Apport de la physiologie pour régler le respirateur dans le SDRA

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Liens d’intérêt

- Fisher & Paykel Healthcare
- Löwenstein Medical
- Air Liquide Medical Systems
- Hamilton
- AbbVie
- Arterya
- Mayan Pharma

Problématique

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*

Prone Positioning in Severe Acute Respiratory Distress Syndrome

Claude Guérin, M.D., Ph.D., Jean Reignier, M.D., Ph.D., Jean-Christophe Richard, M.D., Ph.D., Pascal Beuret, M.D., Arnaud Gacouin, M.D., Thierry Boulain, M.D., Emmanuelle Mercier, M.D., Michel Badet, M.D., Alain Mercat, M.D., Ph.D., Olivier Baudin, M.D., Marc Clavel, M.D., Delphine Chatellier, M.D., Samir Jaber, M.D., Ph.D., Sylvène Rosselli, M.D., Jordi Mancebo, M.D., Ph.D., Michel Sirodot, M.D., Gilles Hilbert, M.D., Ph.D., Christian Bengler, M.D., Jack Richecoeur, M.D., Marc Gainnier, M.D., Ph.D., Frédérique Bayle, M.D., Gael Bourdin, M.D., Véronique Leray, M.D., Raphaele Girard, M.D., Loredana Baboi, Ph.D., and Louis Ayzac, M.D., for the PROSEVA Study Group*

Neuromuscular Blockers in Early Acute Respiratory Distress Syndrome

Laurent Papazian, M.D., Ph.D., Jean-Marie Forel, M.D., Arnaud Gacouin, M.D., Christine Penot-Ragon, Pharm.D., Gilles Perrin, M.D., Anderson Loundou, Ph.D., Samir Jaber, M.D., Ph.D., Jean-Michel Arnal, M.D., Didier Perez, M.D., Jean-Marie Seghboyan, M.D., Jean-Michel Constantin, M.D., Ph.D., Pierre Courant, M.D., Jean-Yves Lefrant, M.D., Ph.D., Claude Guérin, M.D., Ph.D., Gwenaël Prat, M.D., Sophie Morange, M.D., and Antoine Roch, M.D., Ph.D., for the ACURASYS Study Investigators*

Early Neuromuscular Blockade in the Acute Respiratory Distress Syndrome

The National Heart, Lung, and Blood Institute PETAL Clinical Trials Network*

Higher versus Lower Positive End-Expiratory Pressures in Patients with the Acute Respiratory Distress Syndrome

The National Heart, Lung, and Blood Institute ARDS Clinical Trials Network*

Positive End-Expiratory Pressure Setting in Adults With Acute Lung Injury and Acute Respiratory Distress Syndrome
A Randomized Controlled Trial

Ventilation Strategy Using Low Tidal Volumes, Recruitment Maneuvers, and High Positive End-Expiratory Pressure for Acute Lung Injury and Acute Respiratory Distress Syndrome
A Randomized Controlled Trial

Randomized, Placebo-controlled Clinical Trial of an Aerosolized β_2-Agonist for Treatment of Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*[†]

Comparison of Two Fluid-Management Strategies in Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*

Pressure control plus spontaneous ventilation versus volume assist-control ventilation in acute respiratory distress syndrome. A randomised clinical trial

Jean-Christophe M. Richard[1,2*], François M. Beloncle[1], Gaëtan Béduneau[3], Satar Mortaza[1,4], Stephan Ehrmann[5], Jean-Luc Diehl[6], Gwenaël Prat[7], Samir Jaber[8], Hassene Rahmani[9], Jean Reignier[10], Thierry Boulain[11], Hodane Yonis[12], Jack Richecoeur[13], Arnaud W. Thille[14], Pierre-Louis Declercq[15], Emmanuel Antok[16], Guillaume Carteaux[17], Bruno Vielle[18], Laurent Brochard[19] and Alain Mercat[1] on behalf of the REVA network

Rosuvastatin for Sepsis-Associated Acute Respiratory Distress Syndrome

The National Heart, Lung, and Blood Institute ARDS Clinical Trials Network*

Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome
A Randomized Clinical Trial

Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators

Problématique

CONFERENCE REPORTS AND EXPERT PANEL

ESICM guidelines on acute respiratory distress syndrome: definition, phenotyping and respiratory support strategies

Check for updates

Grasselli Intensive Care Med 2023

La physiologie pourrait-elle aider à régler le respirateur?

Caractéristiques du SDRA

Œdème pulmonaire inflammatoire

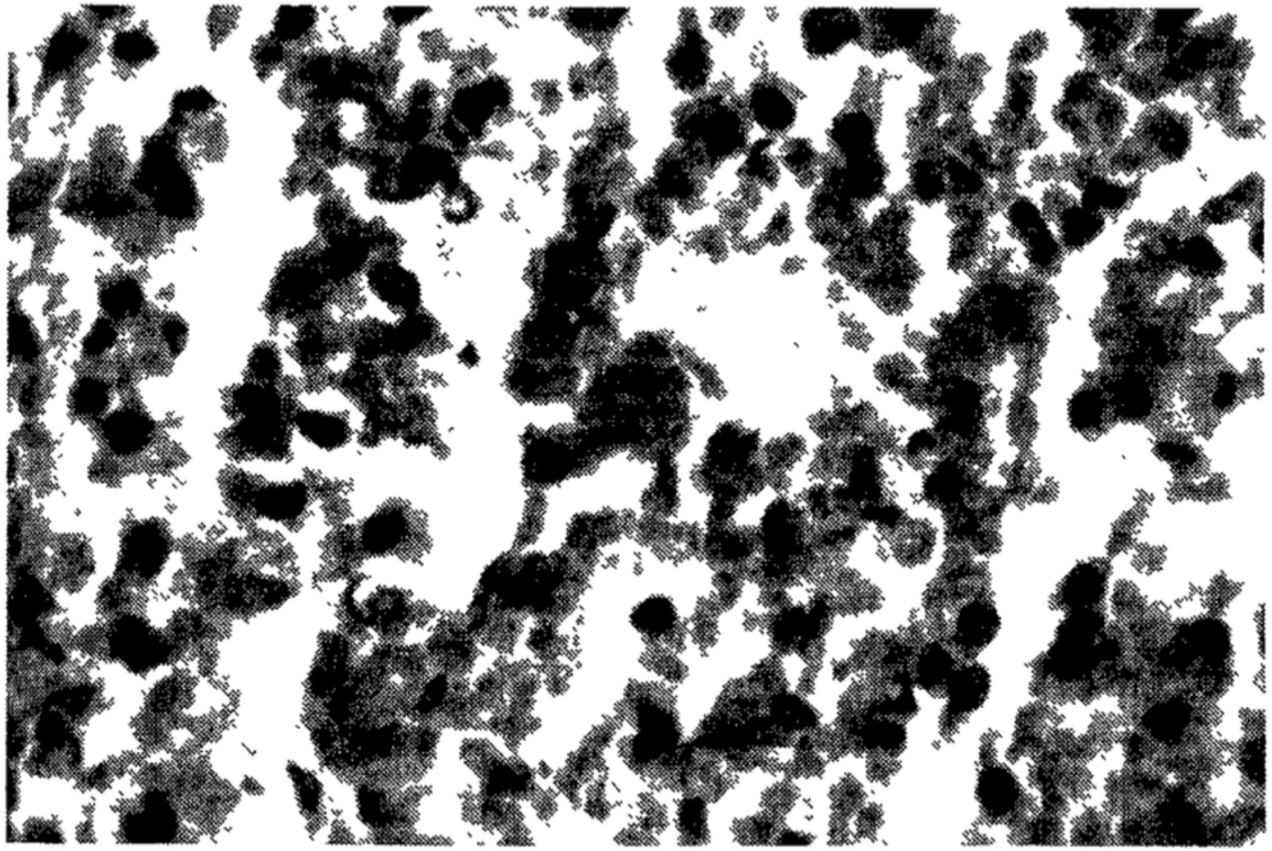


Fig. 3—Case 4: striking alveolar atelectasis and engorgement of capillaries. (Hæmatoxylin and eosin reduced to $^1/_2$ of × 450.)

