PERSONNALISER
LA VENTILATION DU SDRA

Jean-Marie FOREL

Médecine Intensive Réanimation

Marseille

Pas de conflit d'intérêt

Personnaliser le traitement ventilatoire c’est quoi ?

1. Le bon traitement, au bon patient, au bon moment et à la bonne dose

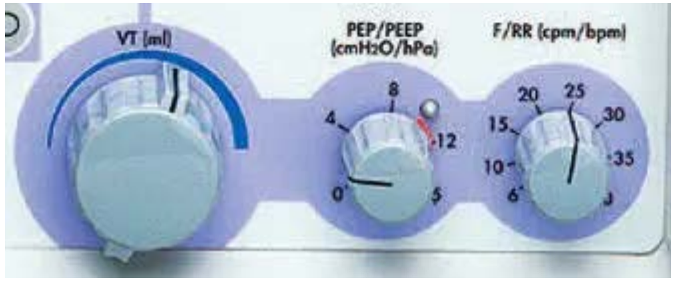
2. Ventilation mécanique
   - Peut amplifier/créer lesions pulmonaires (VILI)
   - Peut être ajustée de façon à limiter VILI (et morbi-mortalité)

3. Comprendre la physiopathologie à l’echelle de l’individu peut aider à identifier celui qui va “répondre” au traitement

Personnaliser : quels paramètres ?

- Personnaliser le Vt

- Personnaliser la PEEP



Volume courant

srlf.org/media/rfe-prise-charge-du-sdra-ladulte-phase-initale

Applications APHM VitalSource Booksh... CCOF - Formations... Mon Drive - Googl... Importés depuis IE

srlf SOCIETE DE REANIMATION DE LANGUE FRANÇAISE

La SRLF Congrès Formations Prix et Bourses

Recherche

Accueil / RFE - Prise en charge du SDRA de l'adulte à la phase initiale

RFE - Prise en charge du SDRA de l'adulte à la phase initale

R2.1.1 – Il faut utiliser un faible volume courant autour de 6 ml/kg de poids prédit par la taille (PPT) comme première approche pour les patients ayant des SDRA reconnus, en l'absence d'acidose métabolique sévère, y compris avec SDRA léger, dans le but de diminuer la mortalité.

GRADE 1+, ACCORD FORT

Personnaliser le Vt

= Repérer l'agression = ventilation **non** protectrice

Bedside Assessment of Safety for VT Titration

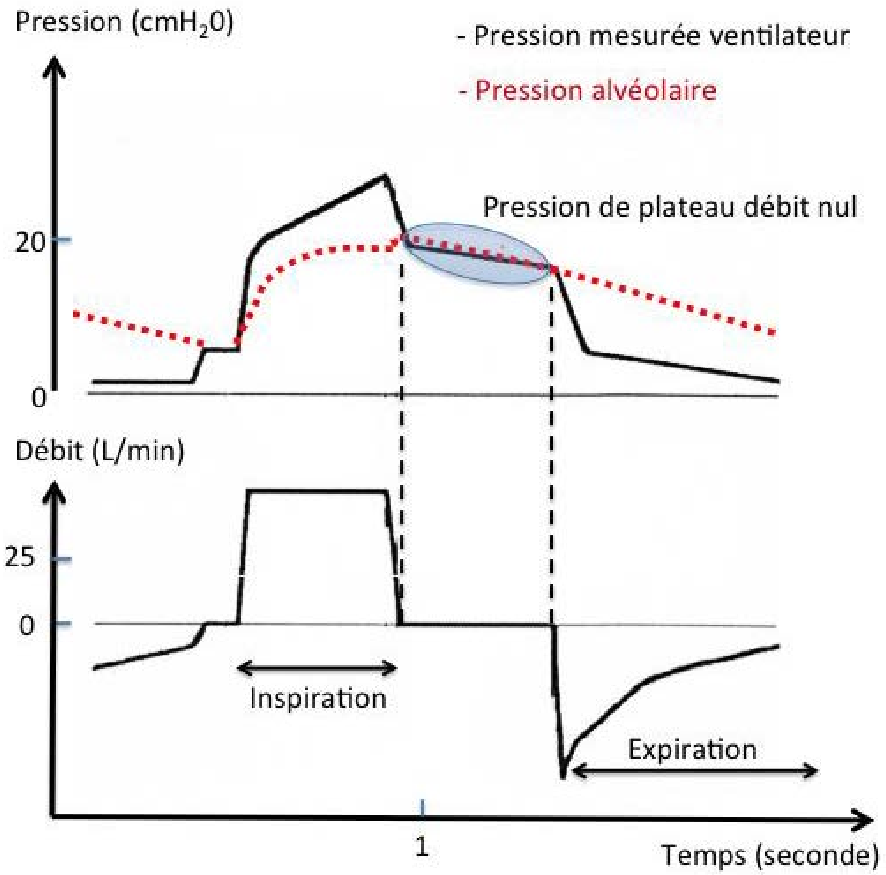
Physiologic Variables	Mechanism	Threshold (cm H_2O)
Plateau pressure	Maximal pressure across the respiratory system at the end of tidal breath Static total mechanical stress and barotrauma	28 (30)
Transpulmonary plateau pressure	Maximal pressure across the lung at the end of tidal breath Mechanical stress and barotrauma to the lung	22–24
Driving pressure	Dynamic pressure change during tidal breath applied to the respiratory system Dynamic mechanical stress and strain	14 (15)
Driving transpulmonary pressure	Dynamic pressure change during tidal breath applied to the lung Dynamic mechanical stress and strain to the lung	8–10
Stress index	`Worsening of respiratory system compliance during tidal breath Overdistension and barotrauma	1

Mauri T. Critical Care Explorations: July 2021 - Volume 3 - Issue 7 - p e0486

Pression de plateau

Bedside Assessment of Safety for VT Titration

Physiologic Variables	Mechanism	Threshold (cm H_2O)
Plateau pressure	Maximal pressure across the respiratory system at the end of tidal breath Static total mechanical stress and barotrauma	28 (30)



Stress Index

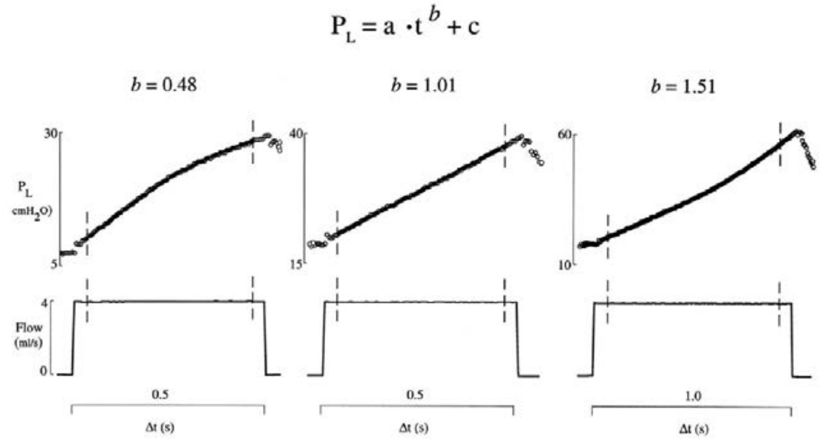


Fig. 8 Pressure-time (*P-t*) curves demonstrating the concept of using stress index to personalize PEEP. Using the power equation $P_L = a \cdot t^b + c$, *b* describes the shape of the *P-t* curve. When $b < 1$, the shape of the curve is a downward concavity as compliance increases over time. When $b > 1$, the curve has an upward concavity as compliance decreases over time. When $b = 1$, the *P-t* curve is straight and compliance is constant. Adjusting tidal volume (Vt) and PEEP so that $b = 1$ produces minimal lung stress, if $b < 1$ would produce low-lung volume stress and $b > 1$ would cause high-lung volume stress [105]

Ranieri VM, Zhang H, Mascia L, Aubin M, Lin CY, Mullen JB, Grasso S, Binnie M, Volgyesi GA, Eng P, Slutsky AS (2000) Pressure-time curve predicts minimally injurious ventilatory strategy in an isolated rat lung model. Anesthesiology 93:1320–1328

