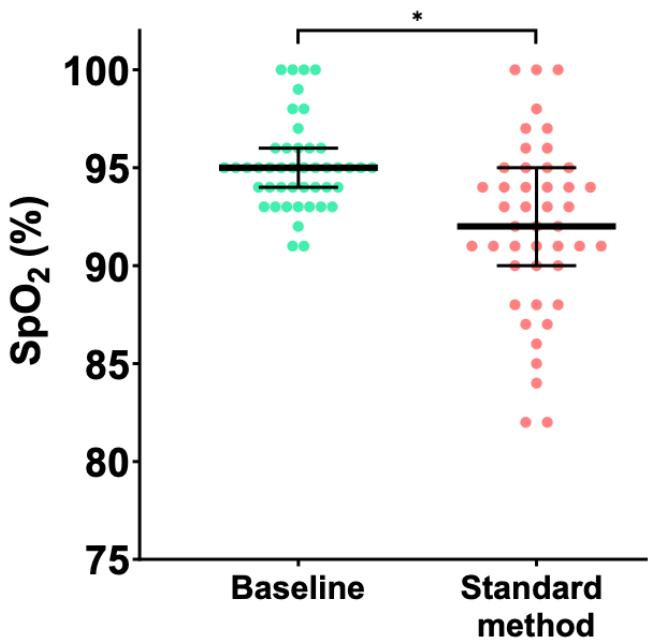


RESEARCH Open Access

A novel method for assessment of airway opening pressure without the need for low-flow insufflation

Anne-Fleur Haudebourg[1,2], Elsa Moncomble[1,2], Arnaud Lesimple[4,5], Flora Delamaire[1,2], Bruno Louis[3], Armand Mekontso Dessap[1,2,3], Alain Mercat[4,6], Jean-Christophe Richard[6,7], François Beloncle[4,6] and Guillaume Carteaux[1,2,3*]

Critical Care (2023) 27:273



Low flow insufflation

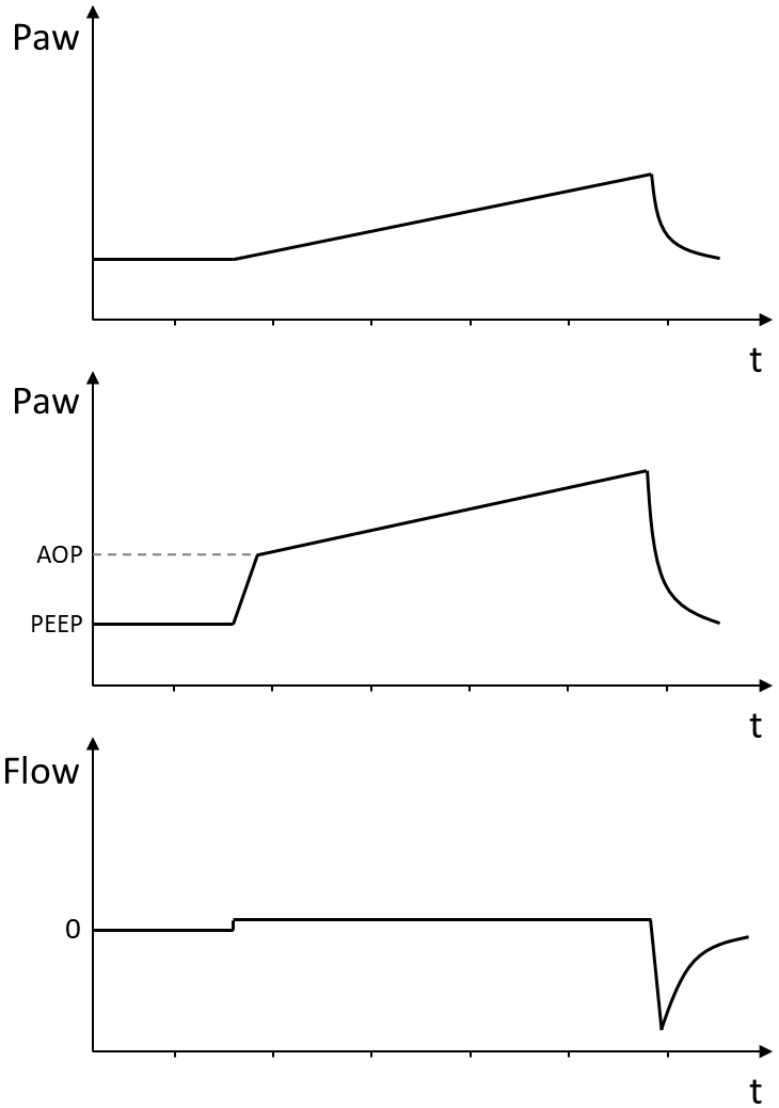
Usual flow insufflation

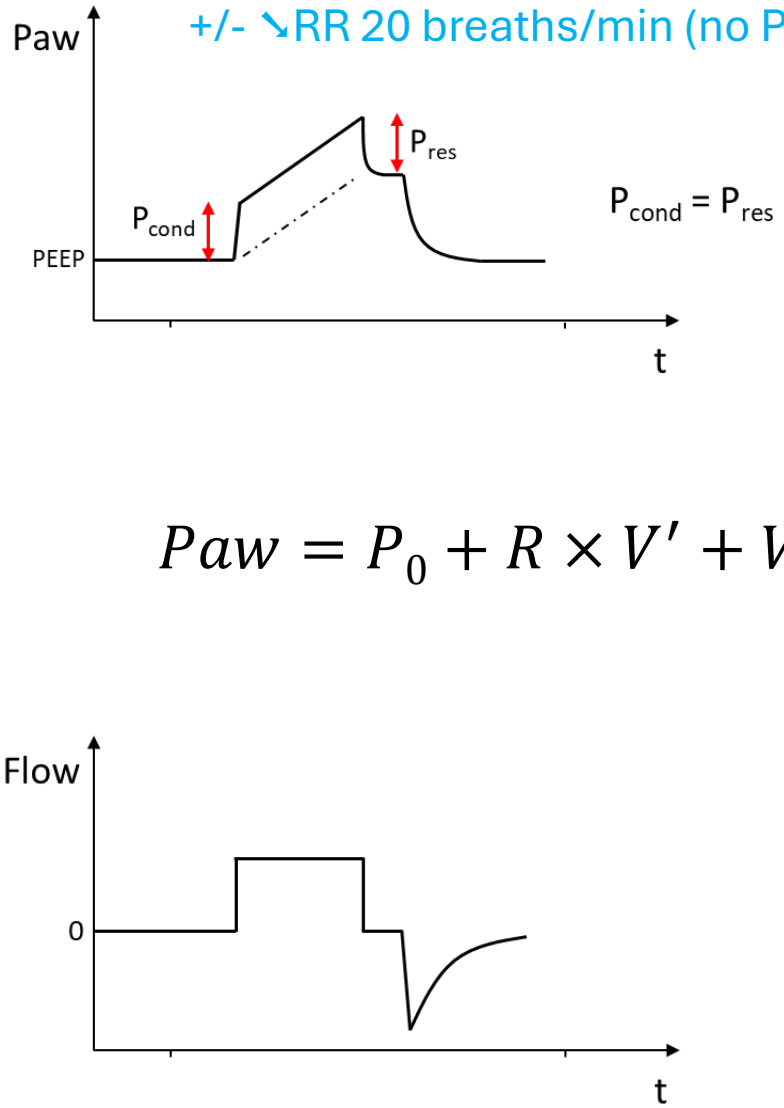
PEEP 5 cm H_2O

+/- ↘RR 20 breaths/min (no PEEPi)