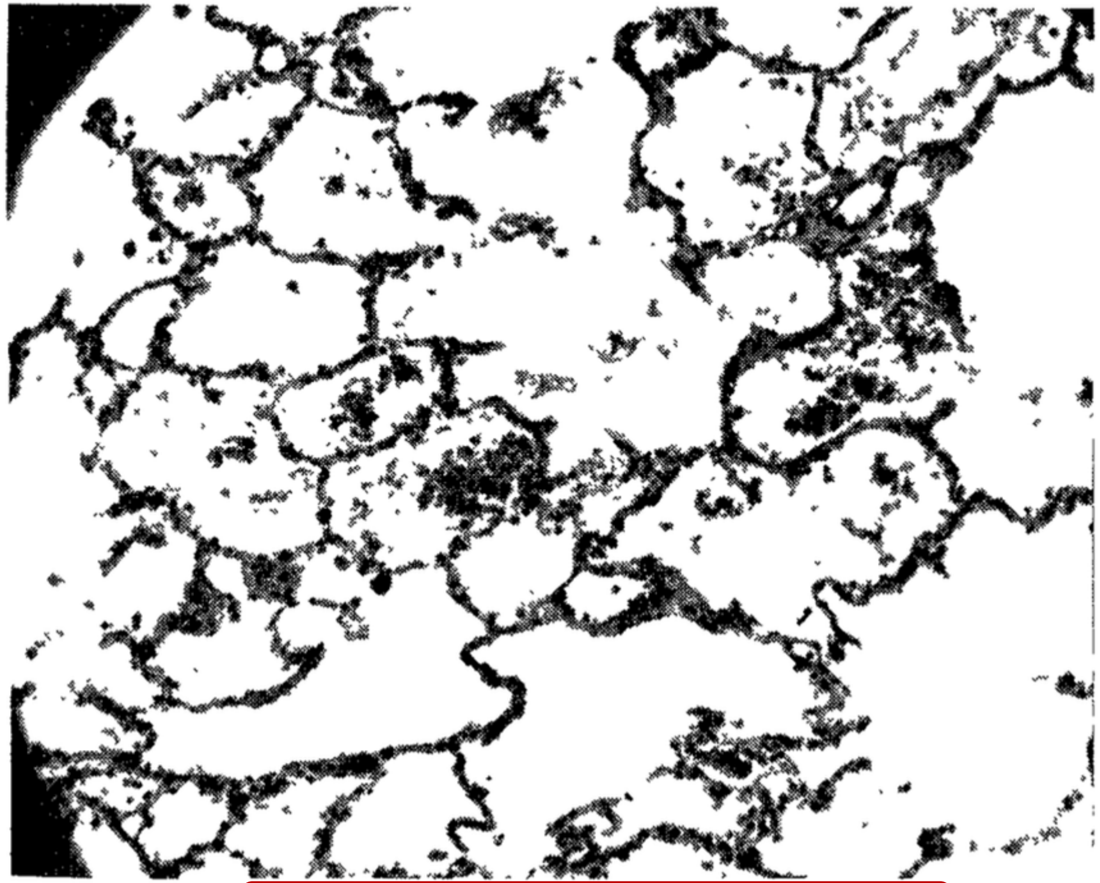
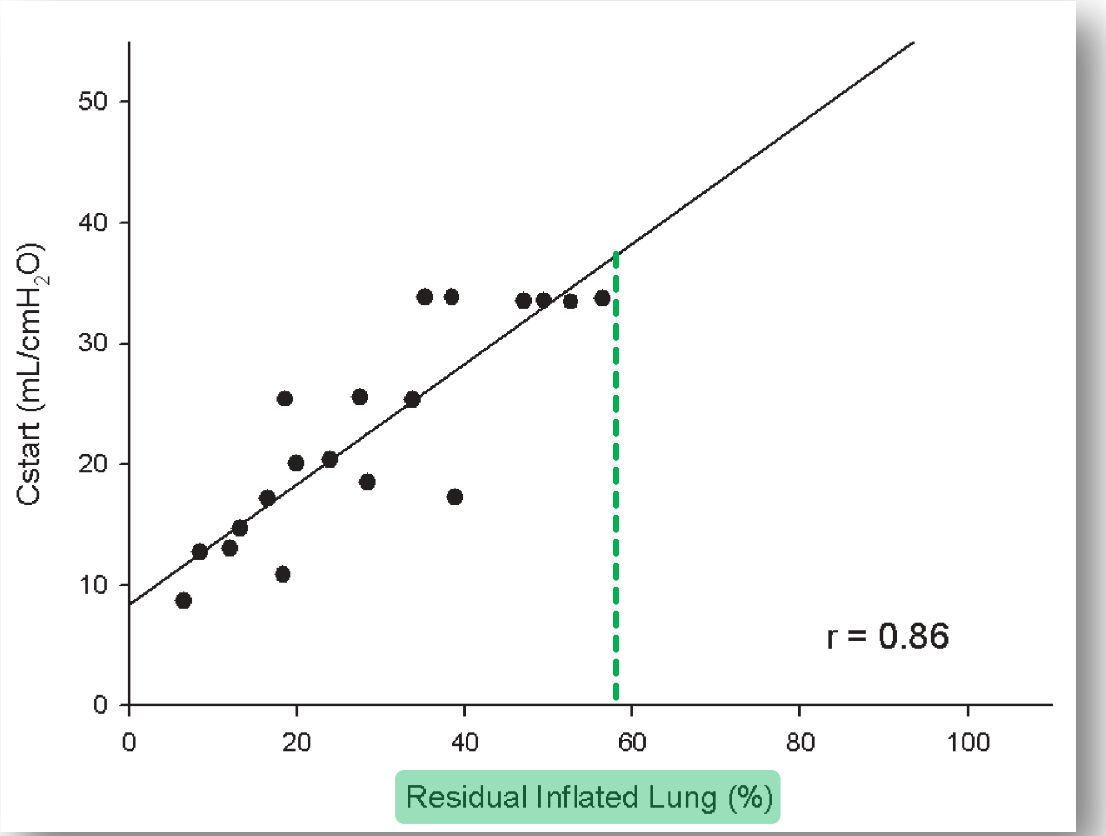
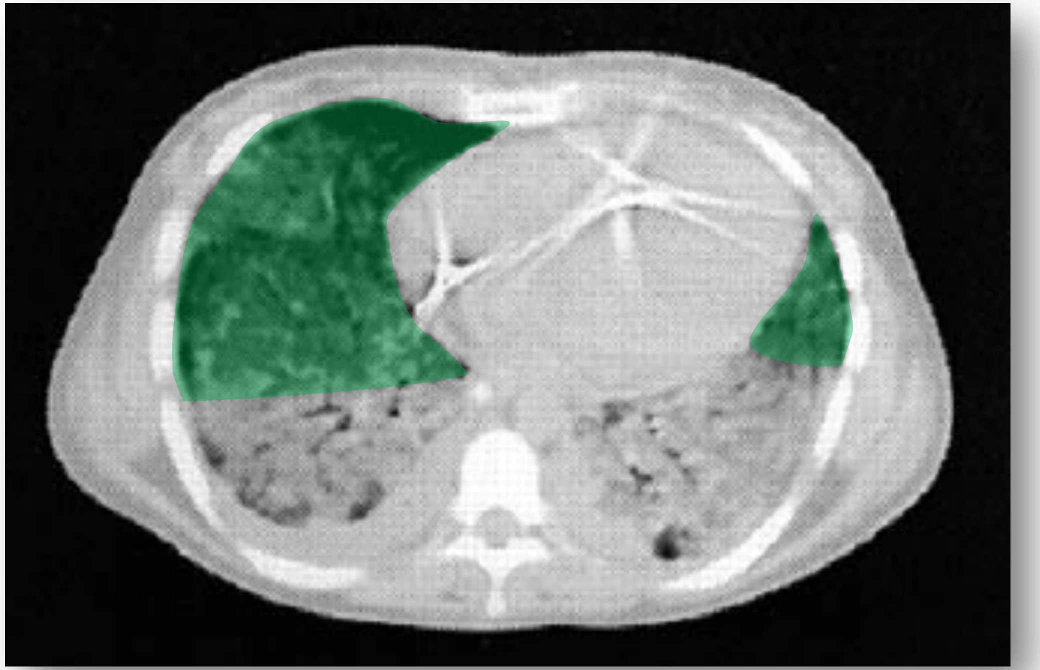


Fig. 4—Case 1: intra-alveolar hæmorrhage and œdema. (Hæmatoxylin and eosin, reduced to $^5/_6$ of × 100.)