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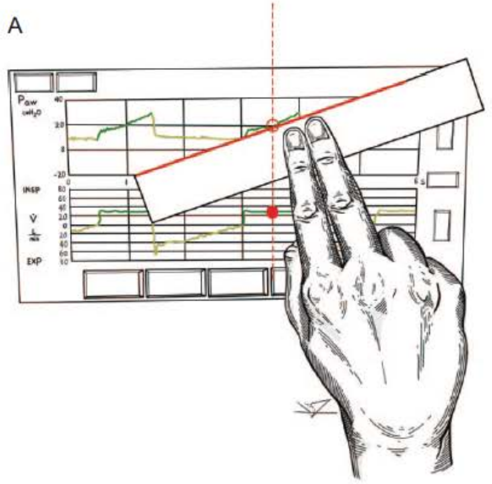
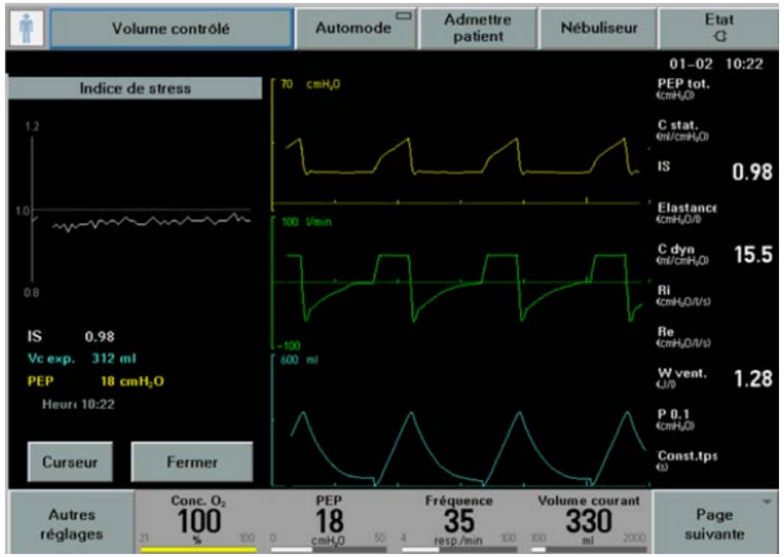
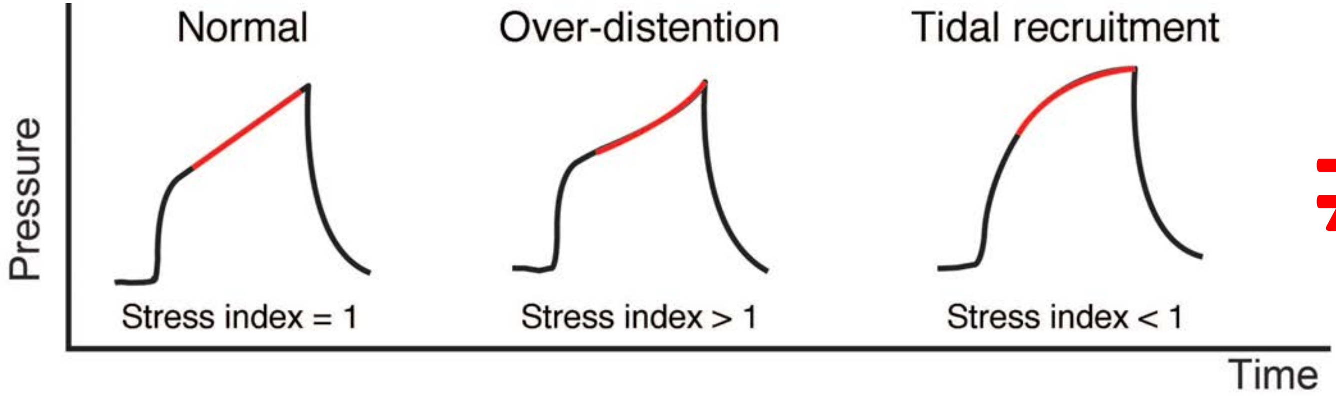




Stress Index Can Be Accurately and Reliably Assessed by Visually Inspecting Ventilator Waveforms

RESPIRATORY CARE • SEPTEMBER 2018 VOL 63 NO 9

Xiu-Mei Sun MSc, Guang-Qiang Chen MD, Kai Chen MD, Yu-Mei Wang MD, Xuan He MSc, Hua-Wei Huang MD, Xu-Ying Luo MD, Chun-Mei Wang MD, Zhong-Hua Shi MD, Ming Xu MD, Lu Chen MD, Eddy Fan MD PhD, and Jian-Xin Zhou MD



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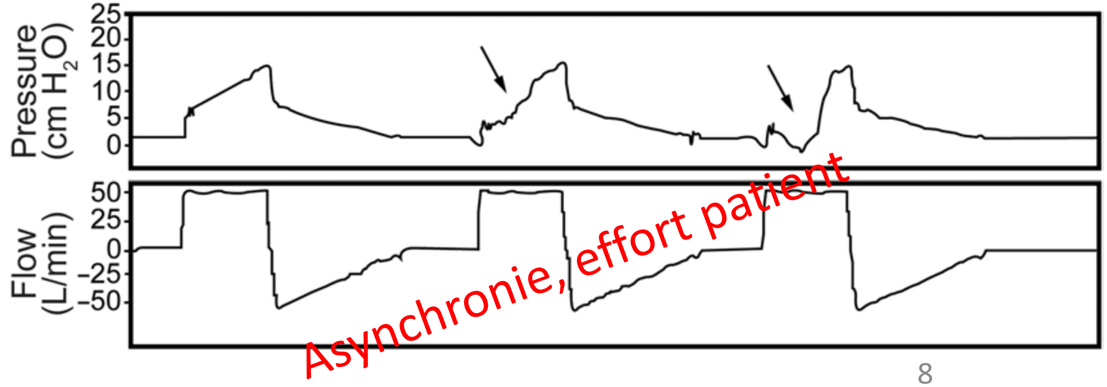
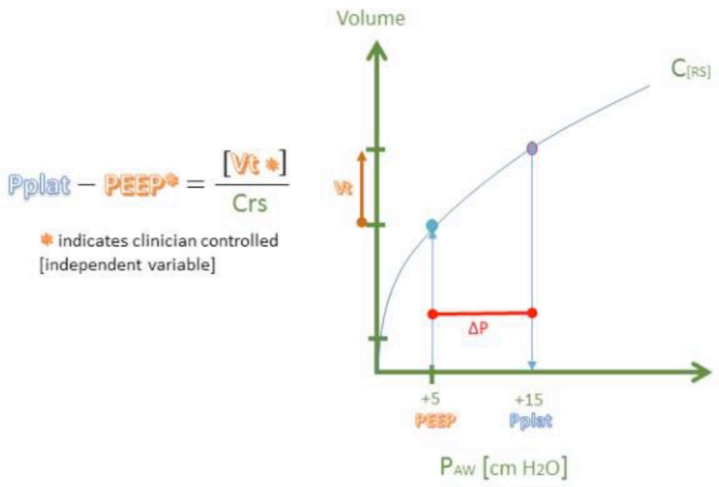
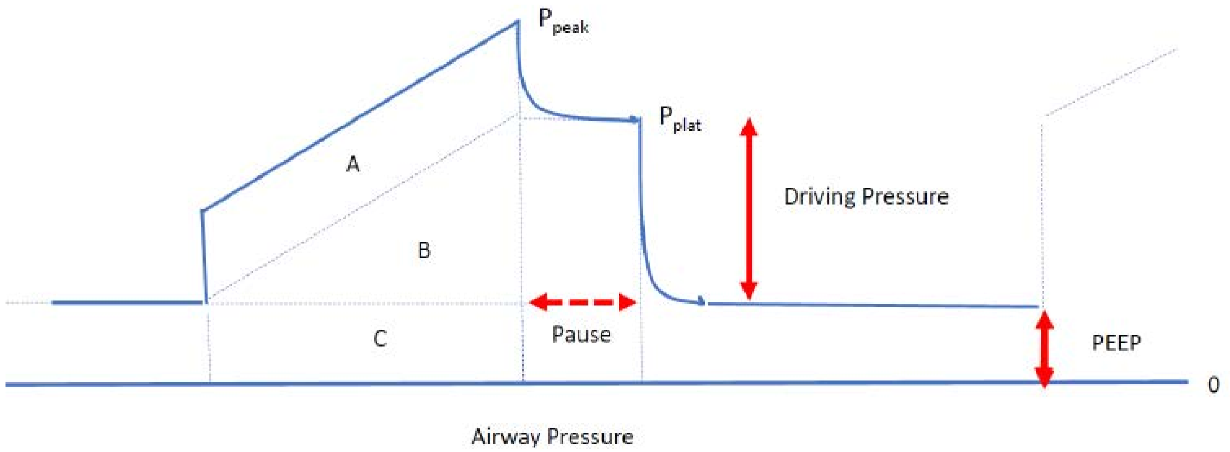


Pression motrice (Driving Pressure)