No AOP

AOP



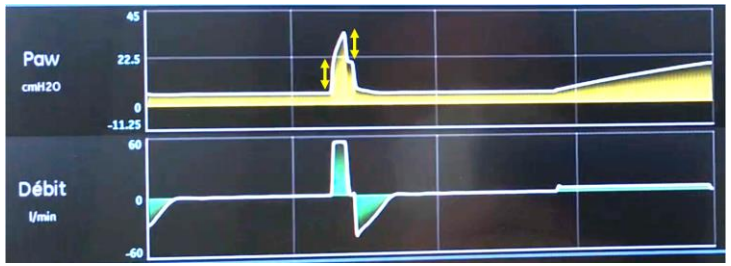


$$Paw = P_0 + R \times V' + V.E$$

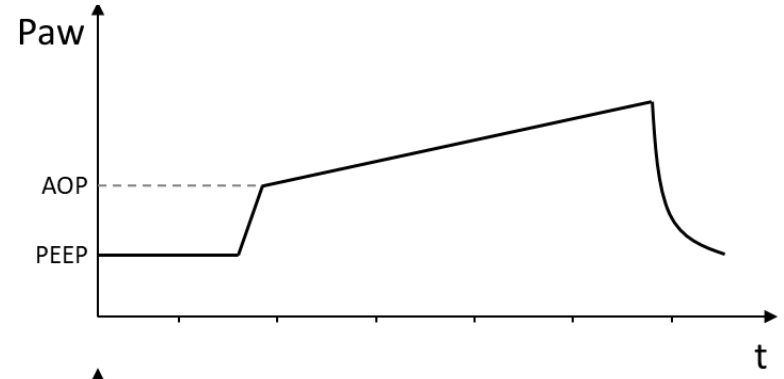
Haudebourg A-F *et al. Crit Care 2023*

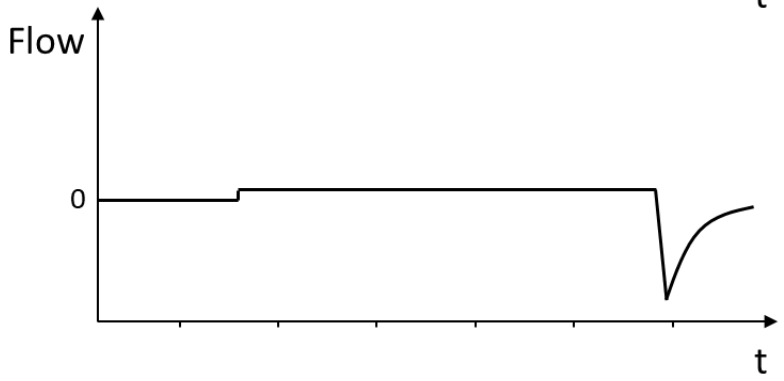
Low flow insufflation

No AOP



AOP

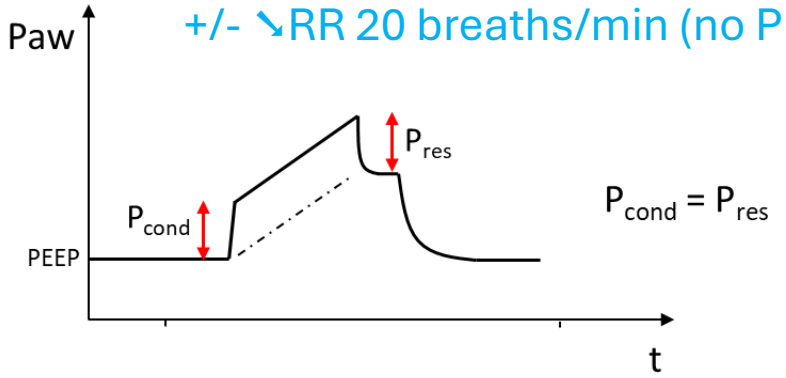




Usual flow insufflation

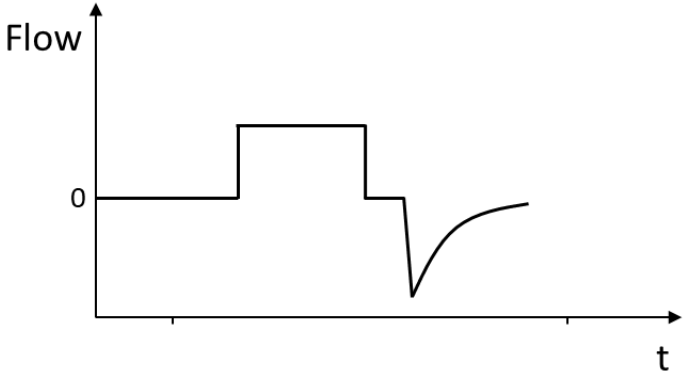
PEEP 5 cm H_2O

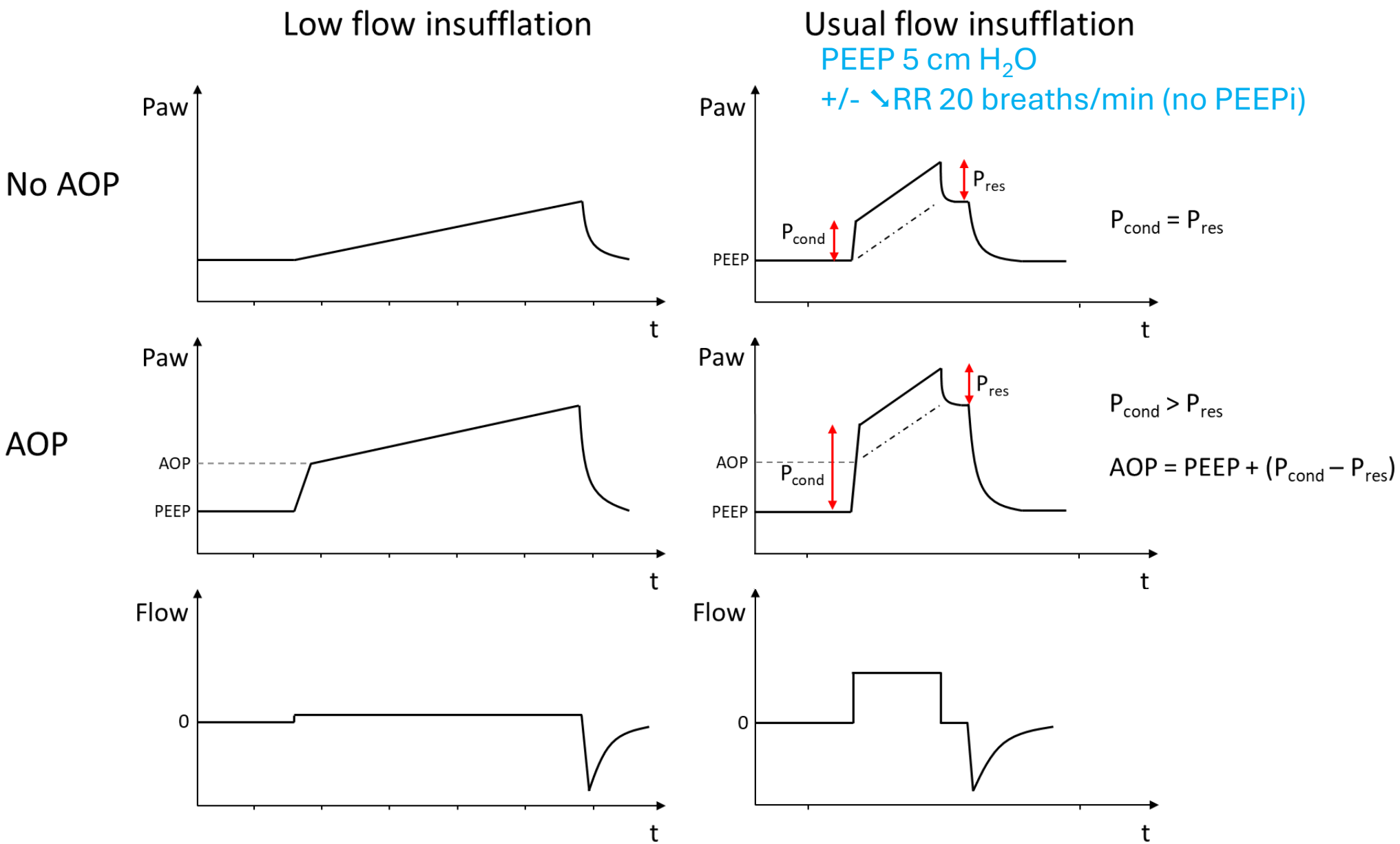
+/- ↘RR 20 breaths/min (no PEEPi)



$P_{cond} = P_{res}$

$$Paw = P_0 + R \times V' + V.E$$





Haudebourg A-F *et al. Crit Care 2023*

Low flow insufflation

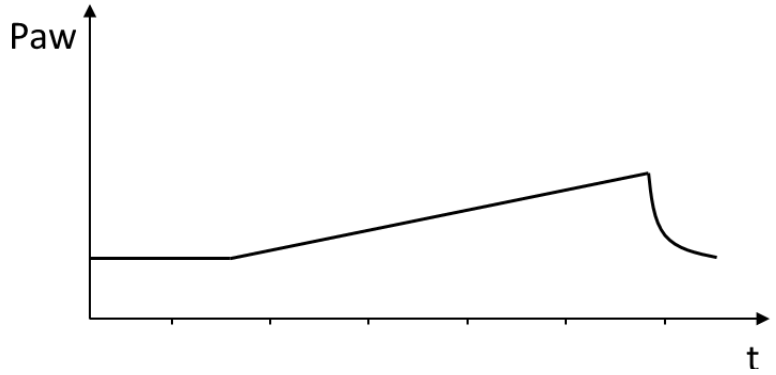
Usual flow insufflation

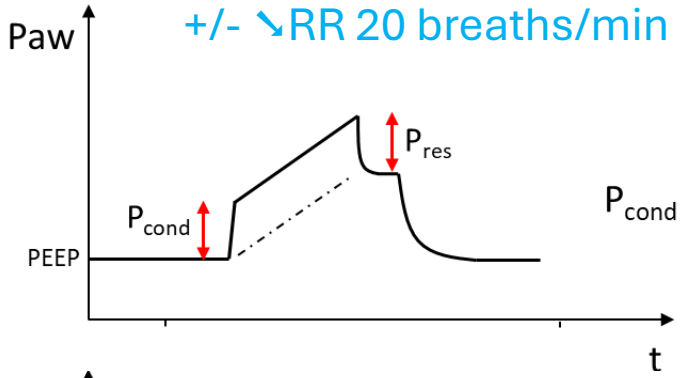
PEEP 5 cm H_2O

+/- ↘RR 20 breaths/min (no PEEPi)