Ashbaugh Lancet 1967

Diminution du volume aéré

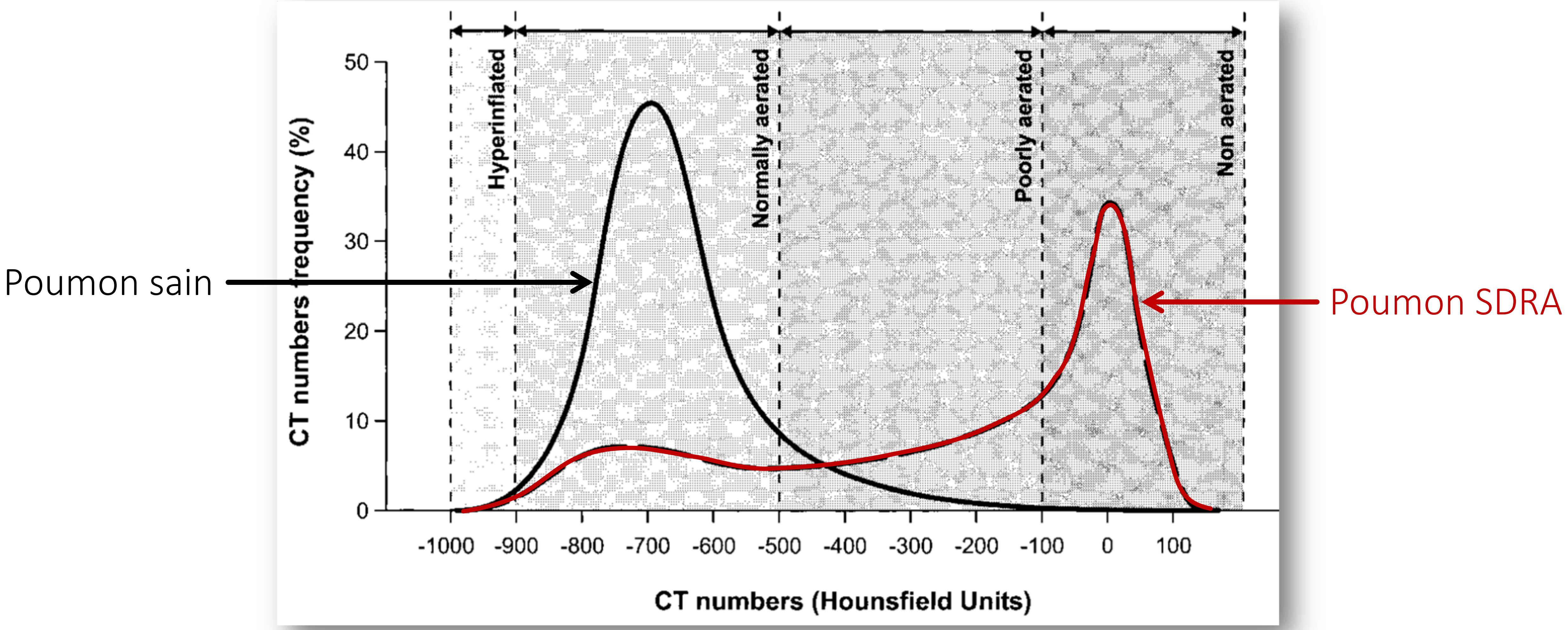




Gattinoni Am Rev Respir Dis 1987

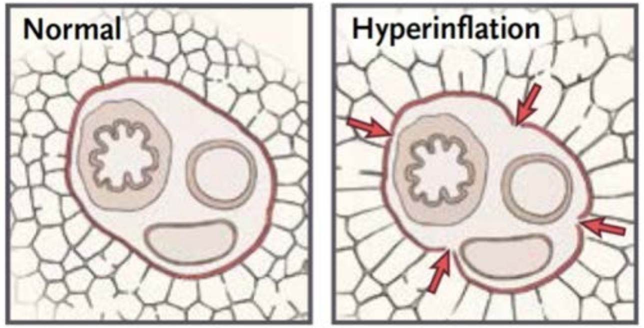
Gattinoni Intensive Care Med 2005

Inhomogène

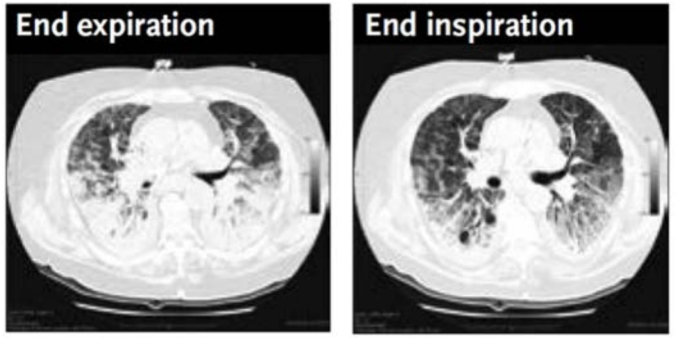


Gattinoni Am J Respir Crit Care Med 2001

Objectif de la ventilation: limiter le VILI



Overdistension



Atelectrauma

Biotrauma

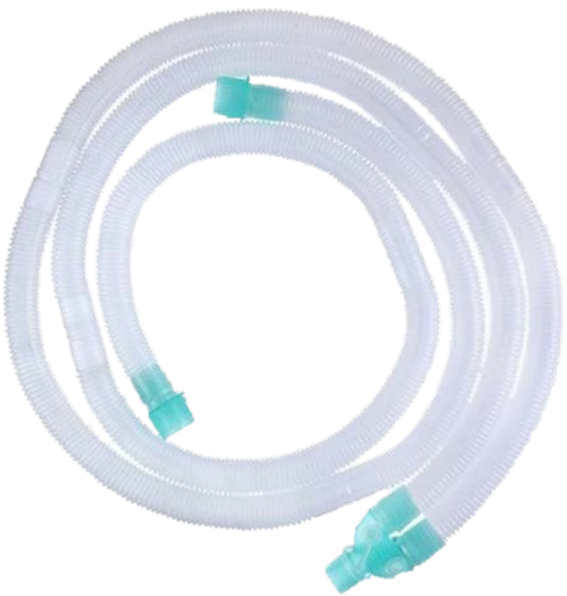
IL-1β, IL-6, TNFα, …

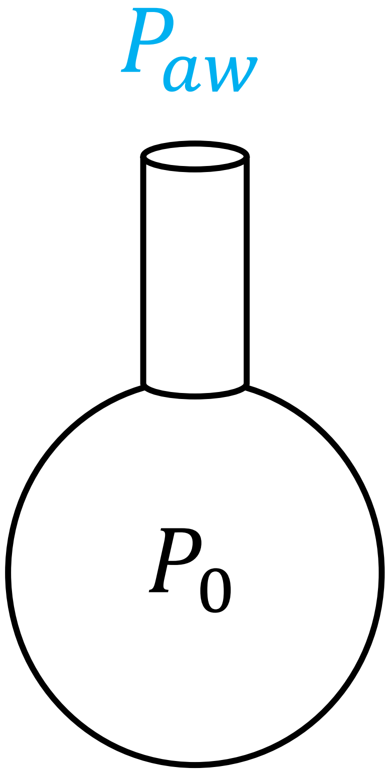
Slutsky N Engl J Med 2013

Grands concepts physiologiques en ventilation passive

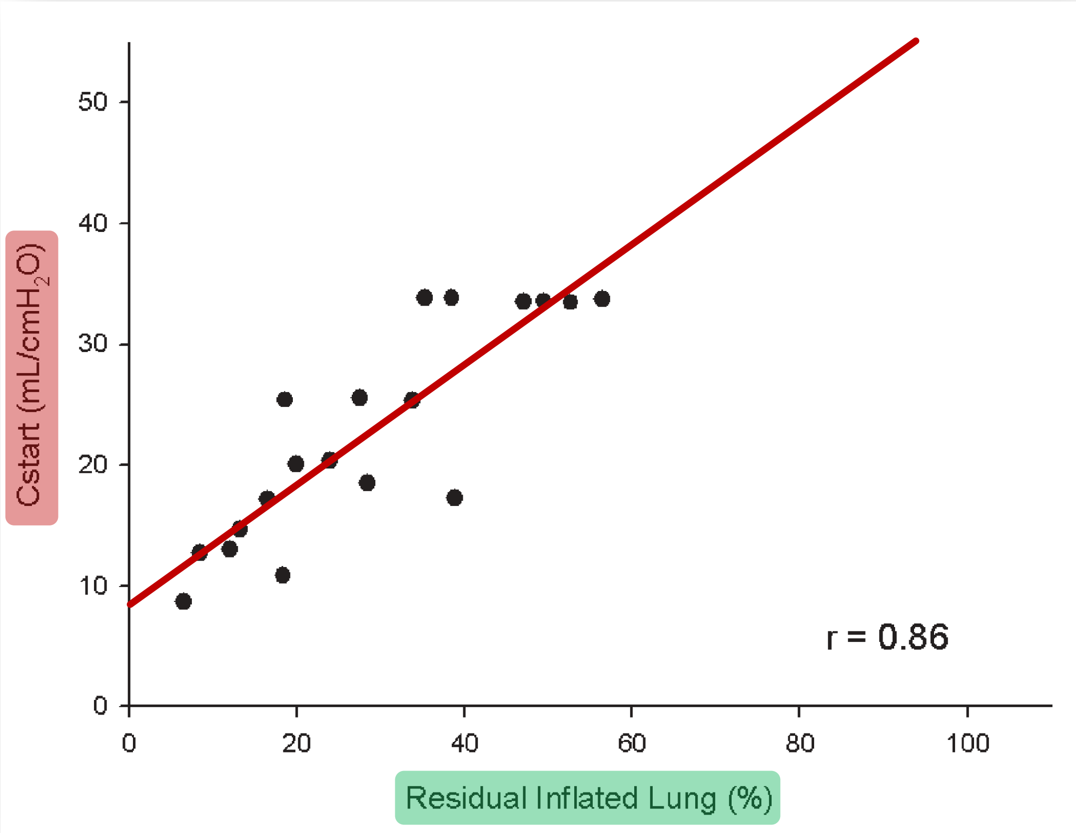
$$P_{aw} = P_0 + P_{res} + P_{el}$$

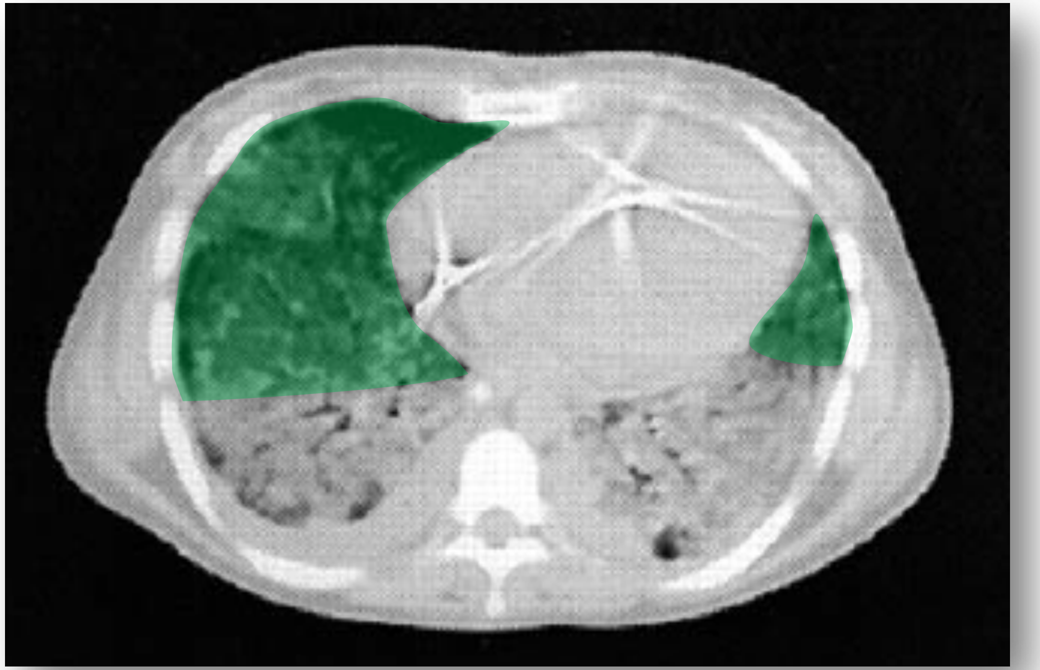
Ventilation passive