Reflet de la quantité de déformation cyclique du parenchyme imposée par un Vt

Bedside Assessment of Safety for VT Titration

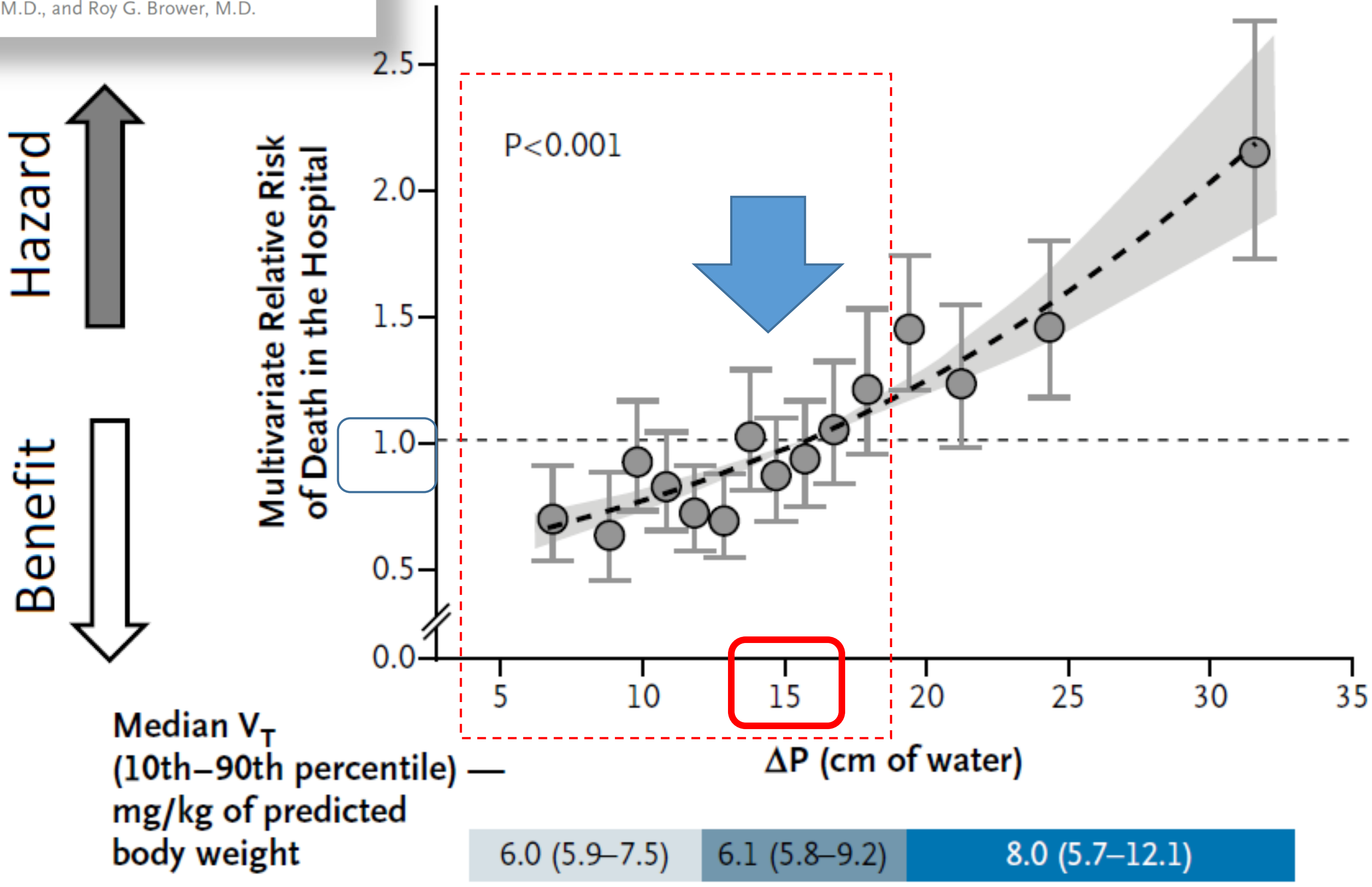
Physiologic Variables	Mechanism	Threshold (cm H_2O)
Driving pressure	Dynamic pressure change during tidal breath applied to the respiratory system Dynamic mechanical stress and strain	14 (15)

Pression motrice = Signal d’alerte
= Douleur des chaussures trop petites
= Vt trop grand / Baby Lung SDRA

Driving Pressure and Survival in the Acute Respiratory Distress Syndrome

Marcelo B.P. Amato, M.D., Maureen O. Meade, M.D., Arthur S. Slutsky, M.D., Laurent Brochard, M.D., Eduardo L.V. Costa, M.D., David A. Schoenfeld, Ph.D., Thomas E. Stewart, M.D., Matthias Briel, M.D., Daniel Talmor, M.D., M.P.H., Alain Mercat, M.D., Jean-Christophe M. Richard, M.D., Carlos R.R. Carvalho, M.D., and Roy G. Brower, M.D.

N Engl J Med 2015;372:747-55.
DOI: 10.1056/NEJMsa1410639



Effect of Lowering VT on Mortality in Acute Respiratory Distress Syndrome Varies with Respiratory System Elastance

Ewan C. Goligher[1,2,3*], Eduardo L. V. Costa[4,5*], Christopher J. Yarnell[1,2,6], Laurent J. Brochard[1,7‡], Thomas E. Stewart[8], George Tomlinson[2], Roy G. Brower[9], Arthur S. Slutsky[1,7], and Marcelo P. B. Amato[4]

American Journal of Respiratory and Critical Care Medicine Volume 203 Number 11 | June 1 2021

$\Delta P = VT/Crs$ $\quad$ $1/Crs = E = \Delta P/VT$ $\quad$ $Crs = VT/\Delta P$

(ARDS). The driving pressure hypothesis predicts that lowering VT will be of greatest benefit when respiratory system elastance (Ers) is high and less beneficial when Ers is low.

Elastance faible = Compliance élevée

Elastance

Compliance

Elastance élevée = Compliance faible

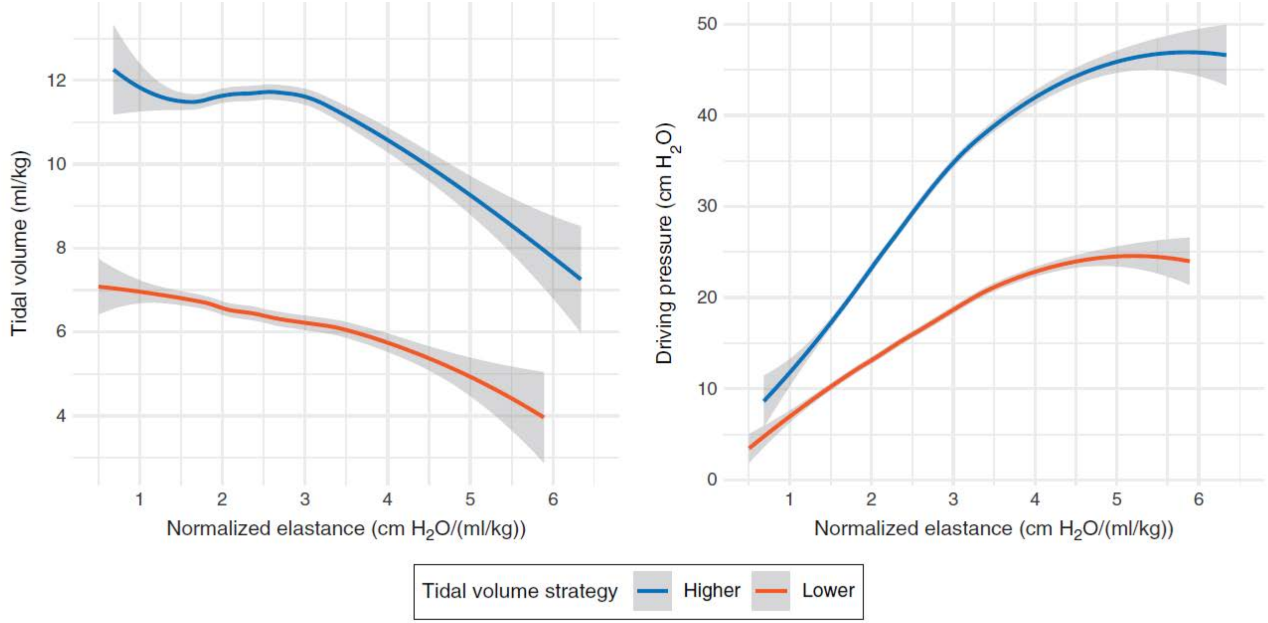


Figure 1. VT and driving pressure according to respiratory system elastance and higher- versus lower-VT strategy. The shaded regions represent the standard errors.

Trial	Ventilation Strategy	
	Lower VT Arm	Higher VT Arm
Amato *et al.*, 1998 (17)	VT < 6 ml/kg of actual BW, ΔP < 20 cm H_2O	VT of 12 ml/kg
Brochard *et al.*, 1998 (14)	VT of 6–10 ml/kg of actual BW, Pplat < 25 cm H_2O	VT > 10 ml/kg
Stewart *et al.*, 1998 (13)	VT < 8 ml/kg of actual BW, Ppeak < 30 cm H_2O	VT of 10–15 ml/kg of actual BW, Ppeak ≤ 50 cm H_2O
Brower *et al.*, 1999 (16)	VT of 8 ml/kg of predicted BW, Pplat < 30 cm H_2O	VT of 10–12 ml/kg, Pplat < 55 cm H_2O
ARDSNet, 2000 (15)	VT of 4–8 ml/kg of predicted BW, Pplat of 25–30 cm H_2O	VT of 12 ml/kg