NPV = 97%

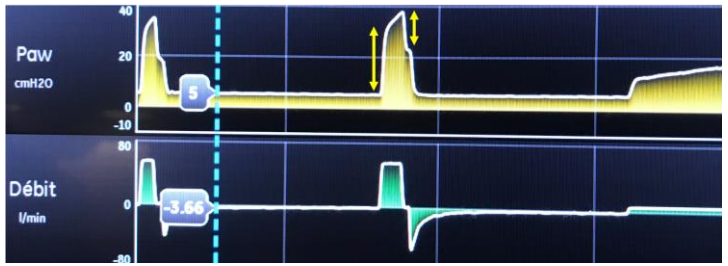
No AOP

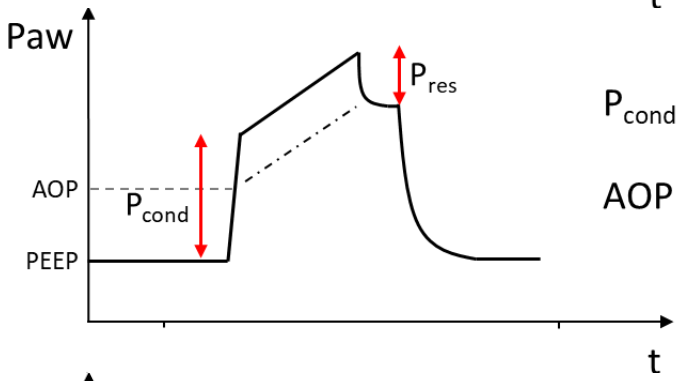




$P_{cond} = P_{res}$

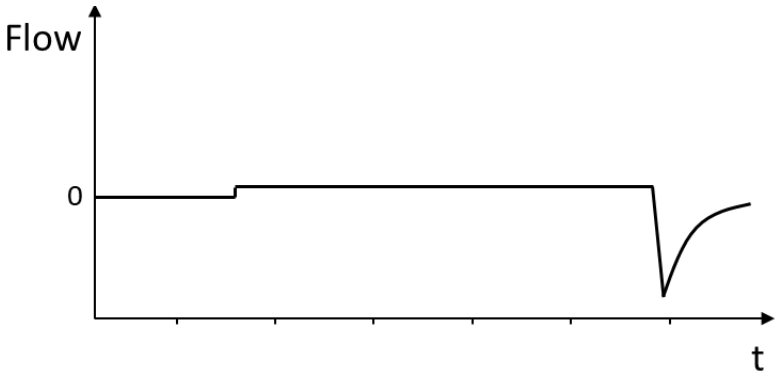
AOP

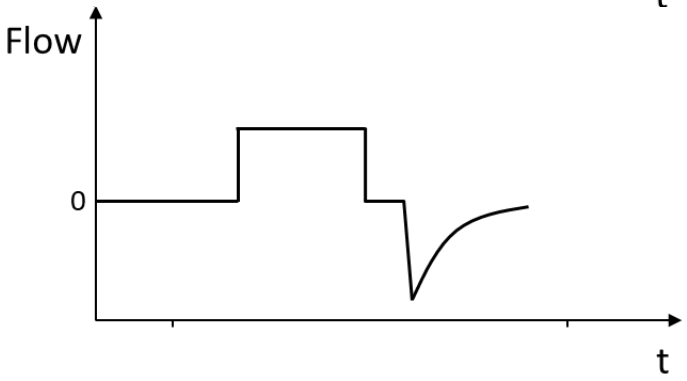




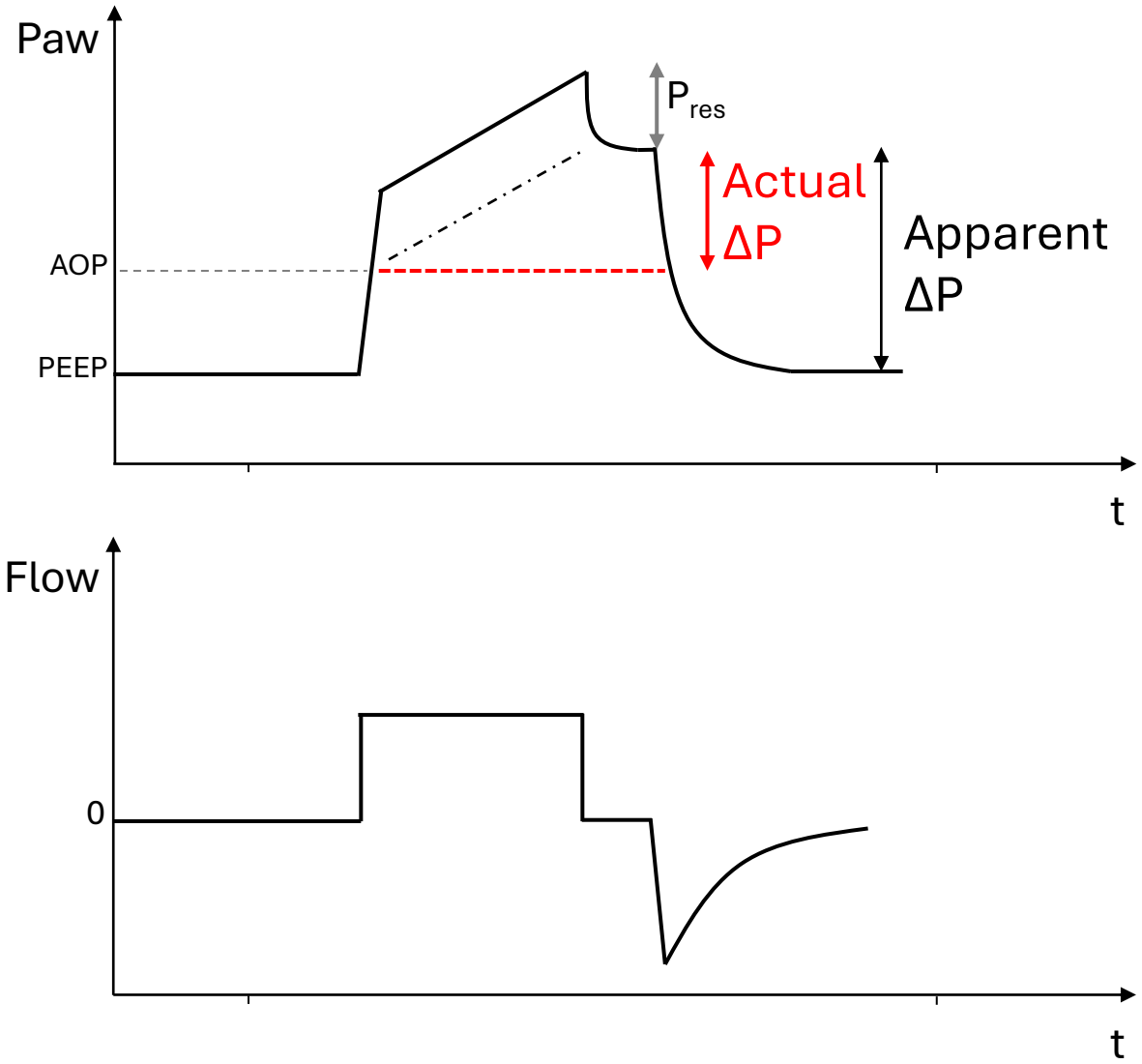
$P_{cond} > P_{res}$

$AOP = PEEP + (P_{cond} - P_{res})$



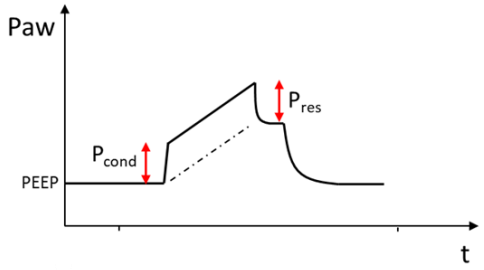


If $P_{cond} > P_{res}$: the apparent ΔP overestimates the actual ΔP

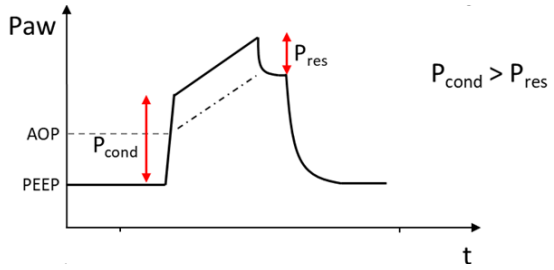


$$C_{RS} = \frac{V_T}{\Delta P}$$

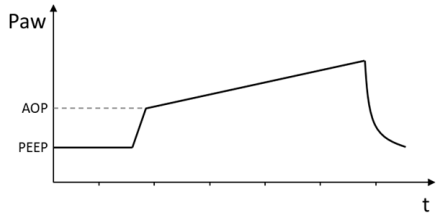
Airway closure?