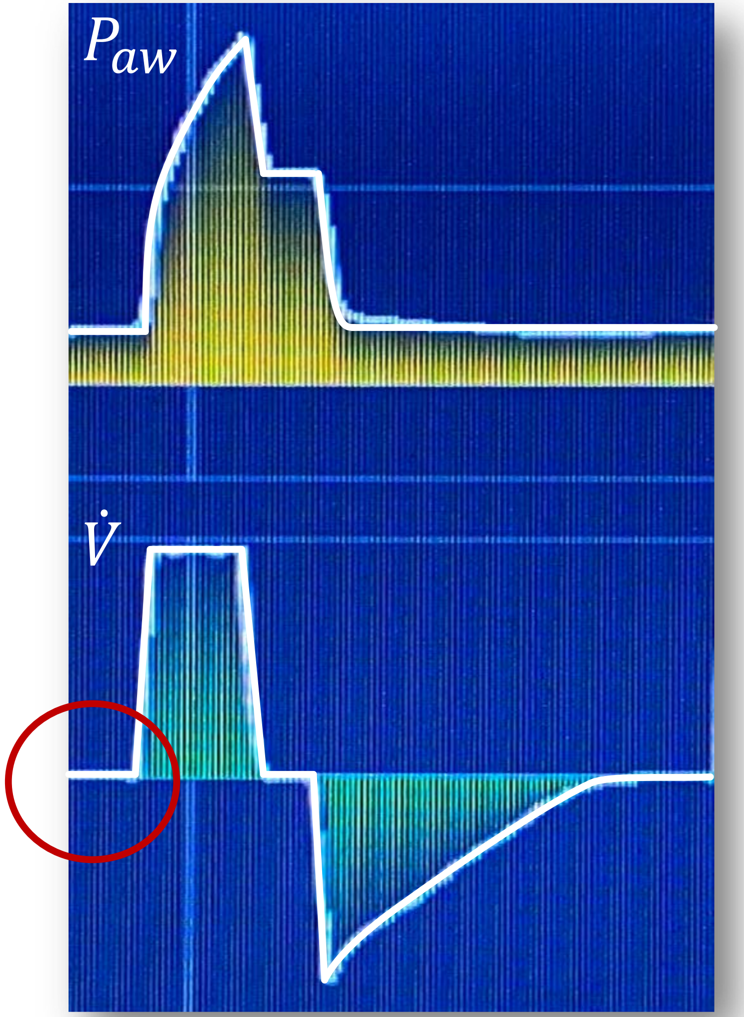
C_{rs} ⟺ volume pulmonaire aéré

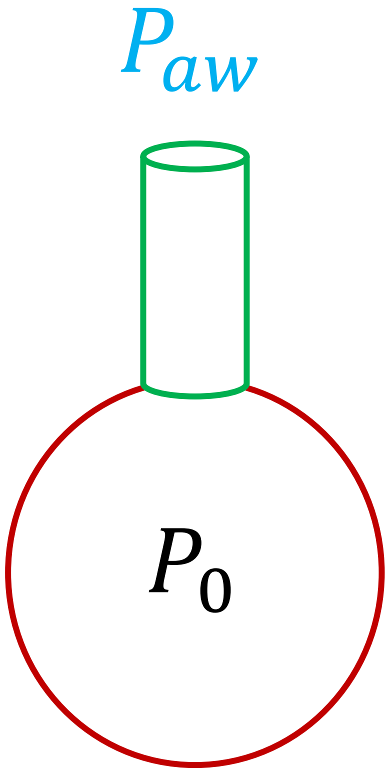




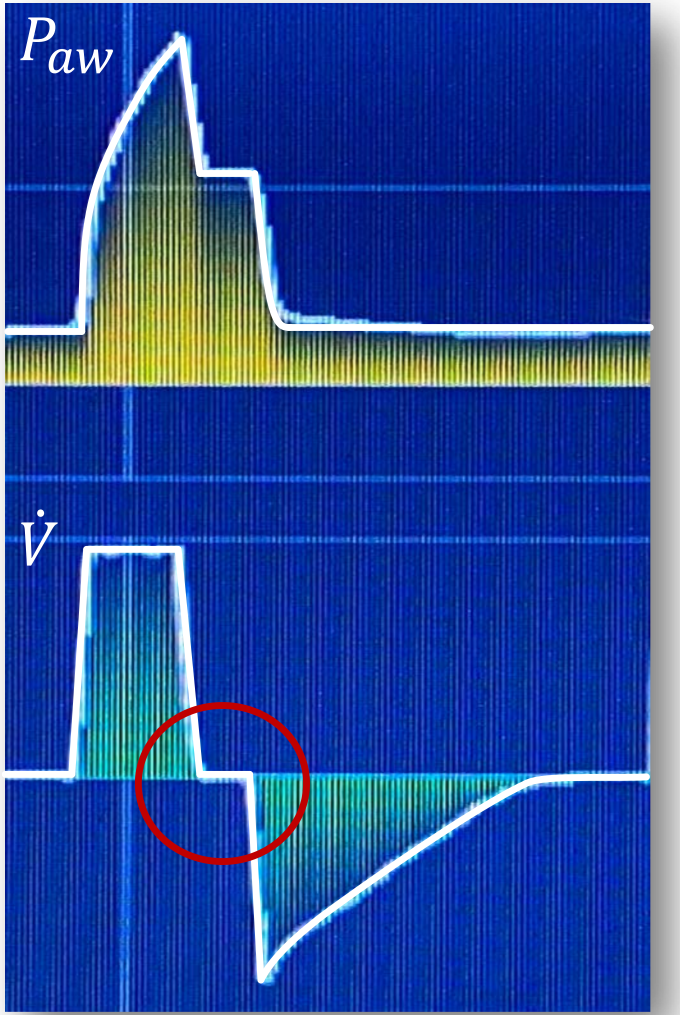
Gattinoni Intensive Care Med 2005

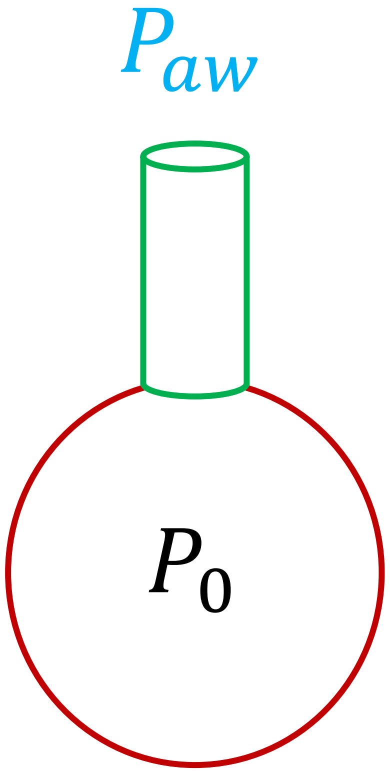
$$PEEP_t = P_0 + 0 + {}^{0}/_{C_{rs}}$$



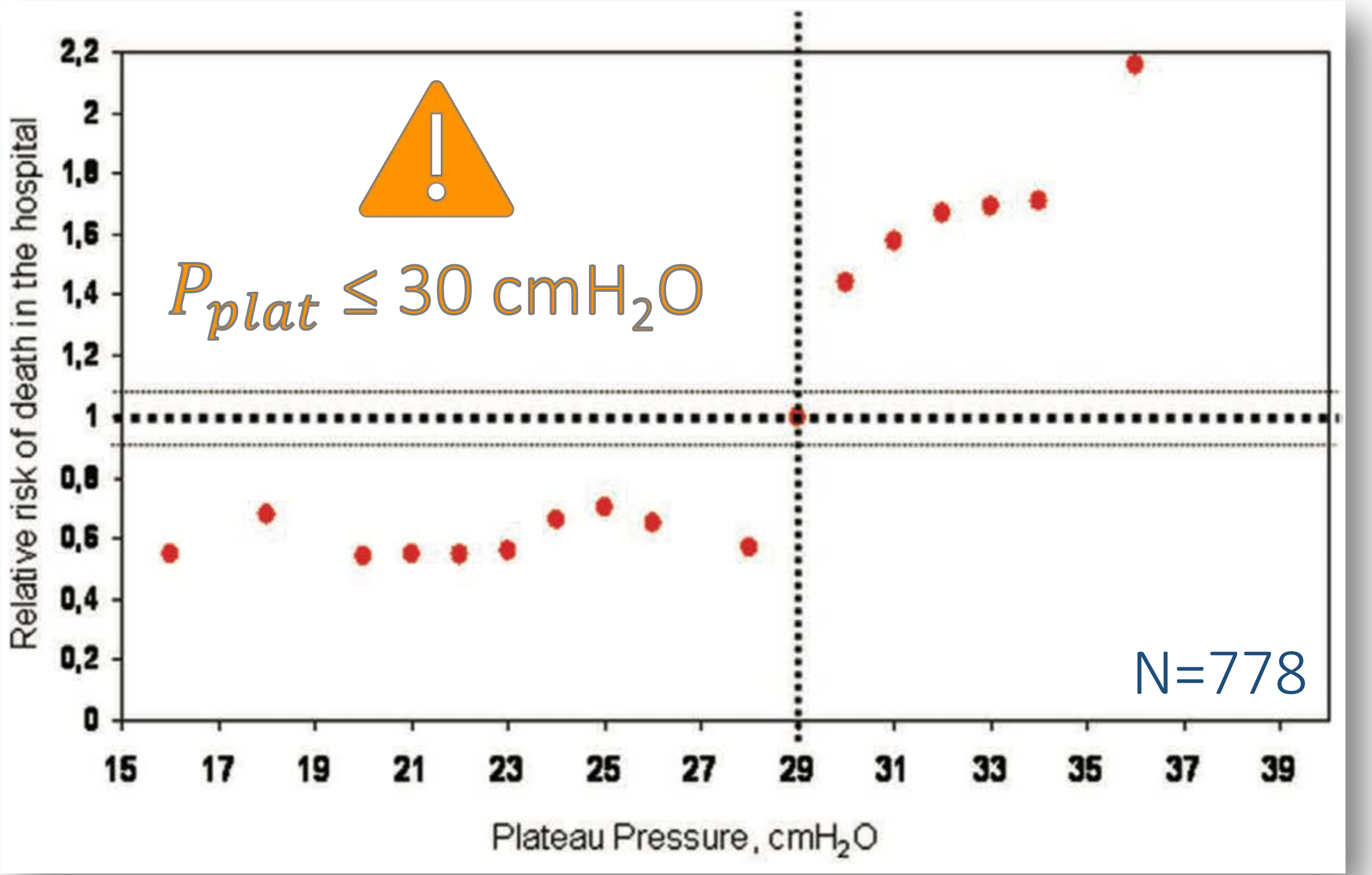


$$P_{plat} = PEEP_t + 0 + V_t / C_{rs}$$





P_{plat} = pression alvéolaire télé-inspiratoire



Villar Crit Care Med 2017

$$P_{plat} = PEEP_t + {}^{V_t}/_{C_{rs}}$$

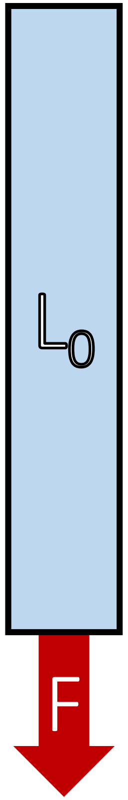
$$C_{rs} = \frac{V_t}{\Delta P}$$

$$\Delta P = \frac{V_t}{\sim aerated\ lung}$$

La pression motrice reflète le *strain*

(volume insufflé sur le poumon disponible)