$\Delta P = VT/Crs$ $1/Crs = E = \Delta P/VT$ $Crs = VT/\Delta P$

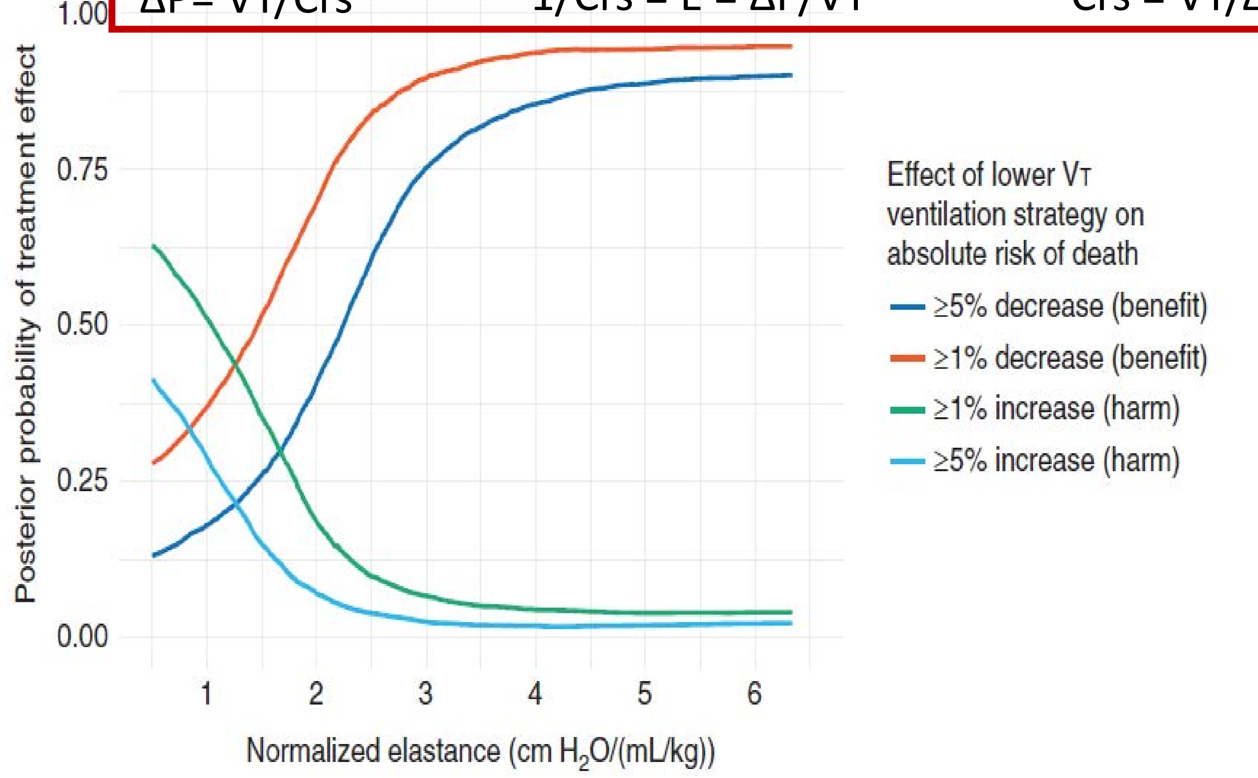


Figure 3. Posterior probabilities of various values of the treatment effect of a lower-VT ventilation strategy on mortality according to respiratory system elastance. The lower panel

Vt reduction: mortality benefit was greater in patients with high elastance and comparatively low in patients with low elastance. This finding suggests that the adequacy of lung protection during mechanical ventilation should be assessed primarily in terms of driving pressure rather than VT.

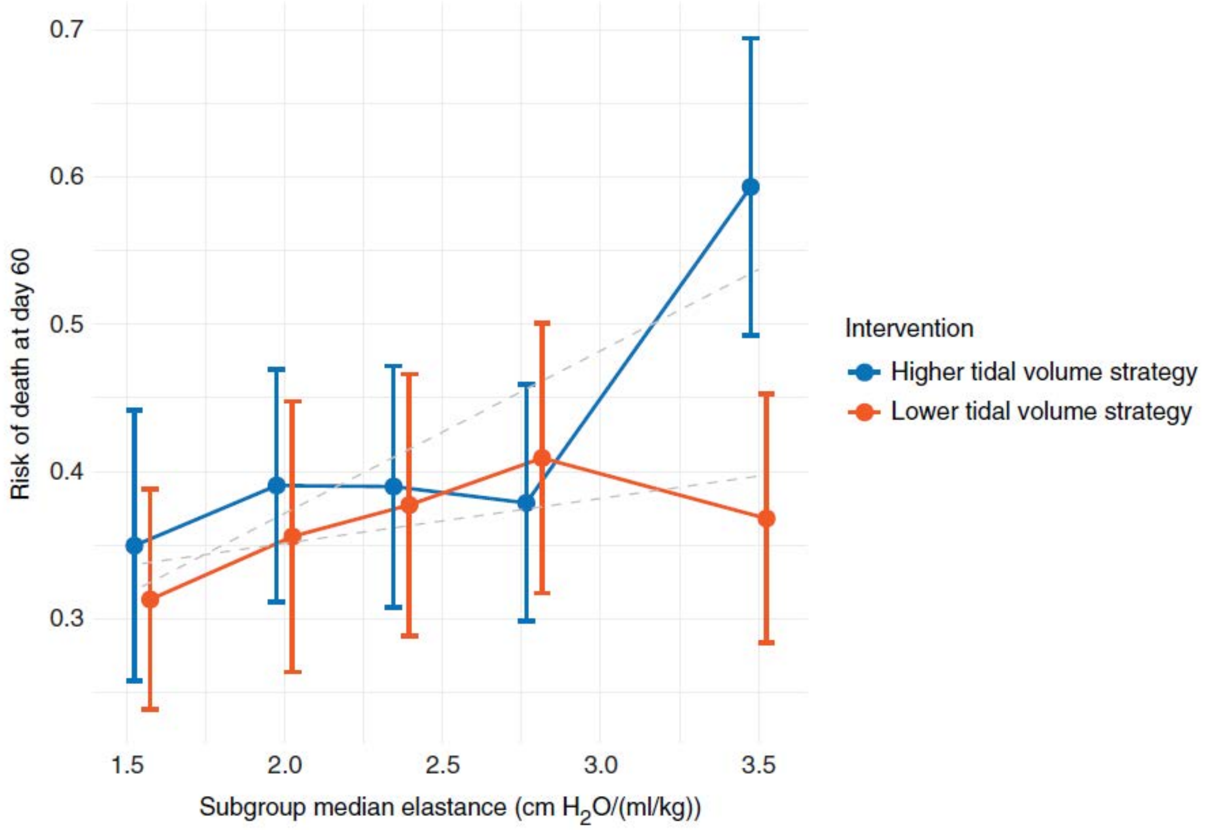


Figure 4. Subpopulation Treatment Effect Pattern Plot analysis of the mortality benefit of a lower-VT ventilation strategy according to respiratory system elastance. The error bars represent 95% confidence intervals. Subgroups are plotted according to the median elastance value in each subgroup. The gray dashed lines represent a linear smooth fit onto the relationship between respiratory system elastance and mortality for the higher- and lower-VT strategy arms.

Vt/Crs > Vt/PBW

zalando

FR	UK	US	Taille (en cm)
36	3,5	X	23
37	4	X	23,6
38	5	X	24,3

Feasibility and safety of ultra-low tidal volume ventilation without extracorporeal circulation in moderately severe and severe ARDS patients

Intensive Care Med (2019) 45:1590–1598
https://doi.org/10.1007/s00134-019-05776-x

J. C. Richard[1,2,3*], S. Marque[4], A. Gros[5], M. Muller[6], G. Prat[7], G. Beduneau[8,9], J. P. Quenot[10], J. Dellamonica[11], R. Tapponnier[12], E. Soum[13], L. Bitker[1,2,3], J. Richecoeur[14] and the REVA research network