No airway closure



AOP



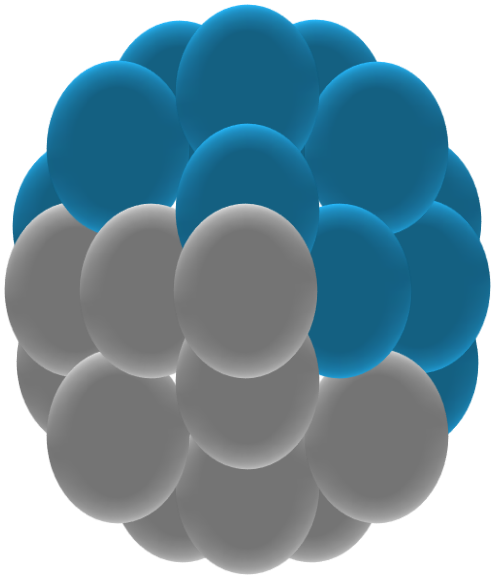
AOP measurement

AOP < 10-12 cm H_2O

AOP ≥ 10-12 cm H_2O

Recruitability assessment

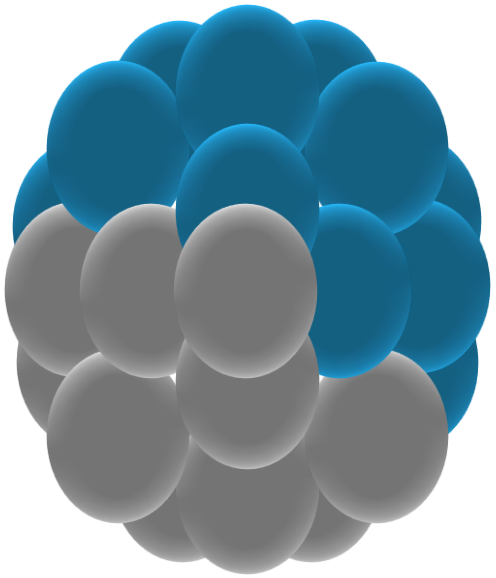
High PEEP

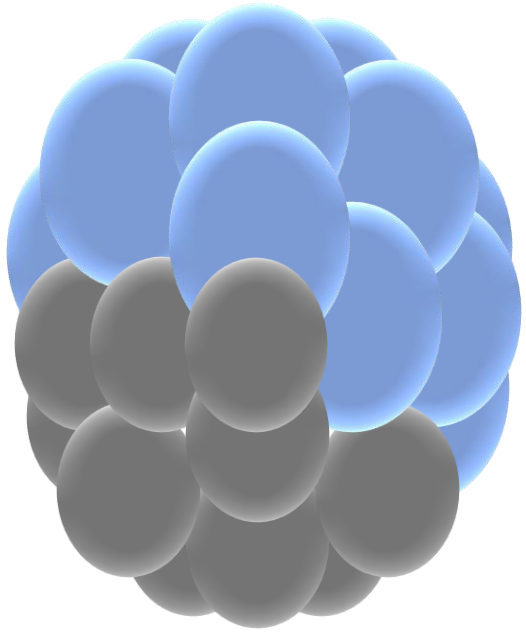


C = 30 ml/cm H_2O

PEEP = 5 cm H_2O

EELV = 800 ml

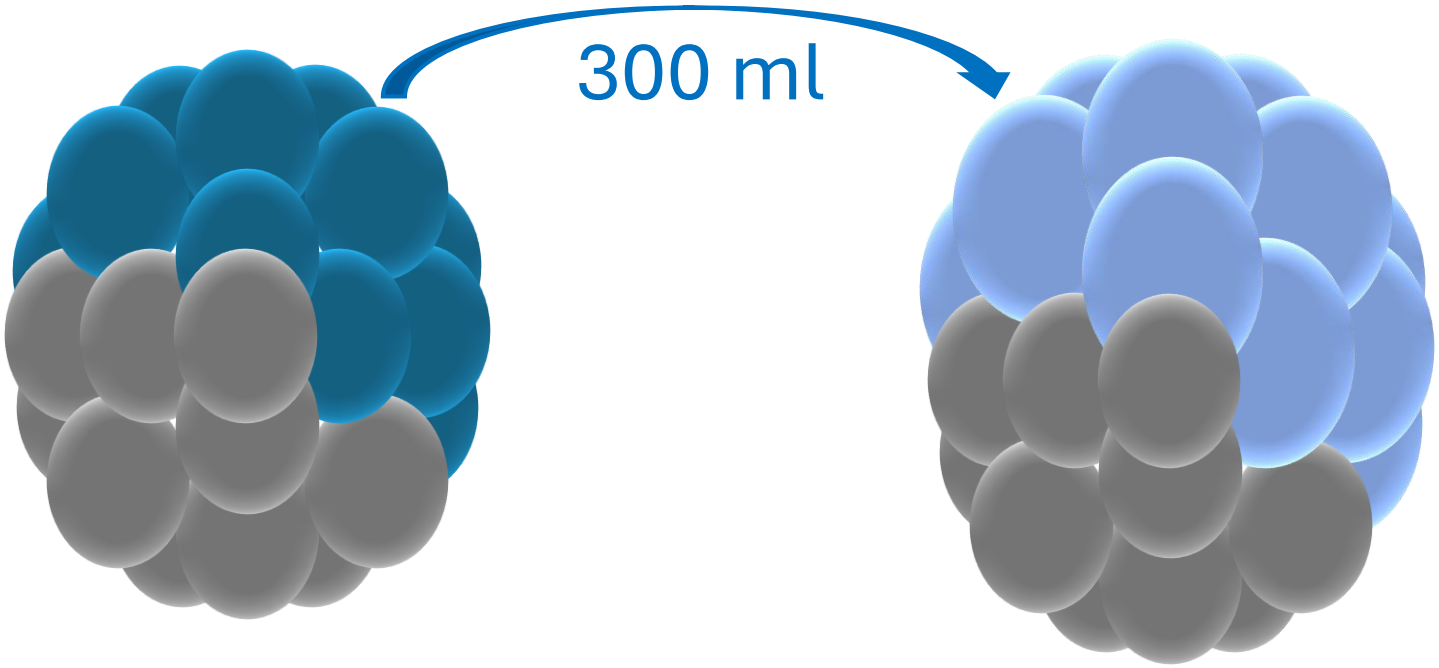




C = 30 ml/cm H_2O

PEEP = 5 cm H_2O ➡ PEEP = 15 cm H_2O

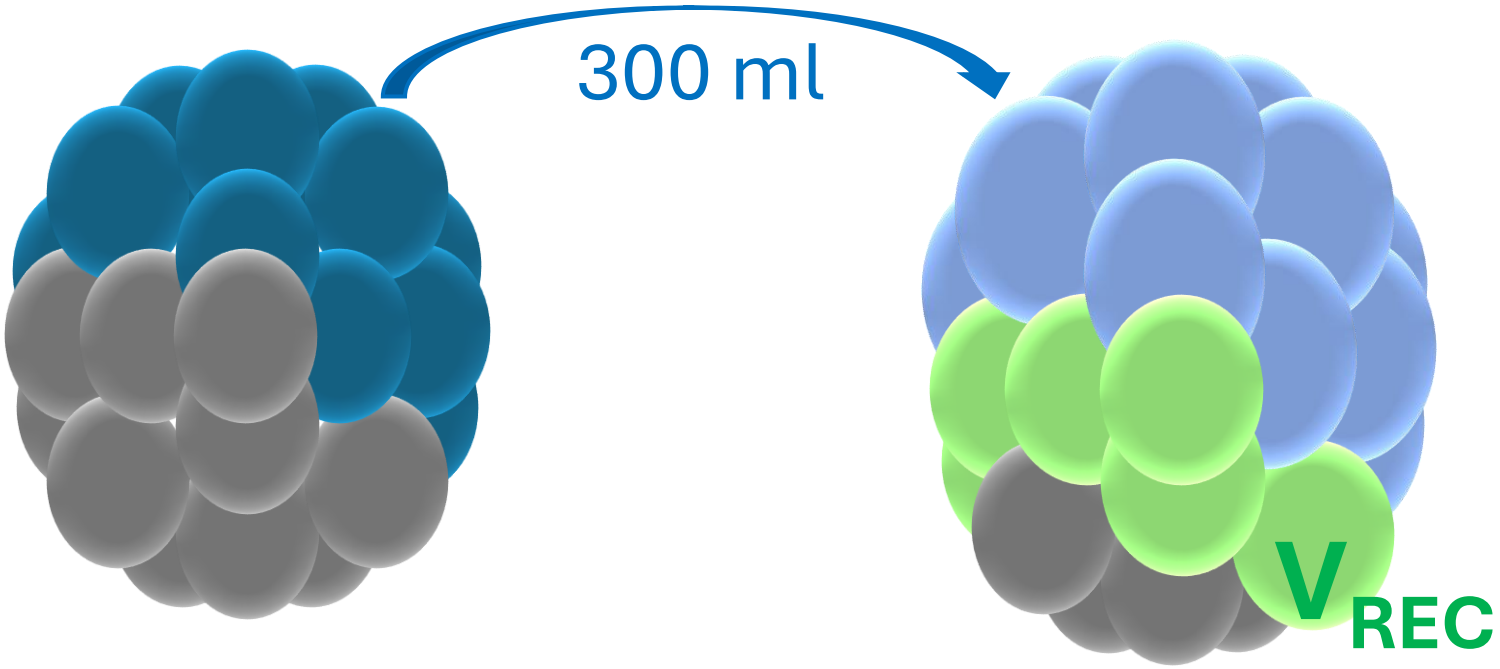
EELV = 800 ml EELV = ?