Stress et strain



Stress

Stress

$$P_{plat} - PEEP_t$$

$$\boxed{\text{Stress} = k \times \text{Strain}}$$

Strain

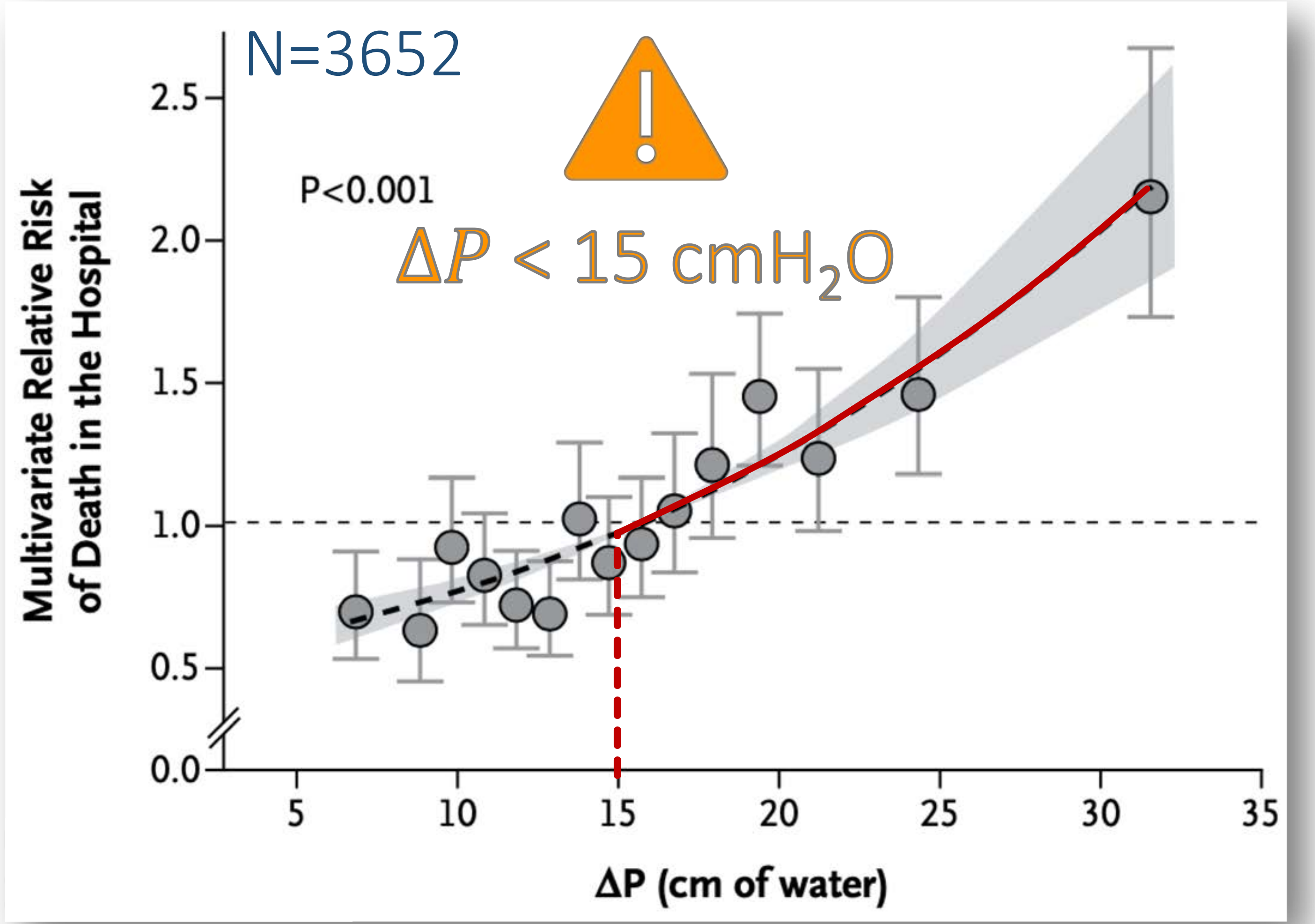
$$\frac{(L_1 + L_0) - L_0}{L_0}$$

Strain

$$\frac{(Vt + EELV) - EELV}{EELV}$$

Inspiré de Martin Dres

ΔP et mortalité



Amato New Engl J Med 2015

$$P_{el} \sim PEEP_t + \sim 0 + V/C_{rs}$$

Ventilation passive

Servillo Am J Respir Crit Care Med 1997

$$P_{el} \sim PEEP_t + \sim 0 + {V_t}/{C_{rs}}$$

Ventilation passive

1/3 SDRA

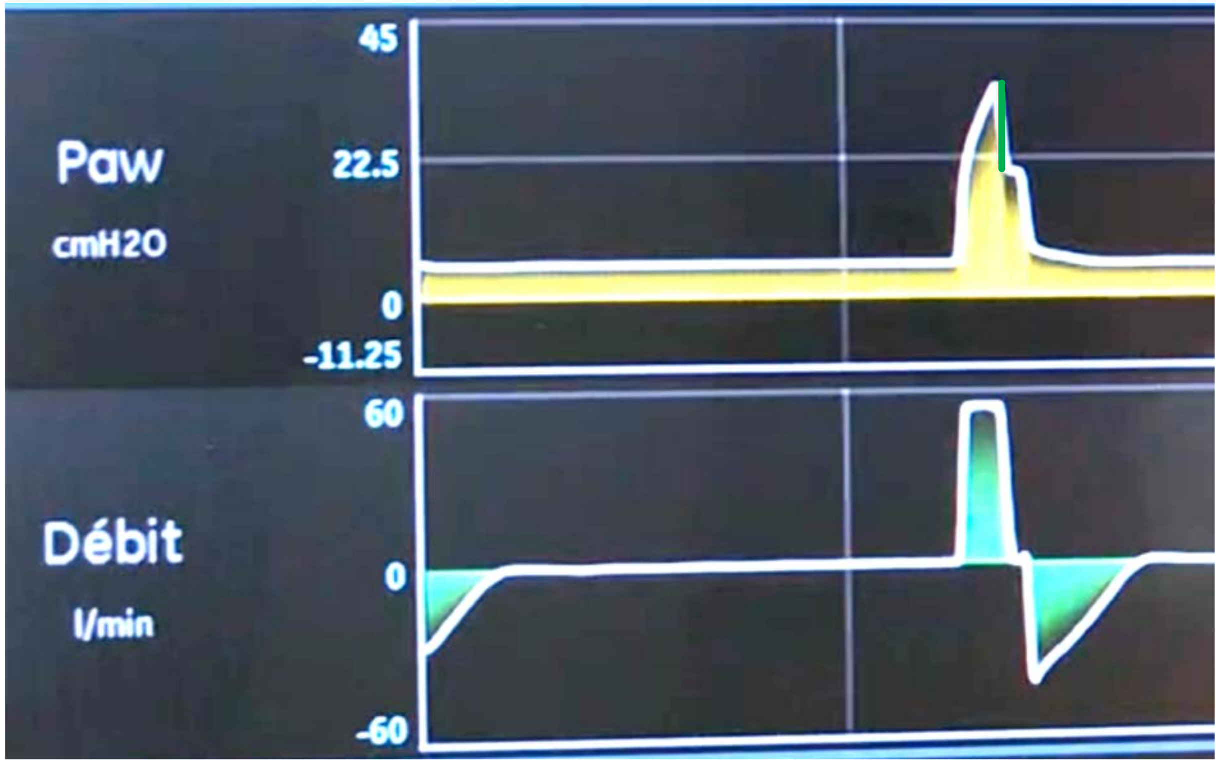
Mécanique respiratoire++