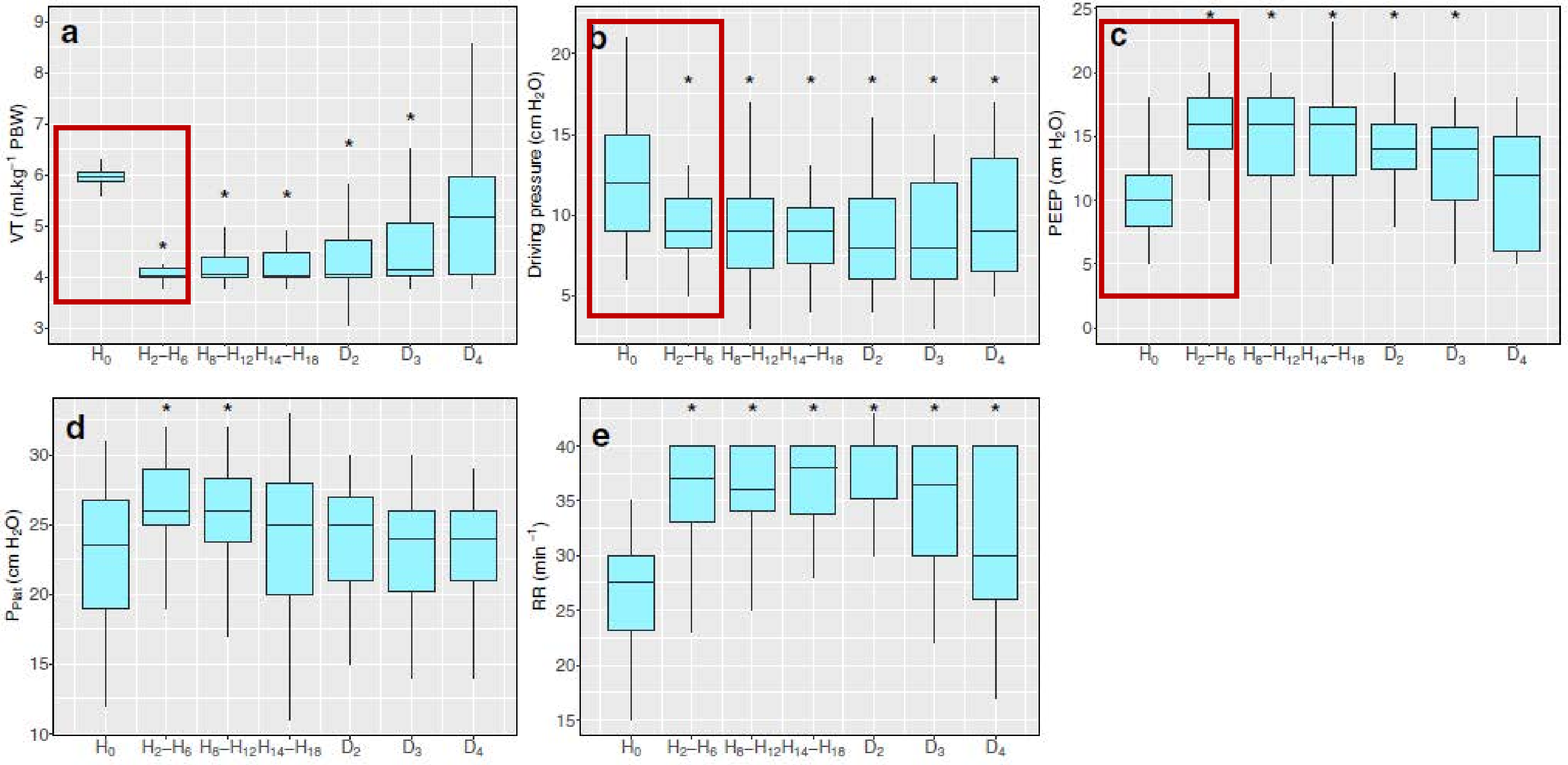


Fig. 1 Ventilatory parameters over the first 4 days following inclusion. *$p < 0.05$ vs. H_0. H_0, H_2–H_6, H_8–H_{12}, H_{14}–H_{18} = time intervals in hours following inclusion (day 1); D_2, D_3, D_4 = study day 2–4; *PBW* predicted body weight, *PEEP* positive end-expiratory pressure, P_{Plat} plateau pressure, *RR* respiratory rate, *VT* tidal volume

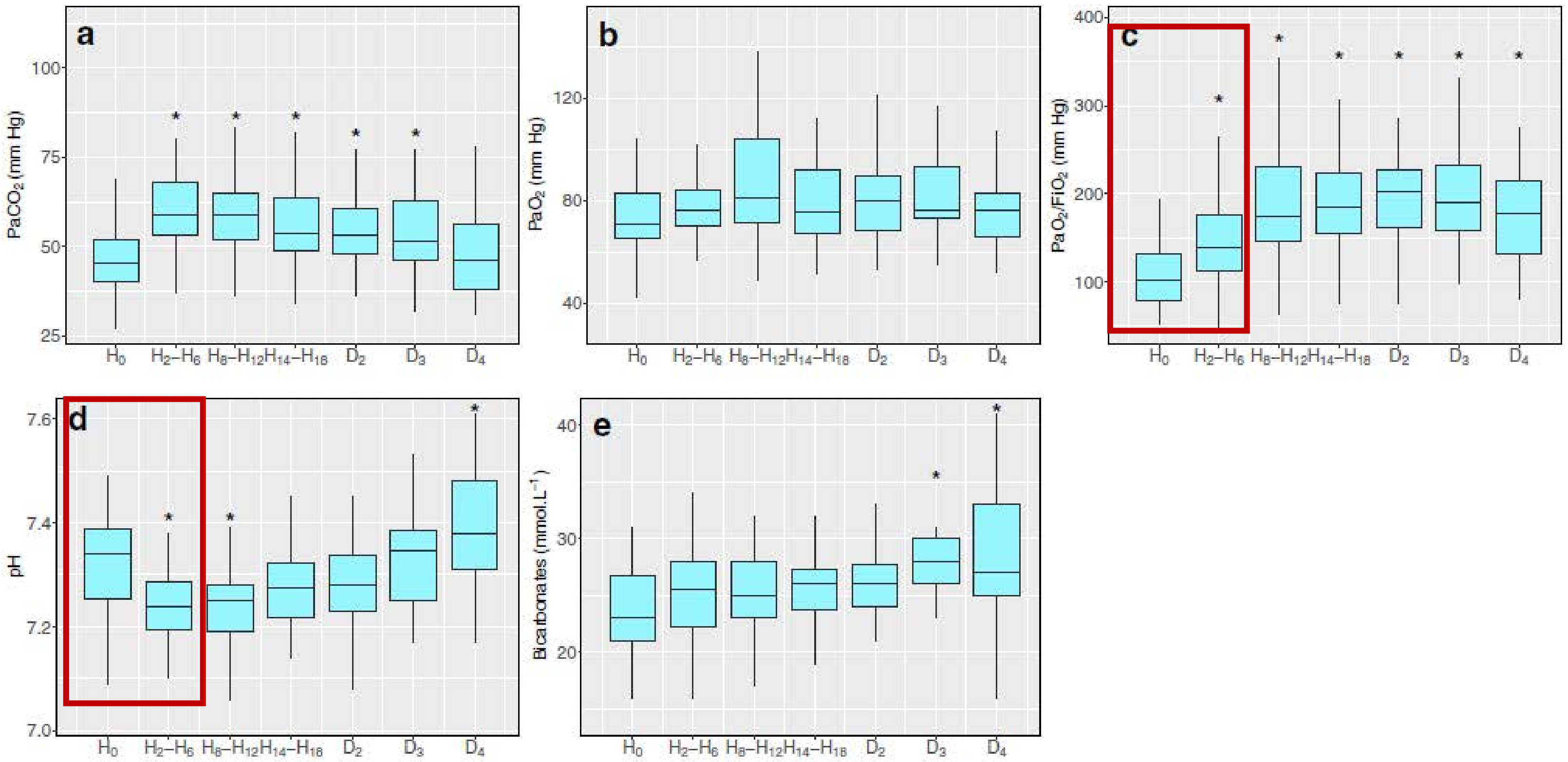
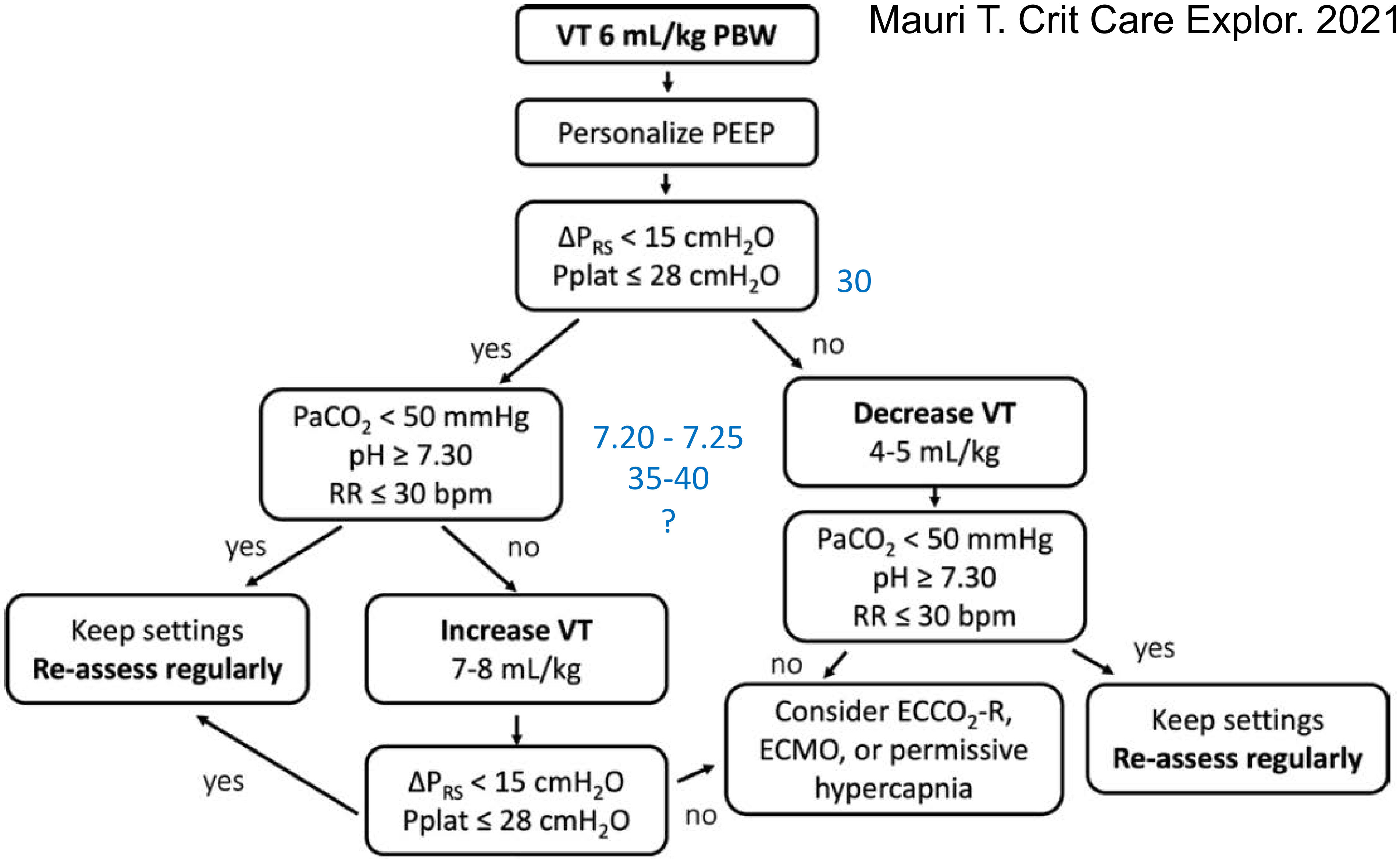