C = 30 ml/cm H_2O

PEEP = 5 cm H_2O ➡ PEEP = 15 cm H_2O

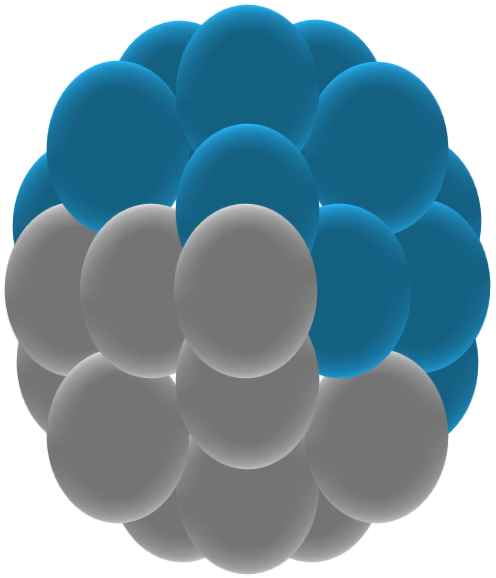
EELV = 800 ml EELV = 1100 ml

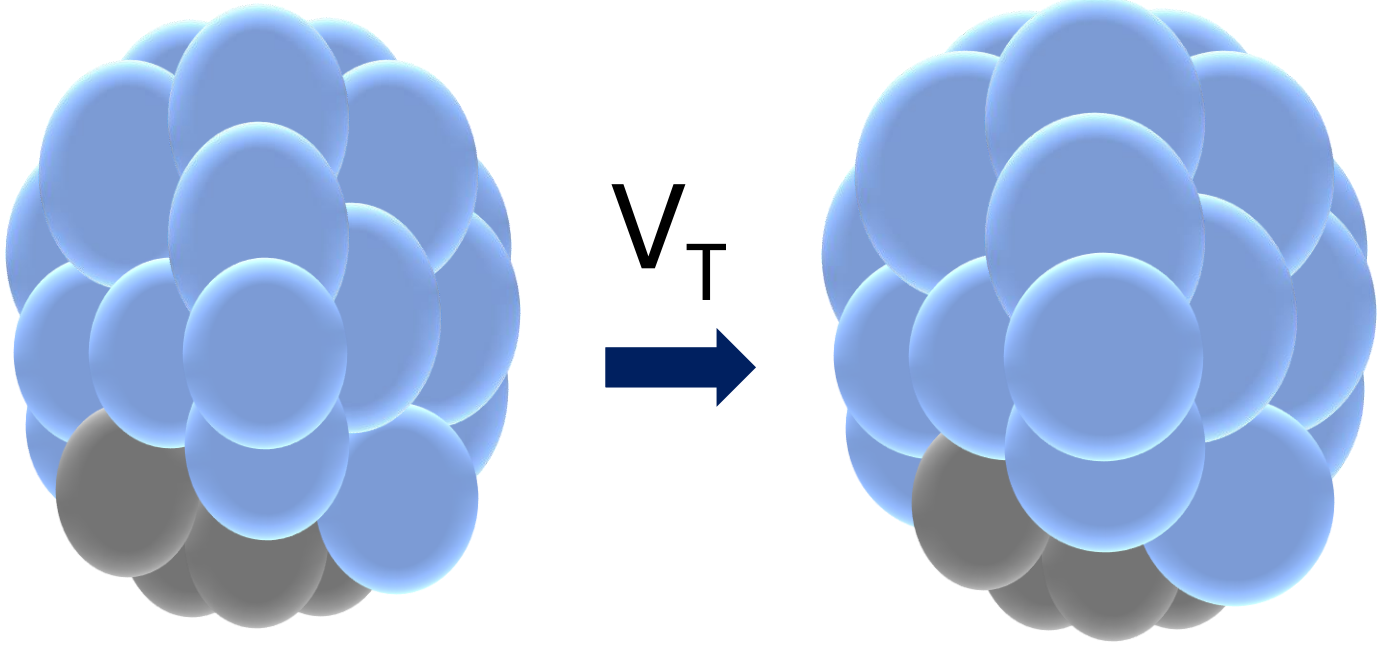


C = 30 ml/cm H_2O

PEEP = 5 cm H_2O ➡ PEEP = 15 cm H_2O

EELV = 800 ml EELV = 1100 ml + Vrec

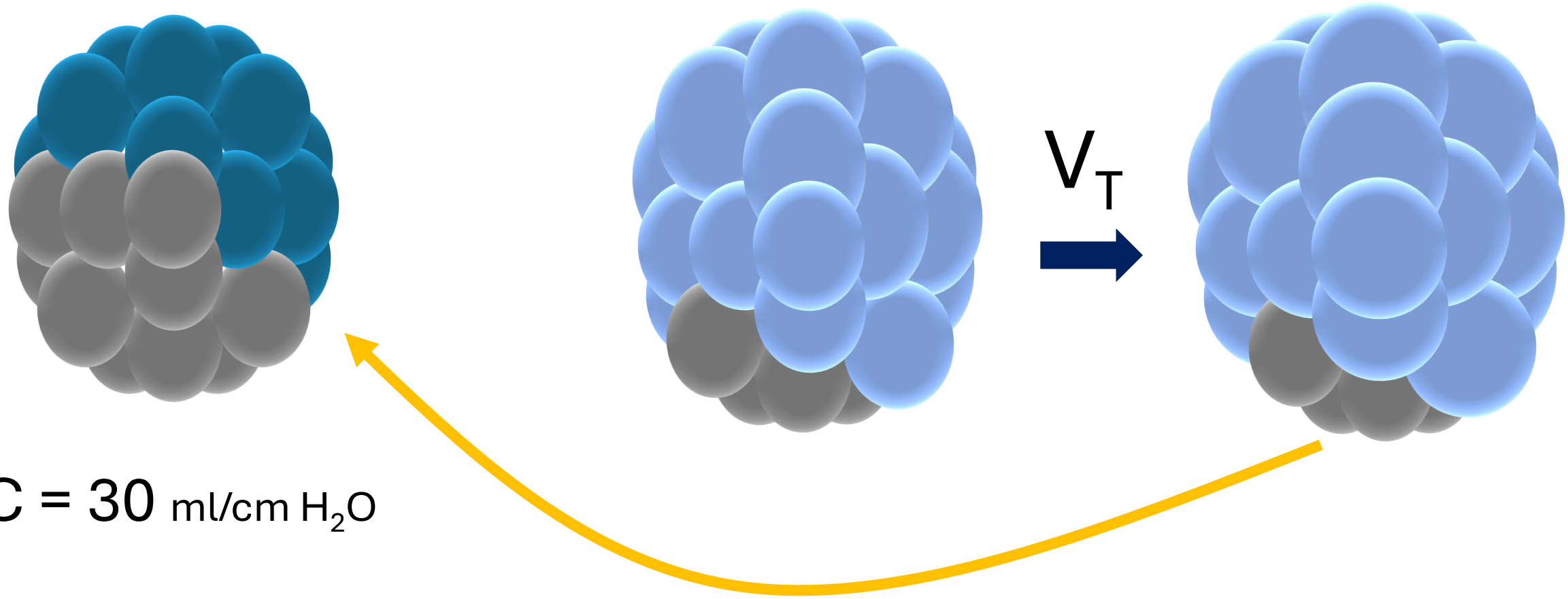




C = 30 ml/cm H_2O

PEEP = 5 cm H_2O ➡ PEEP = 15 cm H_2O

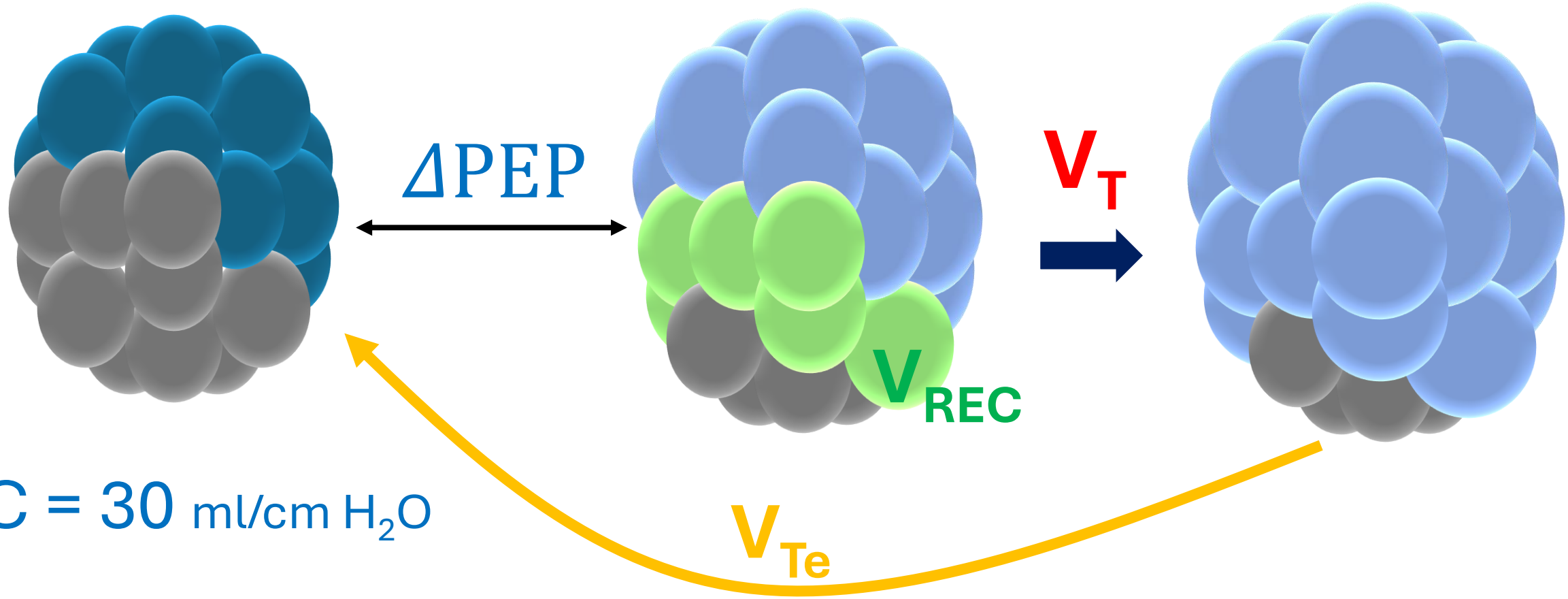
EELV = 800 ml EELV = 1100 ml + Vrec



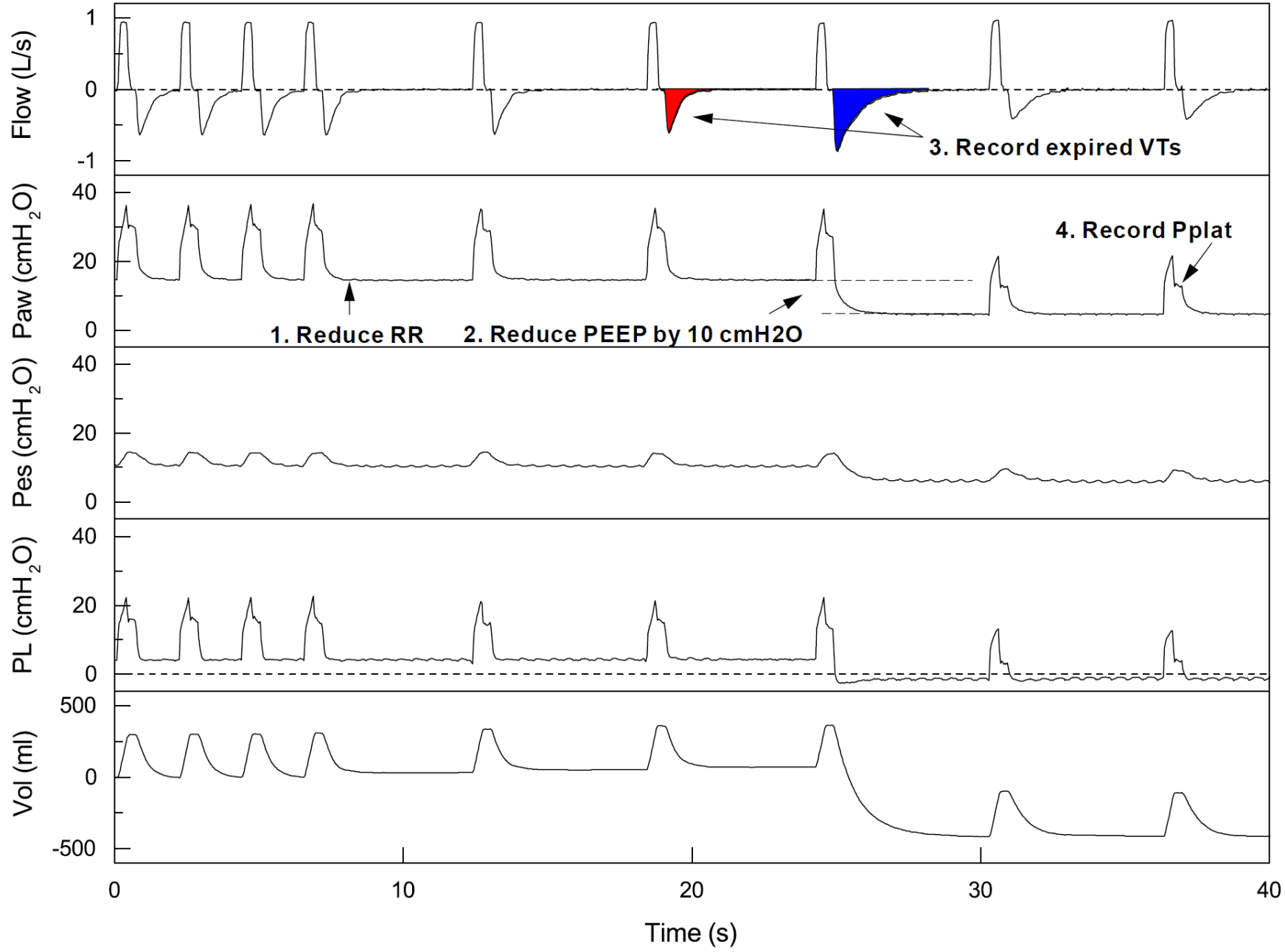
C = 30 ml/cm H_2O

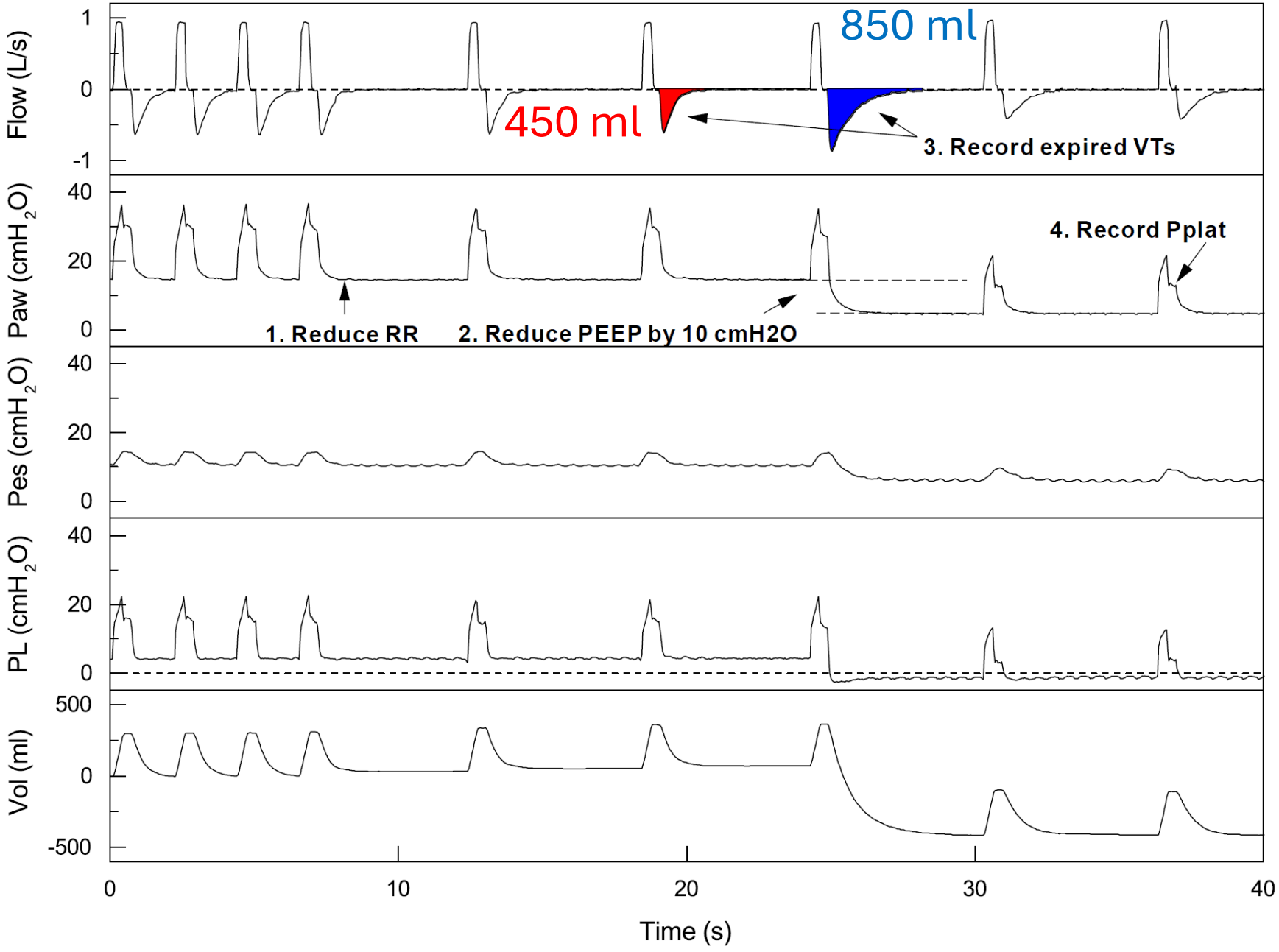
PEEP = 5 cm H_2O ➡ PEEP = 15 cm H_2O