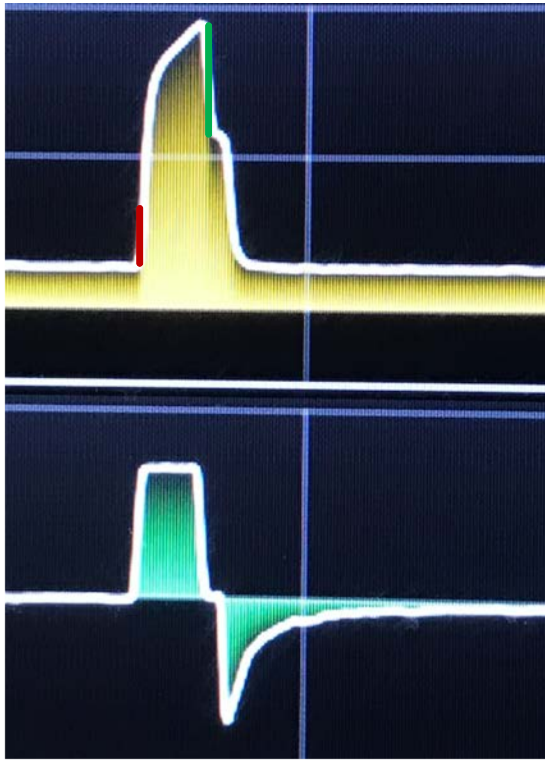
Régler PEEP ≥ AOP

Chen Am J Respir Crit Care Med 2018

Pression conductive pour dépister AOP

Ventilation passive



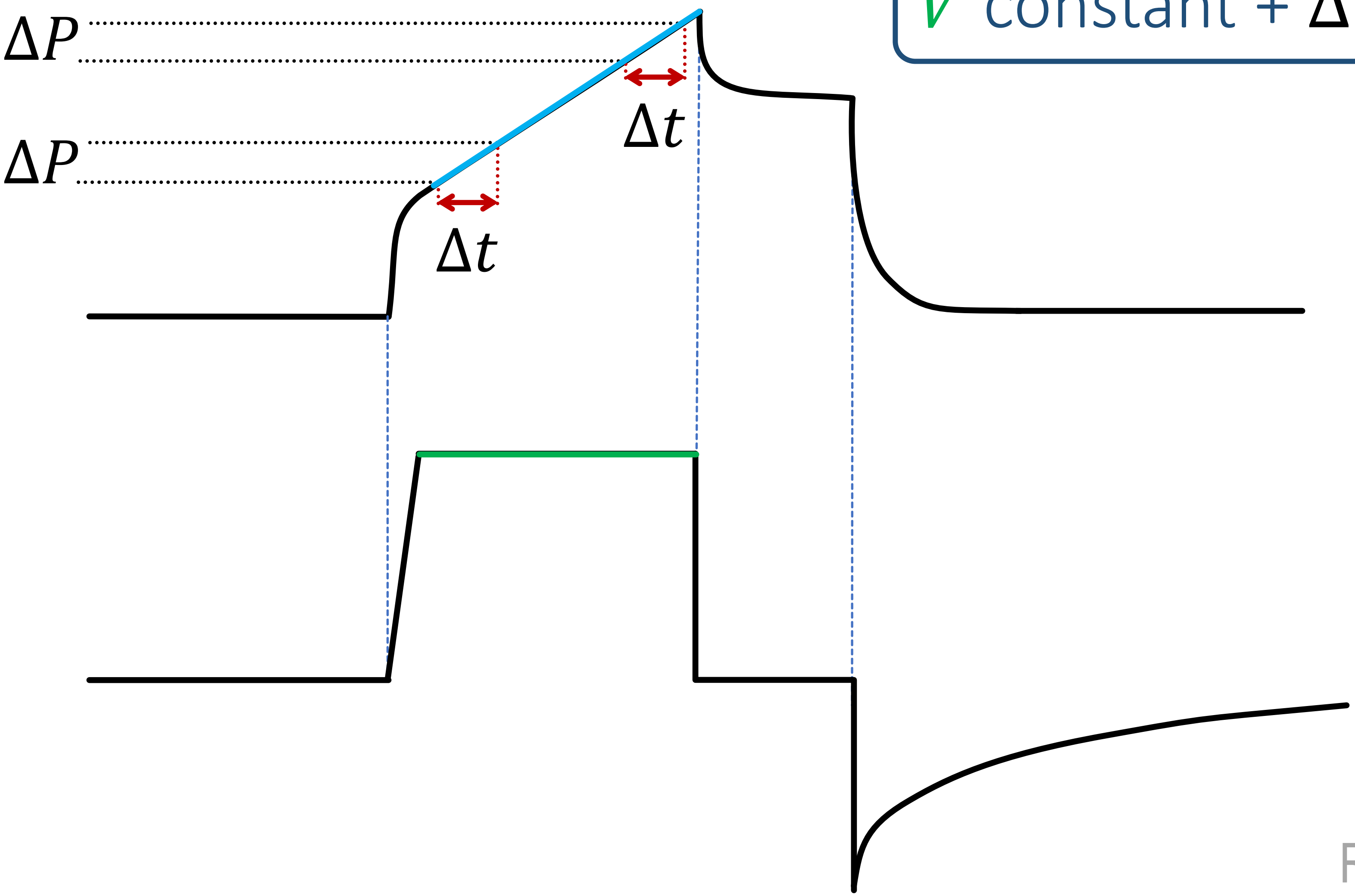


Haudebourg Crit Care 2023

Stress index

Ventilation passive

$\dot{V}$ constant + Δt constant → ΔV constant

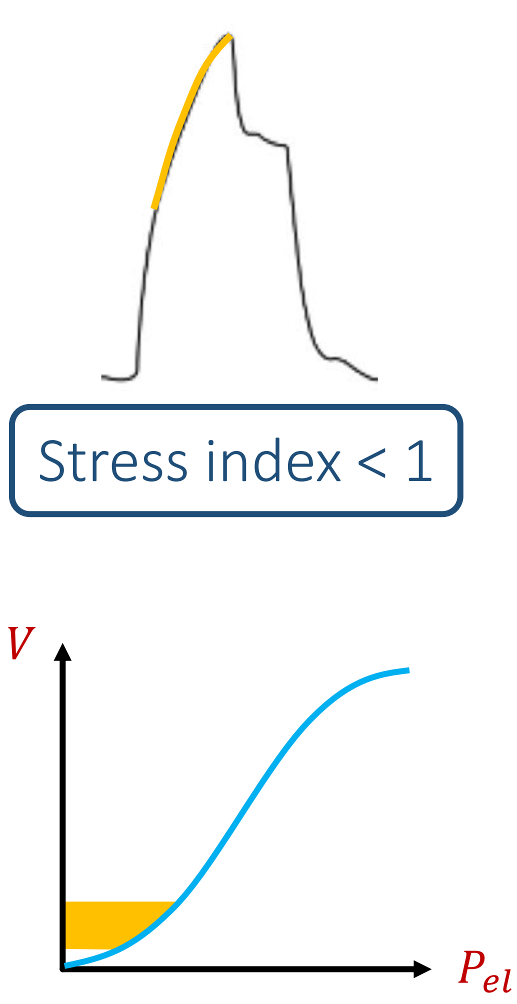


$$C = \frac{\Delta V}{\Delta P}$$

$\boxed{\Delta P \Leftrightarrow C}$

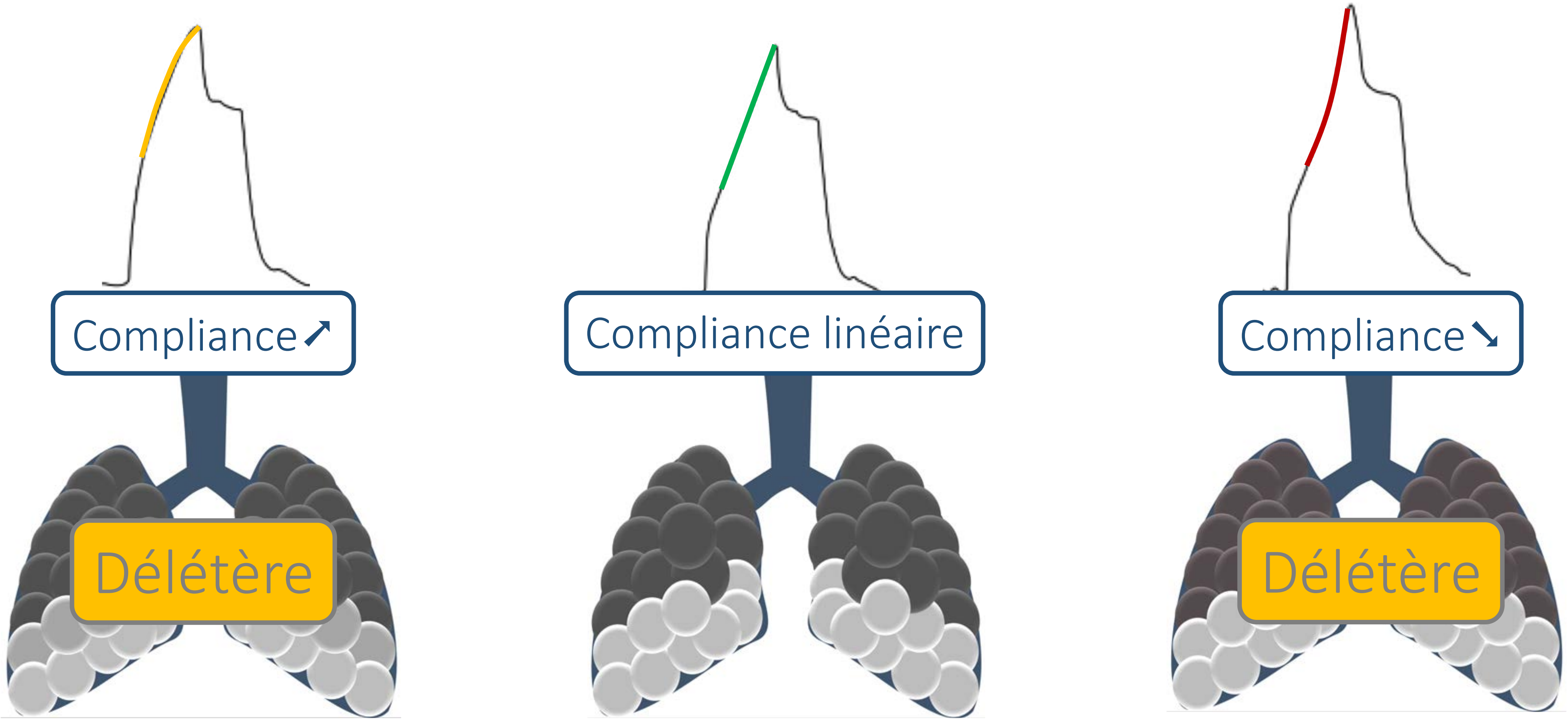
Ranieri Am J Respir Crit Care Med 1994

Stress index ($P_{aw} = a \times time^{b} + c$)