Fig. 2 Arterial blood gas over the first 4 days following inclusion. *$p < 0.05$ vs. H_0. H_0, H_2–H_6, H_8–H_{12}, H_{14}–H_{18} = time intervals in hours following inclusion (day 1); D_2, D_3, D_4 study day 2–4, FiO_2 fraction of inspired oxygen, $PaCO_2$ arterial partial pressure of carbon dioxide, PaO_2 arterial partial pressure of oxygen

The main findings of the study are the following: (1) VT may be reduced down to 4 ml.kg^{-1} in approximately 2/3 of moderately severe-to-severe ARDS patients, and to 5 ml.kg^{-1} in approximately 90%, without ECCO2R, while targeting arterial pH above 7.20; (2) this strategy is associated with a 4 cmH_2O median decrease in ΔP 24 h after inclusion, at the price of substantial increase in RR and transient episodes of severe acidosis in approximately 1/3 of the patients

Personnaliser le Vt

Mauri T. Crit Care Explor. 2021; 3(7): e0486.



Personnaliser la PEEP

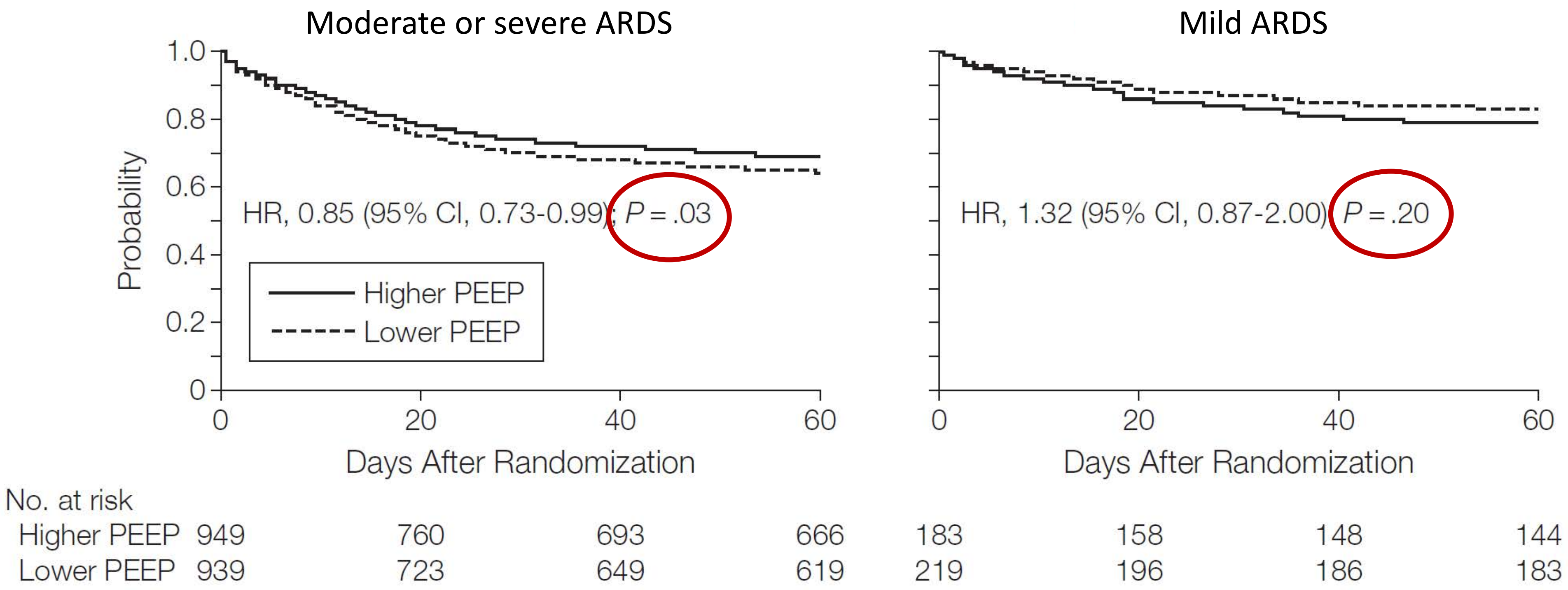
= Evaluer la capacité de recrutement pulmonaire

Higher vs Lower Positive End-Expiratory Pressure in Patients With Acute Lung Injury and Acute Respiratory Distress Syndrome