EELV = 800 ml EELV = 1100 ml + Vrec



$$V_{REC} = V_{Te} - V_T - (C_{low\ PEEP} \times \Delta PEEP)$$

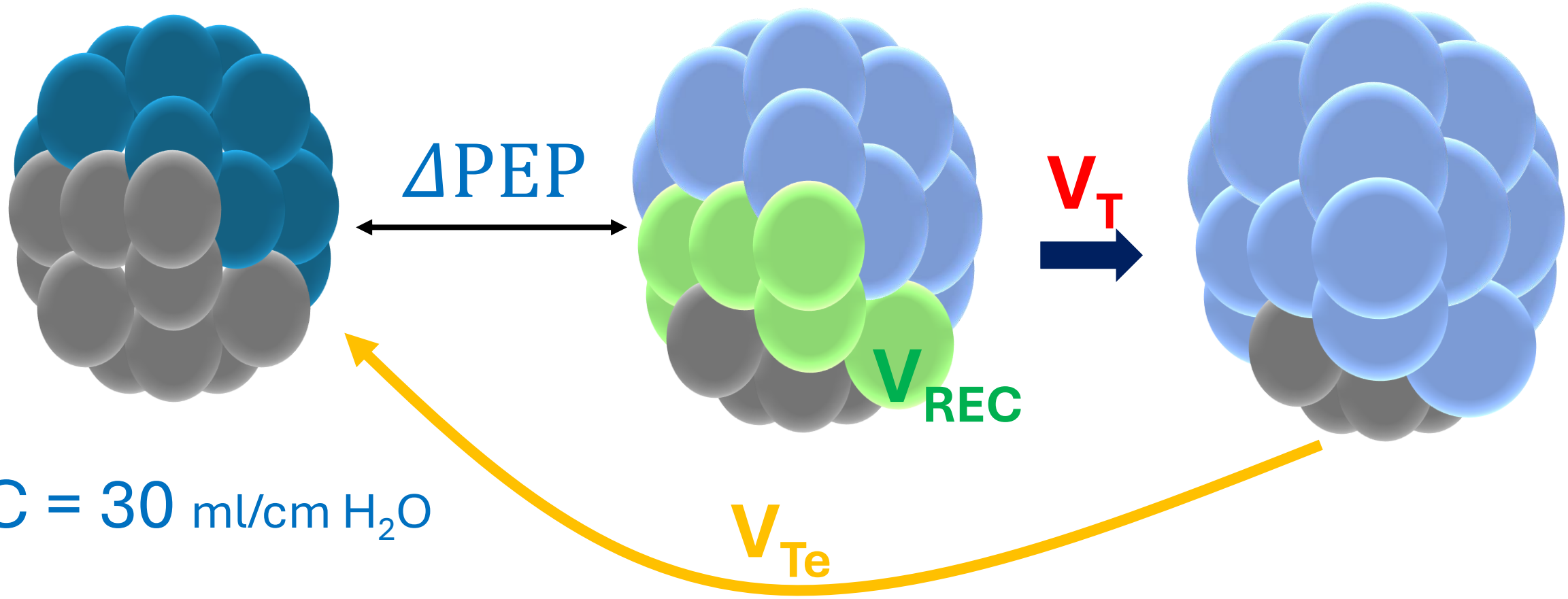

Flow (L/s)
1
0
-1
3. Record expired VTs
Paw (cmH2O)
40
20
0
4. Record Pplat
1. Reduce RR
2. Reduce PEEP by 10 cmH2O
Pes (cmH2O)
40
20
0
PL (cmH2O)
40
20
0
Vol (ml)
500
0
-500
0
10
20
30
40
Time (s)



Pplat = 20 cmH_2O

PEEP = 5 cmH_2O

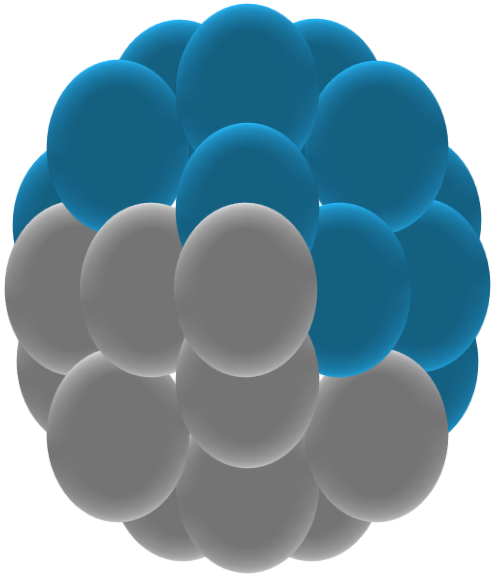
$C_{low\text{-}PEEP}$ = 30 ml/cmH_2O



C = 30 ml/cm H_2O

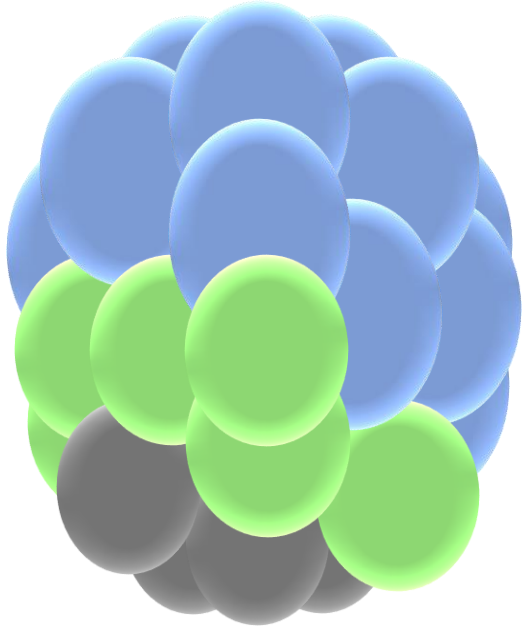
$$V_{REC} = V_{Te} - V_T - (C_{low\text{-}PEEP} \times \Delta PEEP)$$