Ranieri Am J Respir Crit Care Med 1994

Tidal recruitment et tidal overdistension



Grasso Crit Care Med 2004

Ranieri Am J Respir Crit Care Med 1994

Approche physiologique pour régler la PEP

Effets de la PEEP

↗ Recrutement alvéolaire

↘ Shunt

↗ PaO_2

↘ Atelectrauma

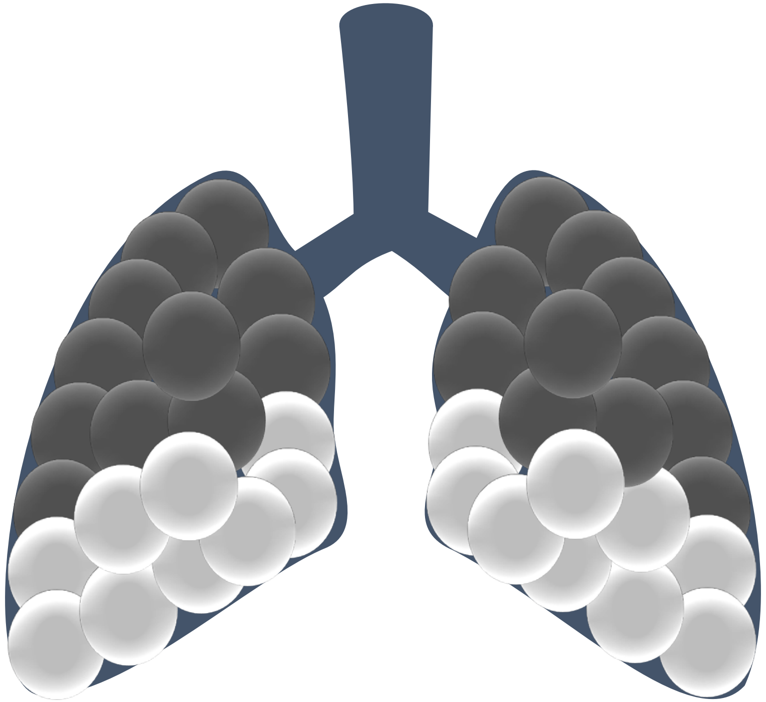


Image: AF Haudebourg

↗ Volume pulm télé-inspi

↘ Précharge VD
↗ Postcharge VD

↘ Qc

↗ Volotrauma

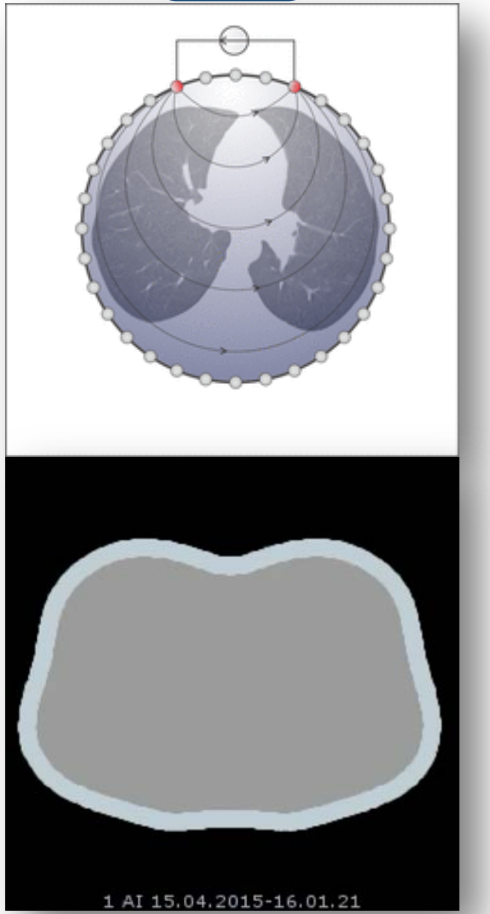
Maggiore Am J Respir Crit Care Med 2001
Dantzker Chest 1980