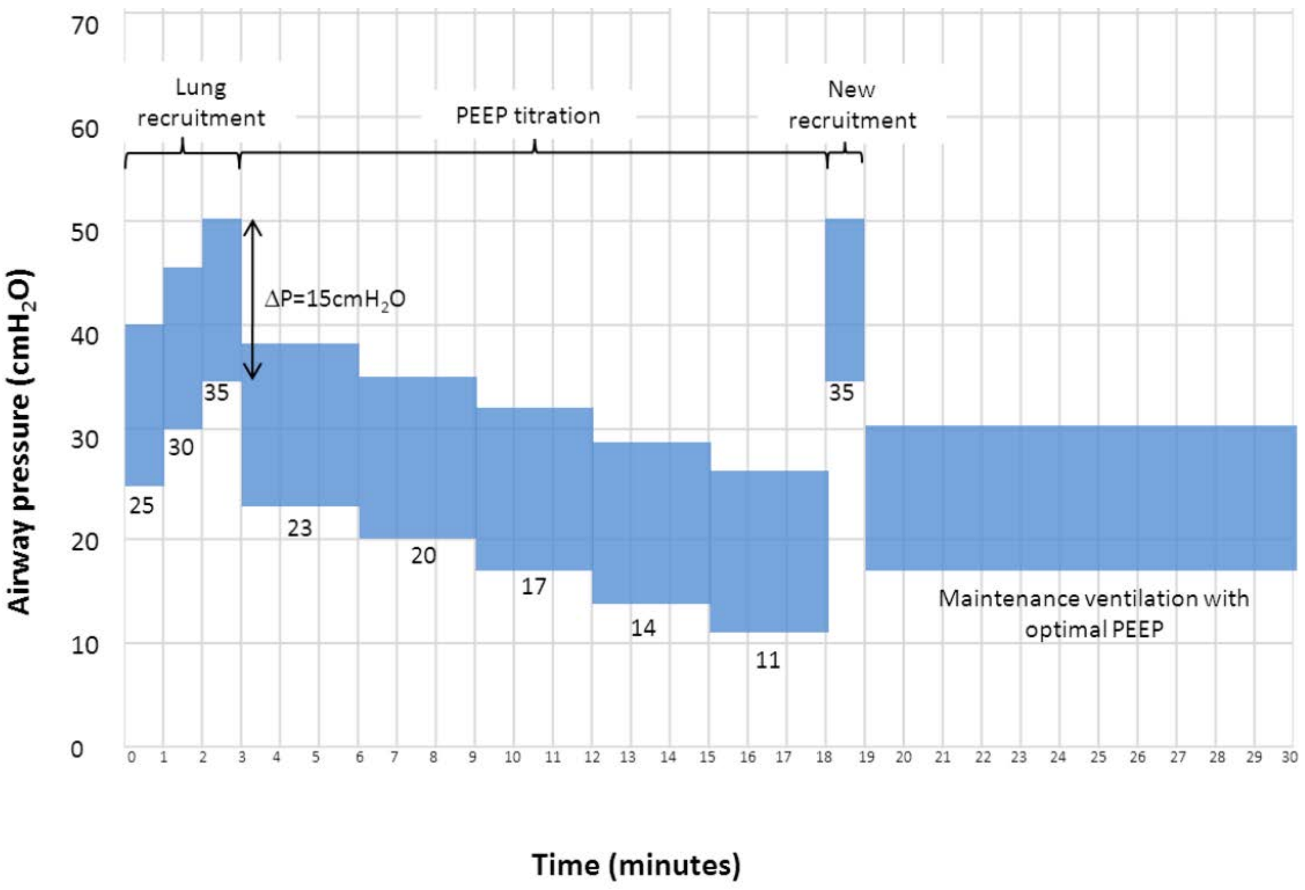
Systematic Review and Meta-analysis

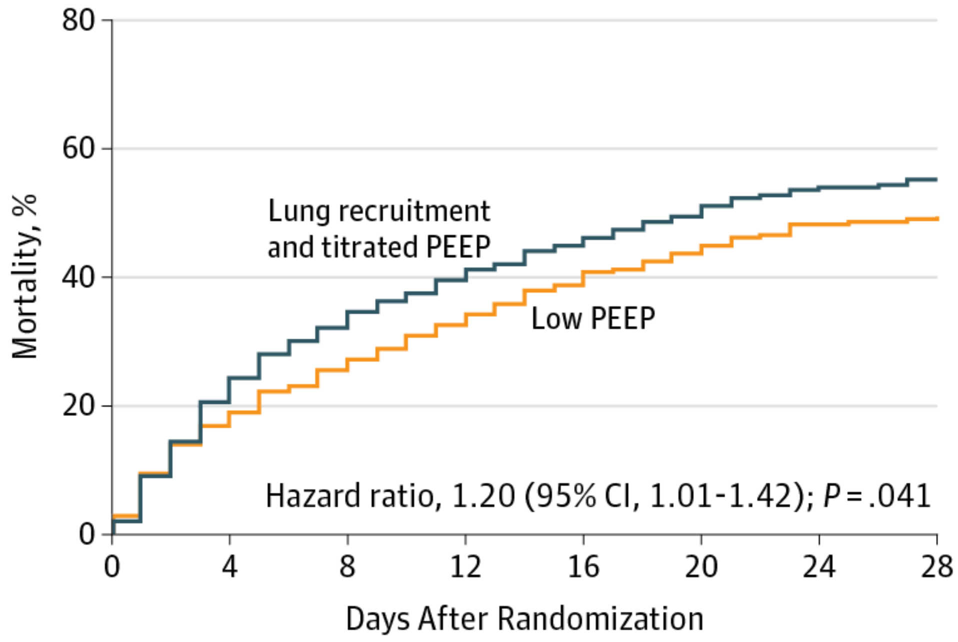
Briel *et al.* JAMA 2010

In-hospital time to death



P/F ratio < 200 mmHg





No. at risk								
Lung recruitment and titrated PEEP	501	397	340	303	276	254	233	225
Low PEEP	509	423	378	343	312	286	264	260

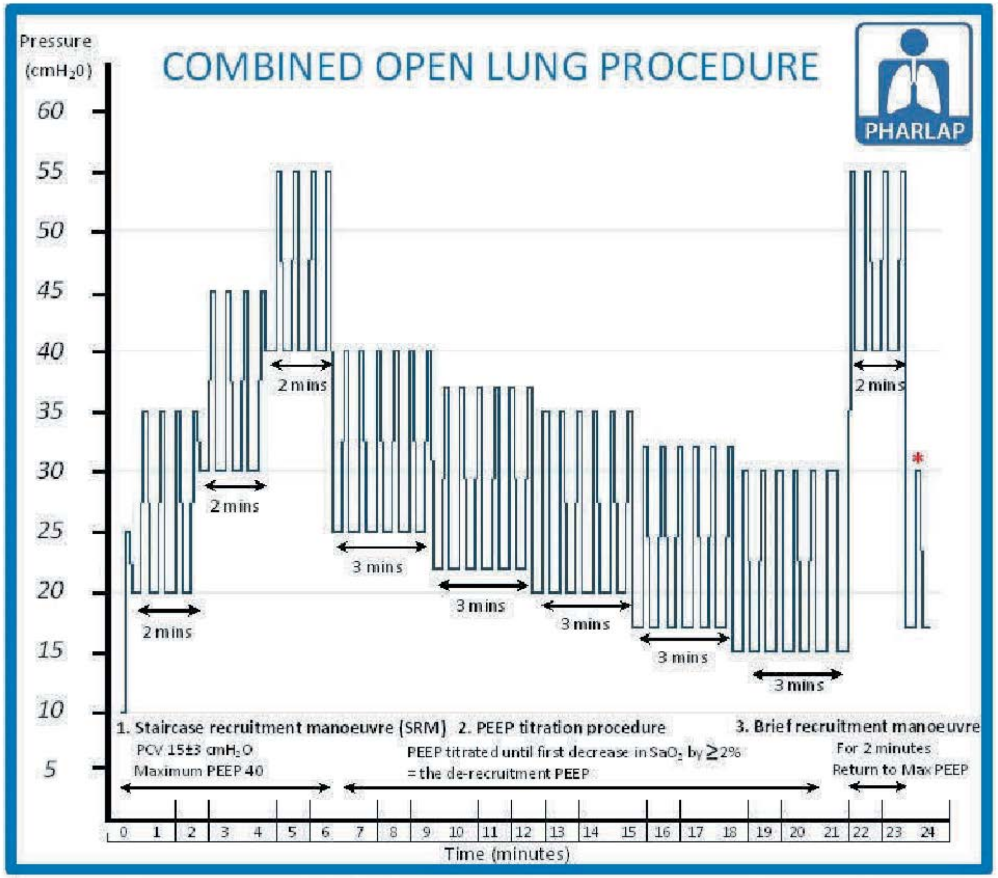

JAMA. 2017 Oct 10; 318(14): 1335–1345.

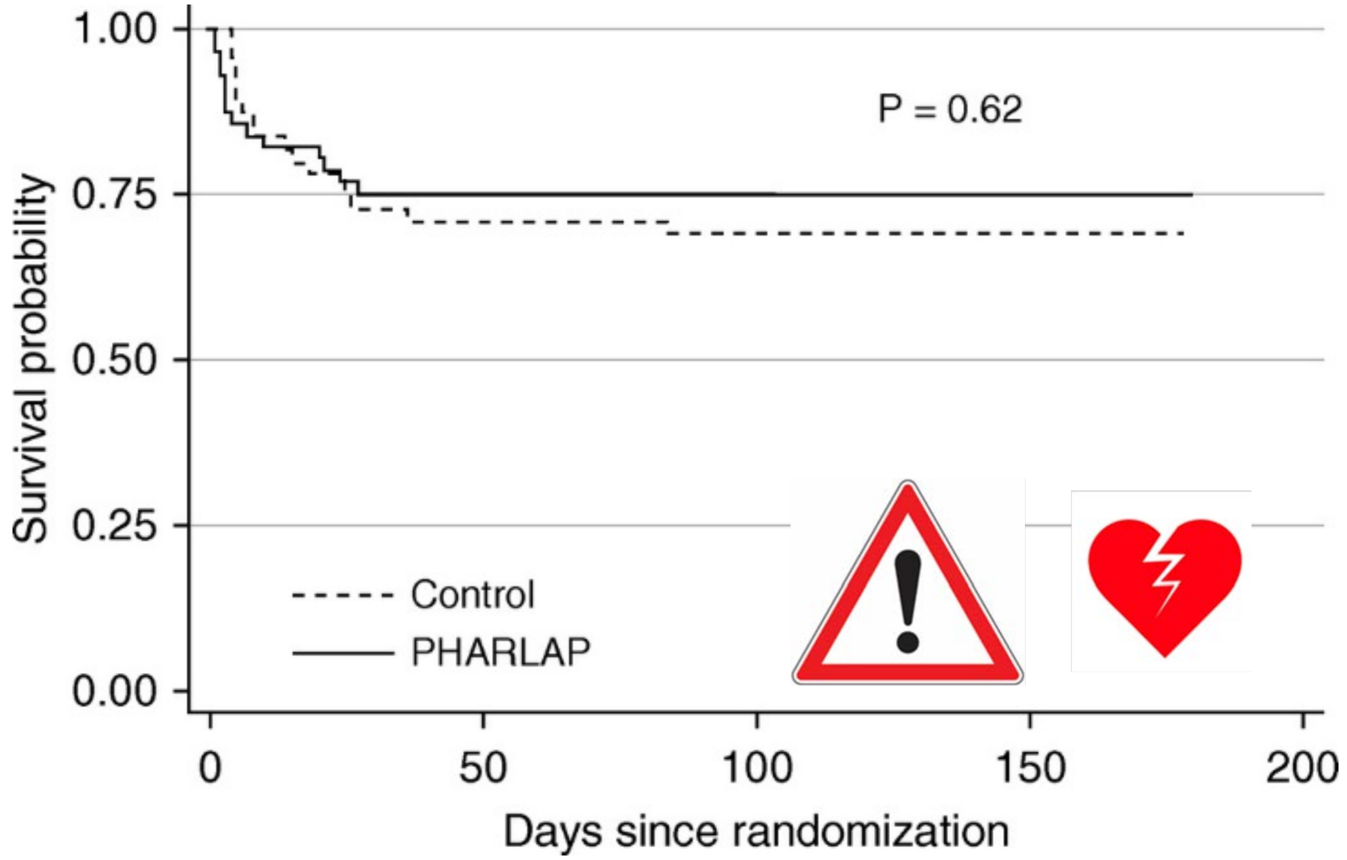
Maximal Recruitment Open Lung Ventilation in Acute Respiratory Distress Syndrome (PHARLAP)

A Phase II, Multicenter Randomized Controlled Clinical Trial

Carol L. Hodgson[1,2], D. James Cooper[1], Yaseen Arabi[3,4], Victoria King[1], Andrew Bersten[5], Shailesh Bihari[5], Kathy Brickell[6], Andrew Davies[7], Ciara Fahey[6], John Fraser[8], Shay McGuinness[9], Lynne Murray[1], Rachael Parke[9], Eldho Paul[1], David Tuxen[2], Shirley Vallance[2], Meredith Young[1], and Alistair Nichol[1,2,6]; on behalf of the PHARLAP Study Investigators* and ANZICS Clinical Trials Group

American Journal of Respiratory and Critical Care Medicine Volume 200 Number 11 | December 1 2019