$$V_{REC} = 850 - 450 - (30 \times 10) = 100 \text{ mL}$$



PEP = 5 cm H_20

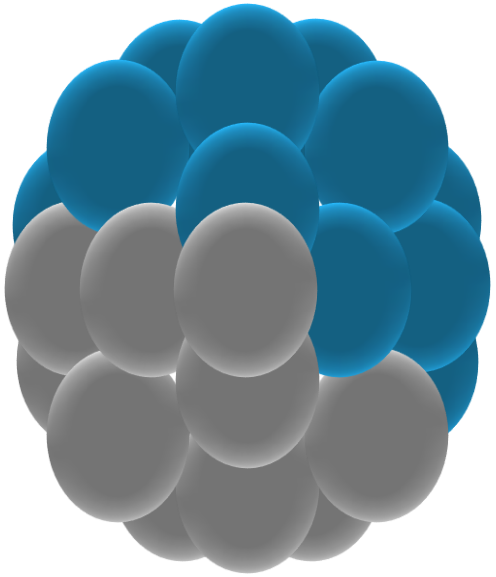
$C_{low\ PEEP}$ = 30 ml/cm H_2O



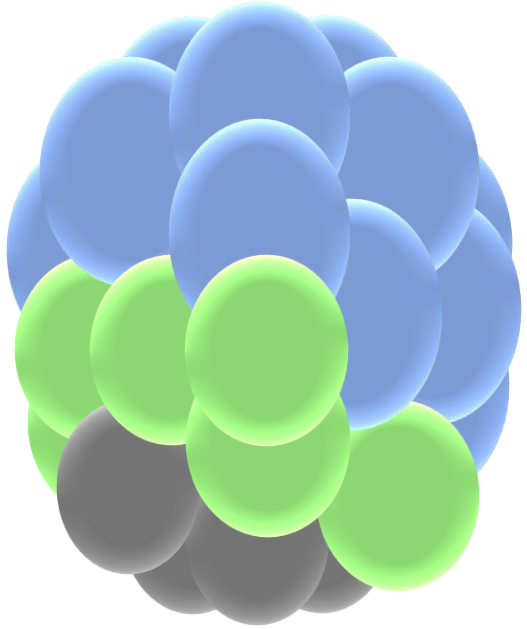
PEP = 15 cm H_20

C_{REC} = 100 ml / 10 cm H20

= 10 ml/cm H_2O



PEEP = 5 cm H_20



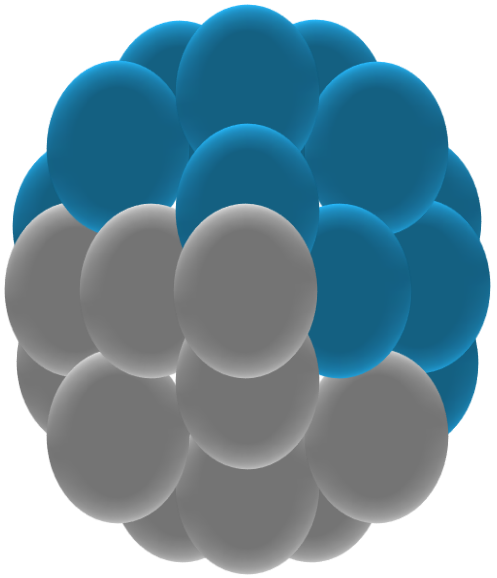
PEEP = 15 cm H_20

$C_{low\ PEEP}$ = 30 ml/cm H_2O

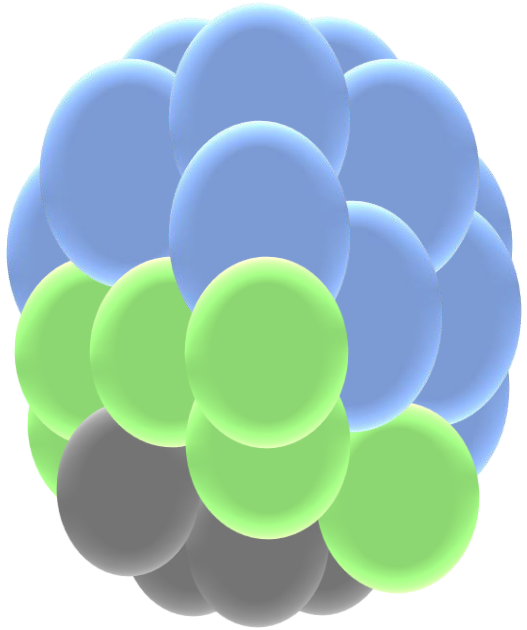
C_{REC} = 100 ml / 10 cm H_20

= 10 ml/cm H_2O

$$\frac{Recrutment}{Inflation} = \frac{R}{I} = \frac{C_{REC}}{C_{low\ PEEP}}$$



PEP = 5 cm H_20



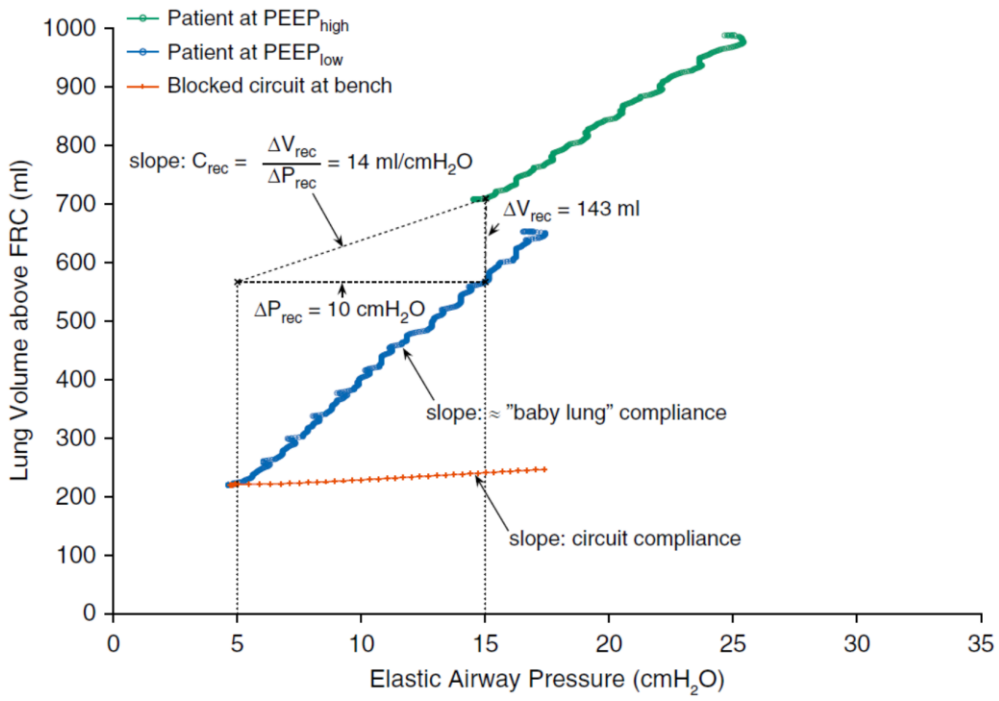
PEP = 15 cm H_20

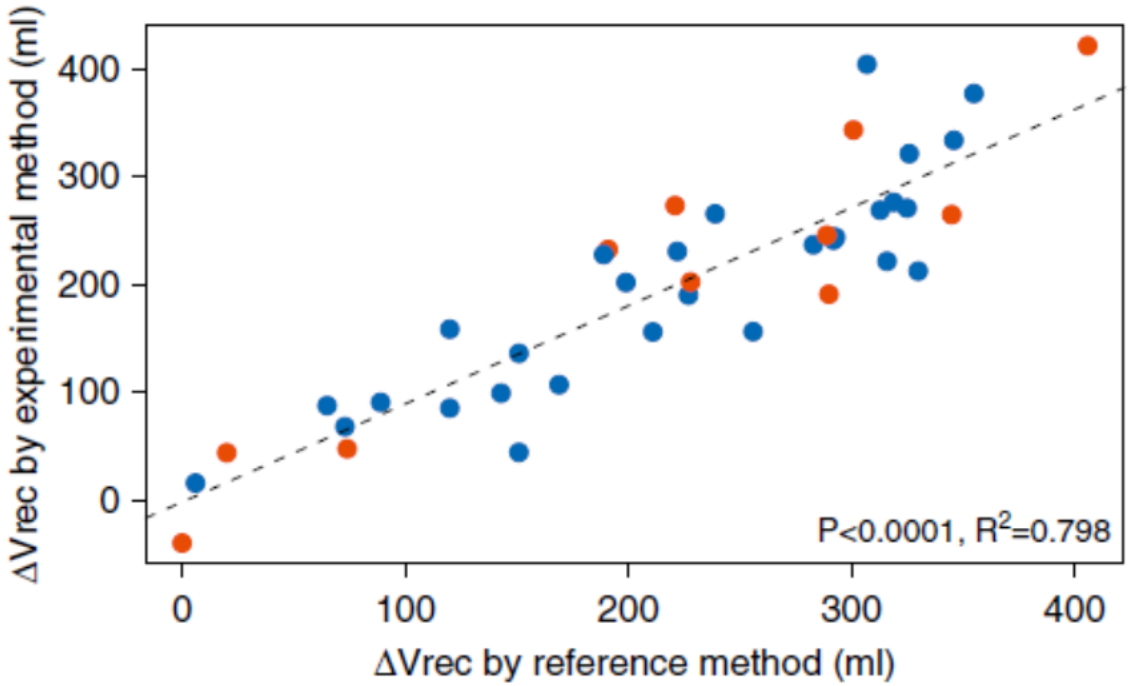
$C_{low\ PEEP}$ = 30 ml/cm H_2O

C_{REC} = 100 ml / 10 cm H20

= 10 ml/cm H_2O

$$\frac{R}{I} = 0{,}3$$





R/I

Median

Low potential for lung recruitment

High potential for lung recruitment

0,5

R/I ratio

R/I ≤ 0.2-0.3

No potential for lung recruitment

« Low » PEEP

PEEP = 8 cm H_2O

R/I > 0.2-0.3

Potential for lung recruitment

« High » PEEP

PEEP = ?

What is High PEEP?