Recruter alvéoles pour ↗ EELV

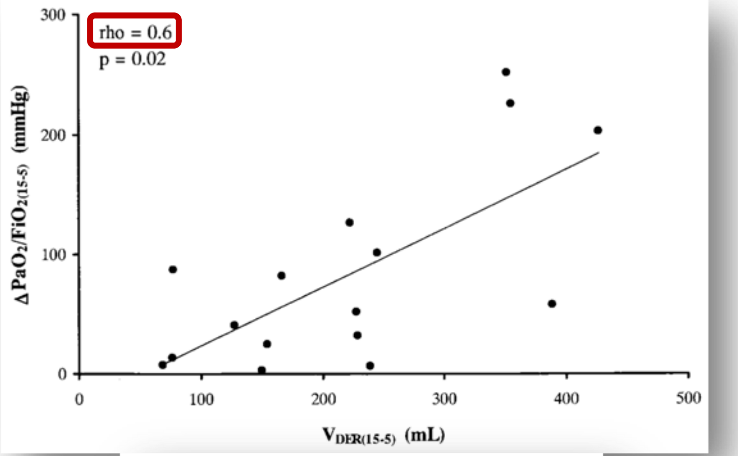
Gattinoni New Engl J Med 2006

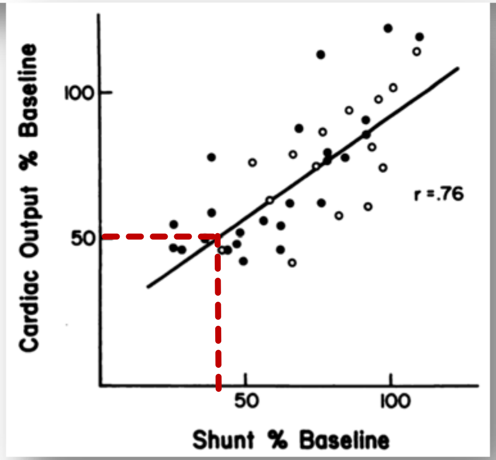
Scanner

EIT



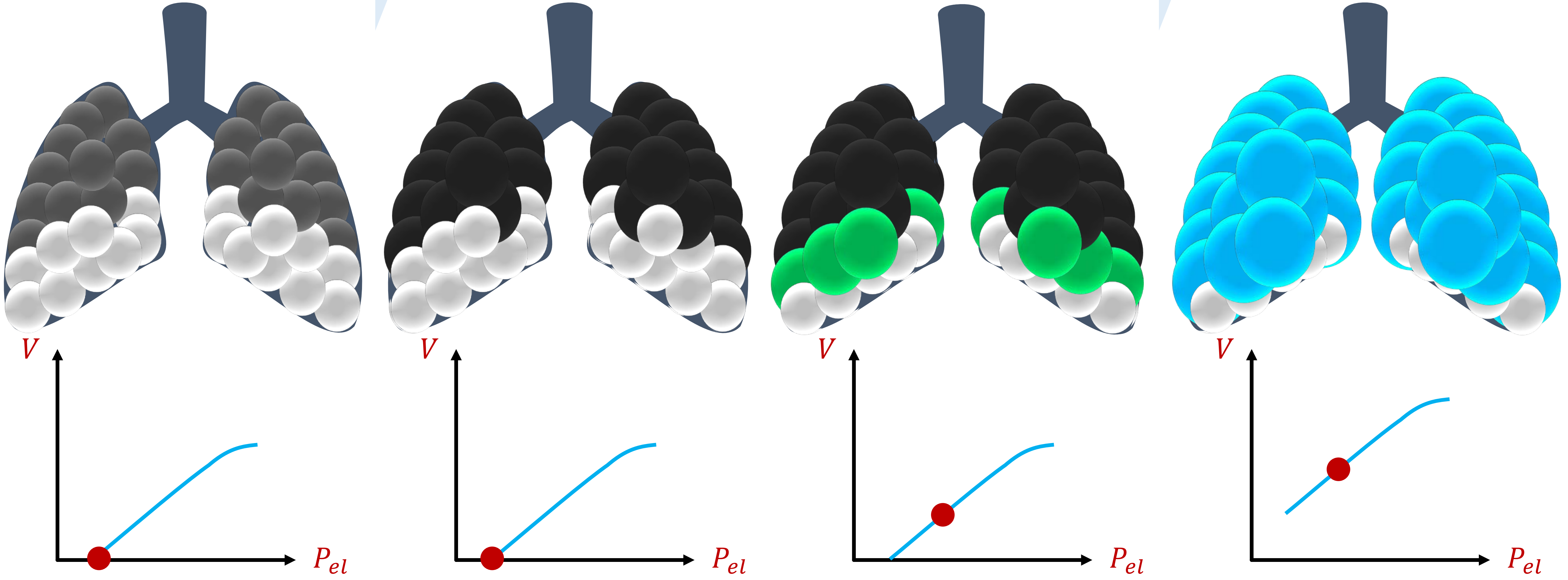
~~Oxygenation~~



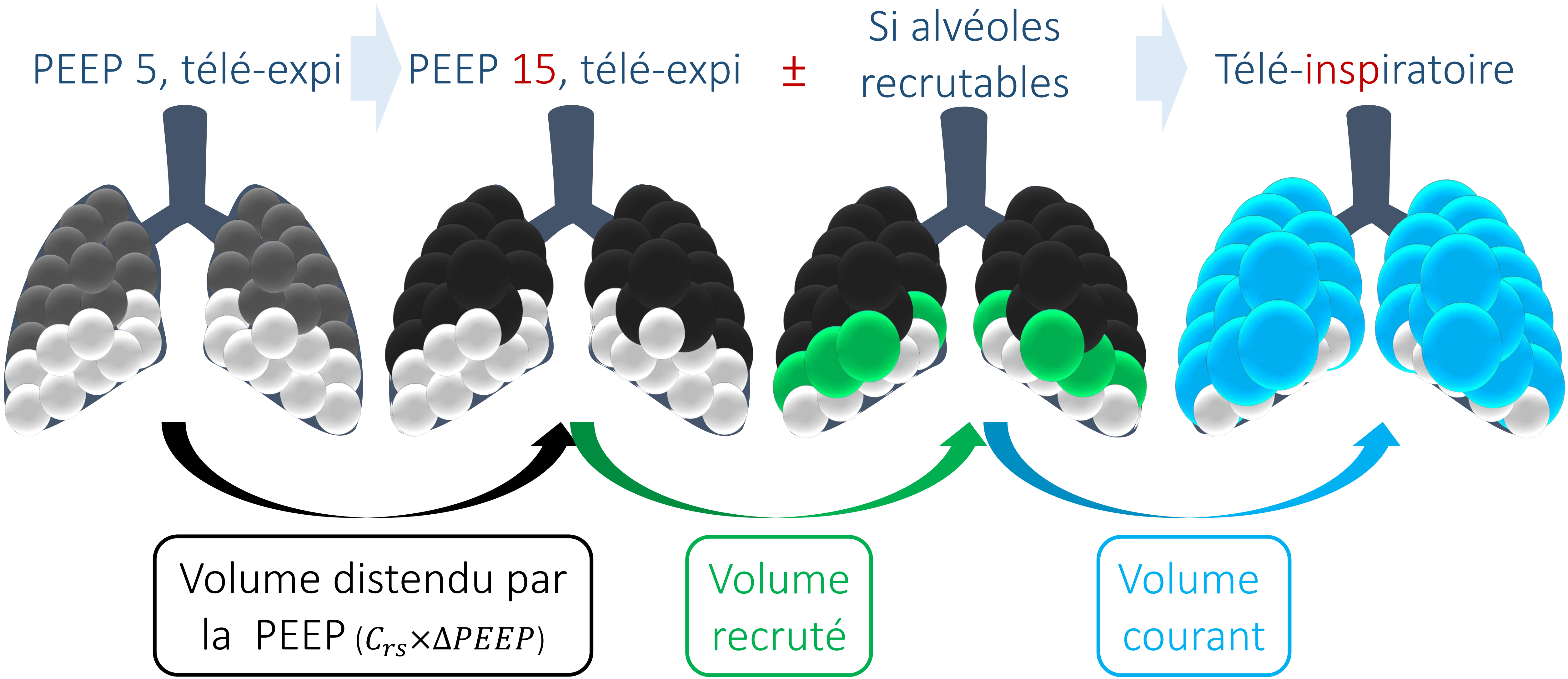


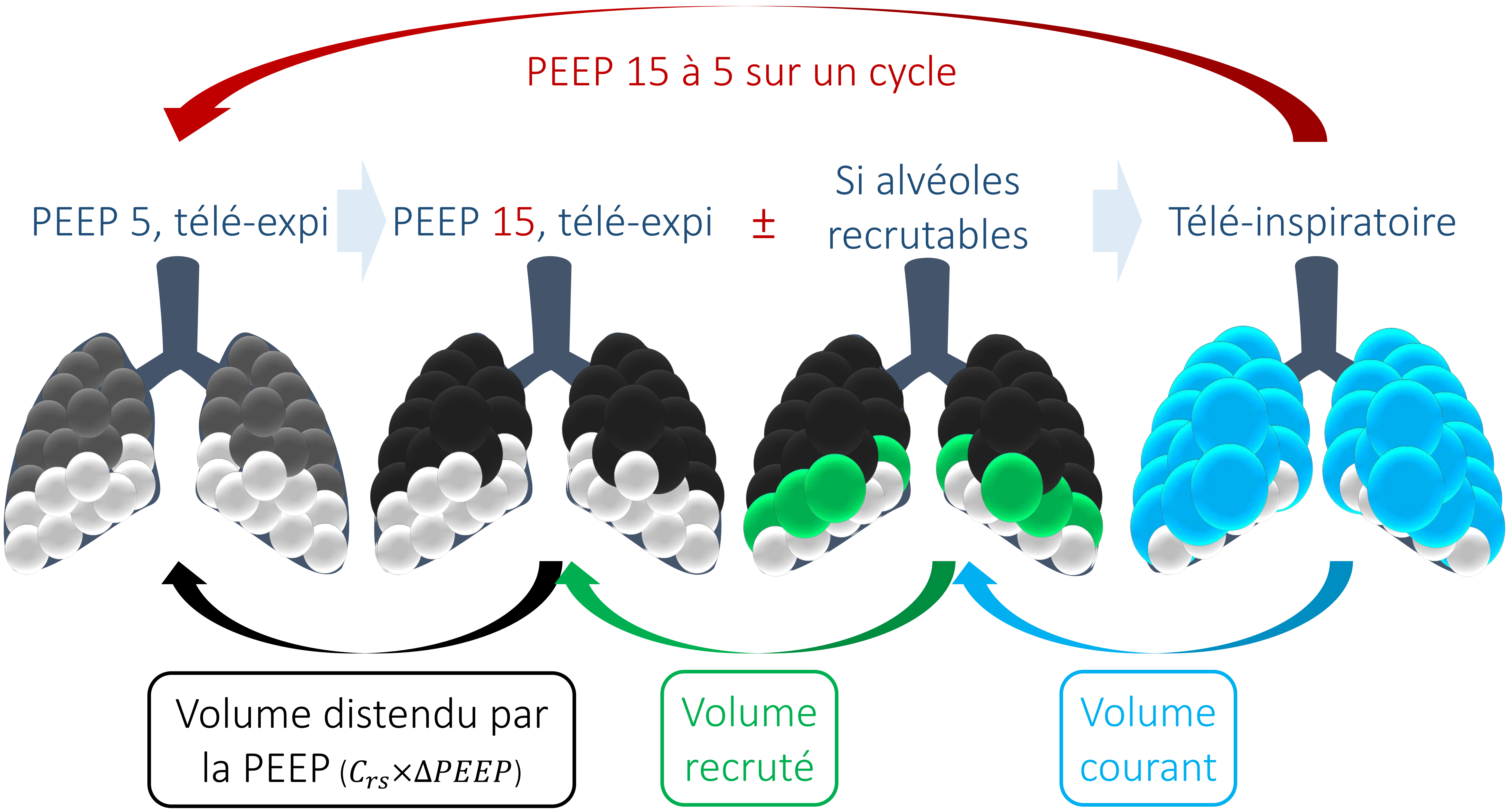
Relation pression-volume

PEEP 5, télé-expi → PEEP 15, télé-expi ± Si alvéoles recrutables → Télé-inspiratoire



Relation pression-volume





PEEP 15 à 5 sur un cycle
PEEP 5, télé-expi
PEEP 15, télé-expi
±
Si alvéoles recrutables
Télé-inspiratoire
Volume distendu par la PEEP ($C_{rs} \times \Delta PEEP$)
Volume recruté
Volume courant

R/I ratio, mode d'emploi

VENTILATION PASSIVE

PEEP 15 pendant 10 min

Diminuer FR à 8/min (éviter PEEPi)

Diminuer PEEP à 5 sur un cycle

Noter le premier grand Vte après diminution de PEEP

Calculer compliance à PEEP 5

R/I ratio, mode d’emploi

Noter le premier grand Vte après diminution de PEEP

Volume distendu par la PEEP

Volume recruté

Volume inspiré

$C_{rs} \times \Delta PEEP$

Qu’on veut connaître

Qu’on a réglé

Volume recruté

Doit être ajusté au ΔPEEP

Compliance du poumon recruté

Doit être rapportée à la compliance à PEEP basse

$$\frac{\text{Compliance}_{\text{poumon recruté}}}{\text{Compliance}_{\text{PEEP5}}} = \text{R/I ratio}$$

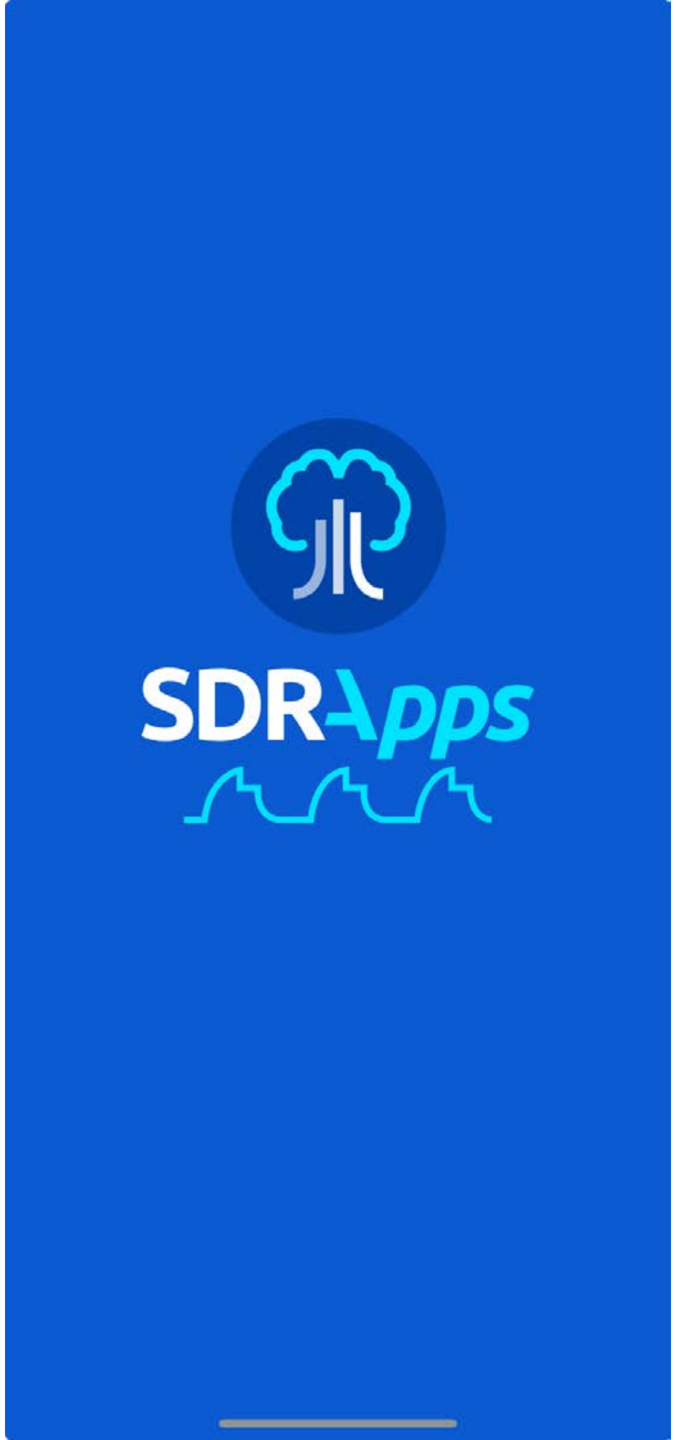
Peu recrutable
Effets HD délétères

Plutôt recrutable
Peu d'effets HD délétères

⚠ Prendre en compte AOP dans les calculs
(C_{rs} à PEEP 5 et ΔPEEP)

Cappio Borlino Am J Respir Crit Care Med 2024

Chen Am J Respir Crit Care Med 2020


SDRApps

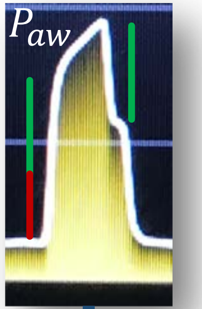

OUTILS DE CALCUL
Diagnostic
Volume courant
Mécanique ventilatoire
Niveau de PEP
Curarisation
Décubitus ventral
Pression oesophagienne
Espace mort
Shunt intrapulmonaire
Outils
Exporter
A propos
Profil

Proposition de réglages guidés par la physiologie

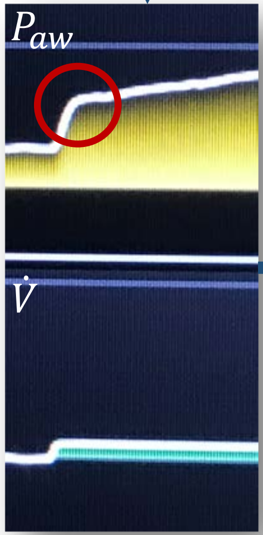
SDRA modéré à sévère

1) Vt 6 mL/kg PPT

2) P_{cond}



3) AOP



$\leq$ 10 cmH_2O

PEEP 8-10 cmH_2O

> 10 cmH_2O

4) R/I ratio

Bas

Haut

P_{plat} 28 cmH_2O sauf si:

- Stress index > 1
- $\Delta P \geq 15$ cmH_2O
- ↘ hémodynamique
- ↗ $PaCO_2$

PEEP haute