Increasing PEEP to the maximum without signs of overdistension

↗ PEEP until

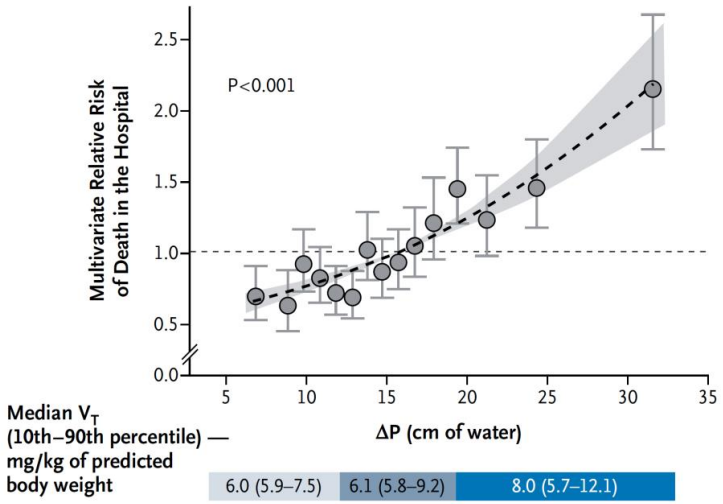
By default

« Express » PEEP

Pplat = 28 cm H_2O

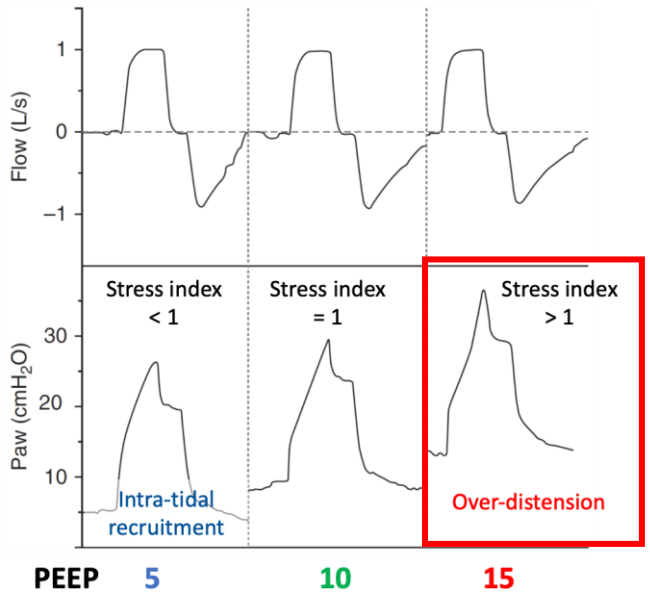
Stop earlier if signs of overdistension occur

ΔP ≥ 15 cm H_2O

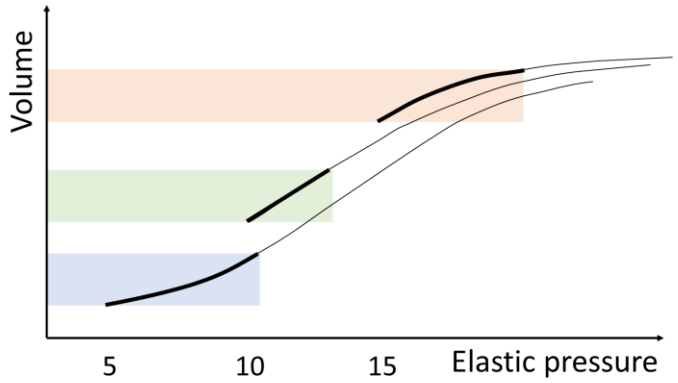


Amato M et al. N Engl J Med 2015

Stress index > 1



$$Paw = a \times time^{b} + c$$

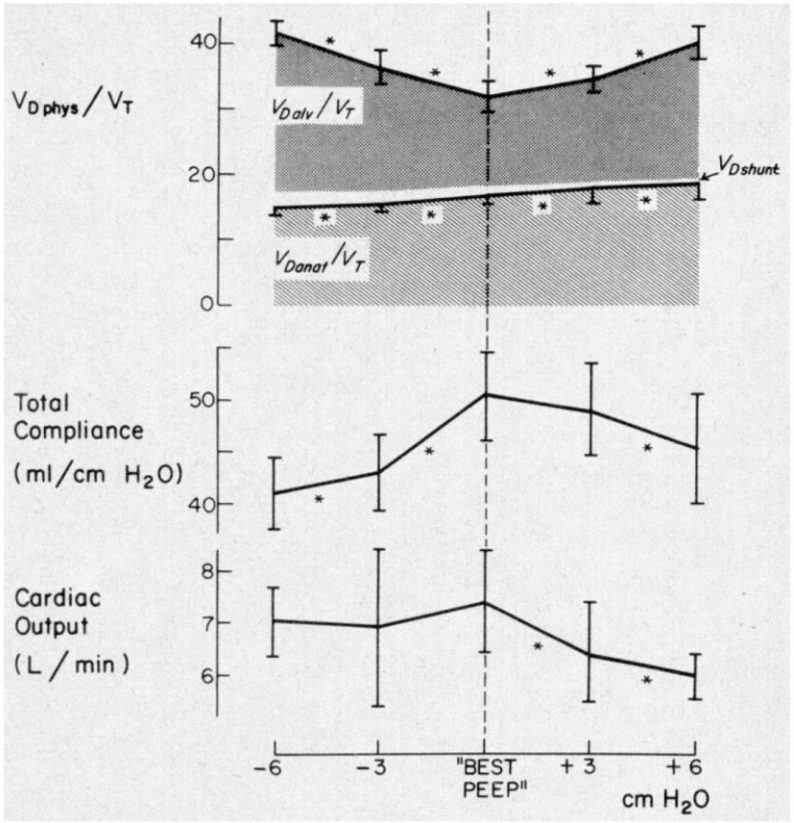


Grasso S *et al. Crit Care Med* 2004

Henderson W.R. *et al. Am J Respir Crit Care Med* 2017

↗ PaCO2

Poor hemodynamic tolerance

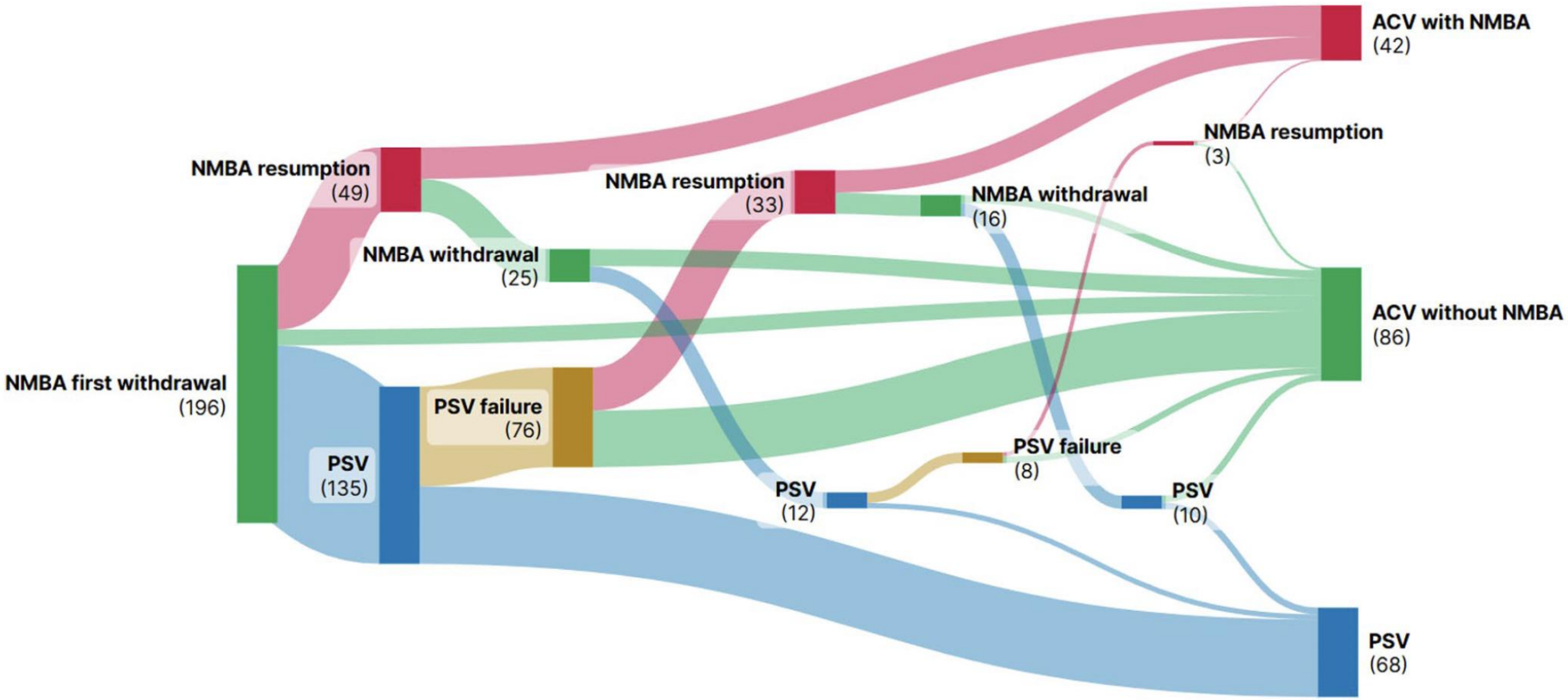


Suter PM *et al. NEJM* 1975

Factors influencing the transition phase in acute respiratory distress syndrome: an observational cohort study

Anne-Fleur Haudebourg[1,2,3,6*], Louise Chantelot[1], Safaa Nemlaghi[1], Luc Haudebourg[4], Pascale Labedade[1,2,3], Mohamed Ahmed Boujelben[1,2], Guillaume Voiriot[5], Armand Mekontso Dessap[1,2,3], Muriel Fartoukh[5] and Guillaume Carteaux[1,2,3]

Annals of Intensive Care (2025) 15:71



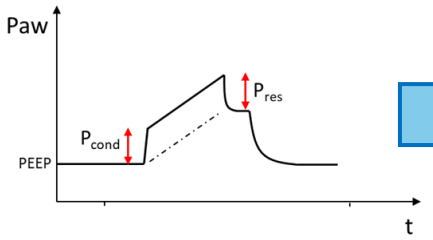
Take home message

$$\Delta P = \frac{V_T}{C_{RS}} \approx \frac{V_T}{\alpha EELV} \approx strain$$

⚠ If $\Delta P \geq 15$ cmH_2O

ΔP too low?
Wait for RCT

Airway closure?



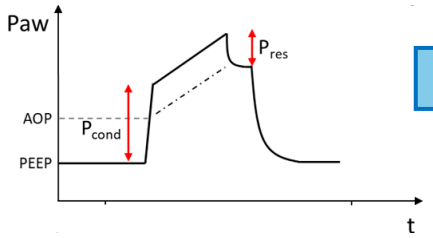
No airway closure

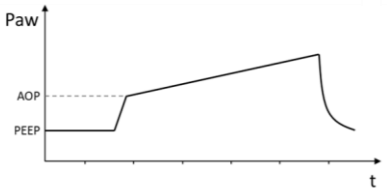
R/I ratio

R/I ratio ≤ 0.2 → **Low PEEP = 8 cm H_2O**

R/I ratio > 0.2

AOP ≤ 10-12 cm H_2O





AOP measurement

AOP > 10-12 cm H_2O → **High PEEP**

↗ PEEP
↳Pplat = 28 cm H_2O
without
Stress index > 1
Resp mecanics deterioration
↗$PaCO_2$
Poor hemodynamic tolerance