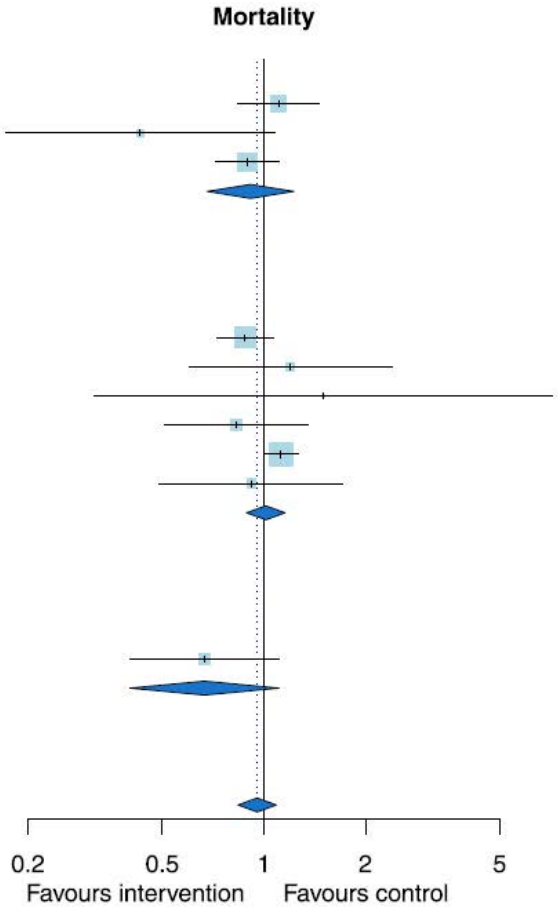


Effects of higher PEEP and recruitment manoeuvres on mortality in patients with ARDS: a systematic review, meta-analysis, meta-regression and trial sequential analysis of randomized controlled trials

Ball *et al. Intensive Care Medicine Experimental* 2020, 8(Suppl 1):39
https://doi.org/10.1186/s40635-020-00322-2

Lorenzo Ball[1,2,3*], Ary Serpa Neto[3,4], Valeria Trifiletti[1], Maura Mandelli[1], Iacopo Firpo[1], Chiara Robba[2], Marcelo Gama de Abreu[5], Marcus J. Schultz[3,6,7], Nicolò Patroniti[1,2], Patricia R. M. Rocco[8], Paolo Pelosi[1,2] and For the PROVE Network: PROtective Ventilation Network

Study	Intervention Events	Intervention Total	Control Events	Control Total	RR	95%–CI	Weight
Higher PEEP alone							
Brower 2004	76	276	68	273	1.11	[0.83; 1.46]	13.4%
Talmor 2008	5	30	12	31	0.43	[0.17; 1.07]	1.9%
Mercat 2008	107	385	119	382	0.89	[0.72; 1.11]	17.7%
Subgroup	**188**	**691**	**199**	**686**	**0.91**	**[0.68; 1.23]**	**33.1%**
Heterogeneity: $I^2 = 53\%$, $\tau^2 = 0.03$, $p = 0.12$							
Test for effect in subgroup: $z = -0.60$ ($p = 0.55$)							
Higher PEEP and recruitment manoeuvres							
Meade 2008	135	475	164	508	0.88	[0.73; 1.06]	20.2%
Huh 2009	12	30	9	27	1.20	[0.60; 2.39]	3.3%
Hodgson 2011	3	10	2	10	1.50	[0.32; 7.14]	0.7%
Kacmarek 2016	22	99	27	101	0.83	[0.51; 1.36]	5.9%
Cavalcanti 2017	277	501	251	509	1.12	[1.00; 1.26]	27.5%
Hodgson 2019	14	57	15	56	0.92	[0.49; 1.72]	3.9%
Subgroup	**463**	**1172**	**468**	**1211**	**1.01**	**[0.89; 1.16]**	**61.4%**
Heterogeneity: $I^2 = 17\%$, $\tau^2 = < 0.01$, $p = 0.30$							
Test for effect in subgroup: $z = 0.20$ ($p = 0.84$)							
Recruitment manoeuvres alone							
Xi 2010	16	55	24	55	0.67	[0.40; 1.11]	5.5%
Subgroup	**16**	**55**	**24**	**55**	**0.67**	**[0.40; 1.11]**	**5.5%**
Heterogeneity: not applicable							
Test for effect in subgroup: $z = -1.56$ ($p = 0.12$)							
Random effects model	**667**	**1918**	**691**	**1952**	**0.96**	**[0.84; 1.09]**	**100.0%**
Heterogeneity: $I^2 = 35\%$, $\tau^2 = 0.01$, $p = 0.12$							
Test for overall effect: $z = -0.68$ ($p = 0.50$)							
Test for subgroup differences: $\chi^2_2 = 2.65$, df = 2 ($p = 0.27$)							



"one-size-fits-all" approach

ARMA

ARDSnet NEJM 2000

Lower-PEEP group														
FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18–24

ALVEOLI

ARDSnet NEJM 2004

Higher-PEEP group (before protocol changed to use higher levels of PEEP)													
FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22–24
Higher-PEEP group (after protocol changed to use higher levels of PEEP)													
FiO_2	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0			
PEEP	12	14	14	16	16	18	20	22	22	22–24			

LOV

O'Meade *et al.* JAMA 2008

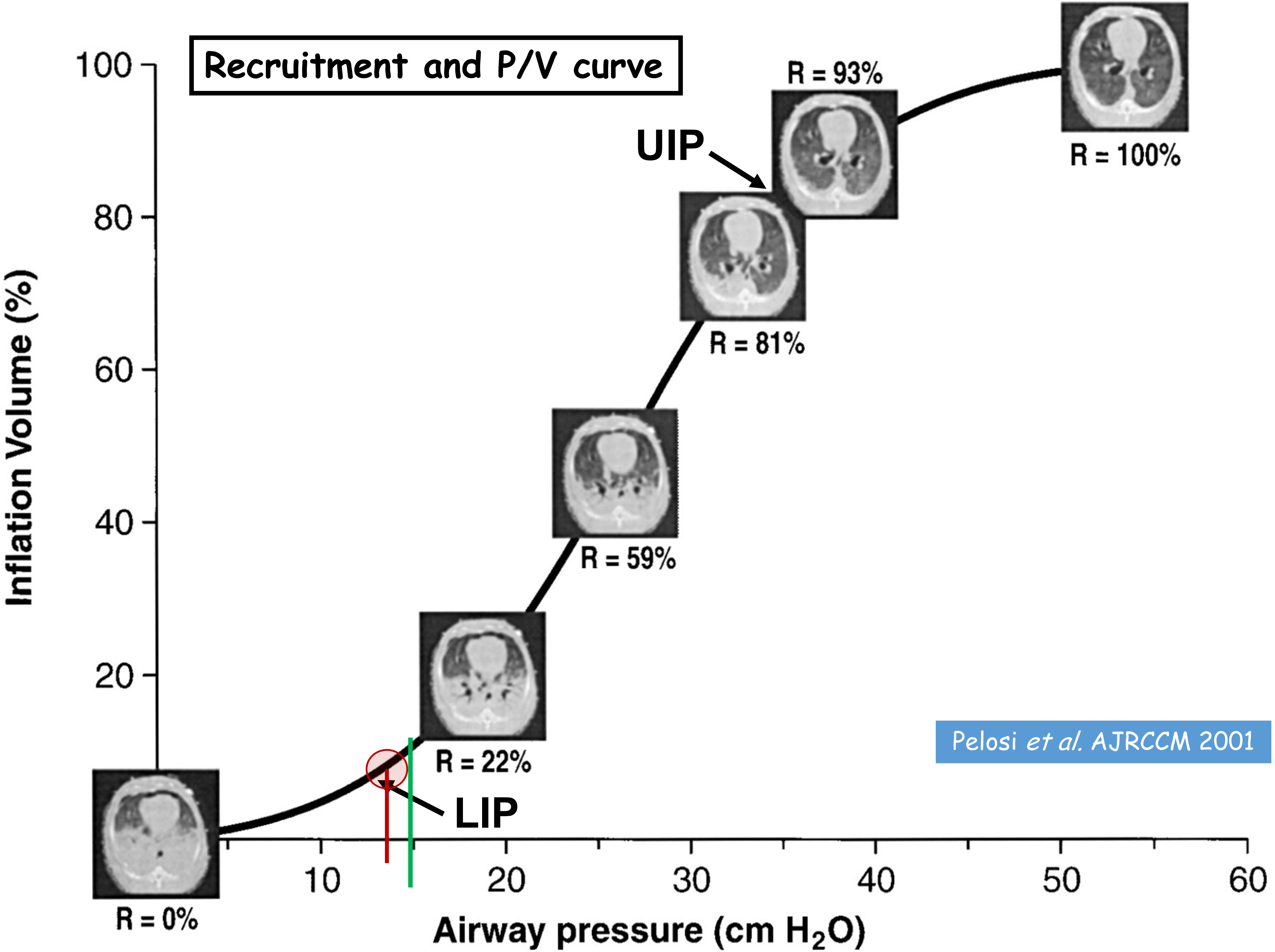
	Fraction of Inspired Oxygen (FIO_2)							
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Control PEEP ranges, cm H_2O	5	5-8	8-10	10	10-14	14	14-18	18-24
Lung open ventilation PEEP ranges, cm H_2O								
Before protocol change	5-10	10-14	14-20	20	20	20	20	20-24
After protocol change	5-10	10-18	18-20	20	20	20-22	22	22-24

ExPress

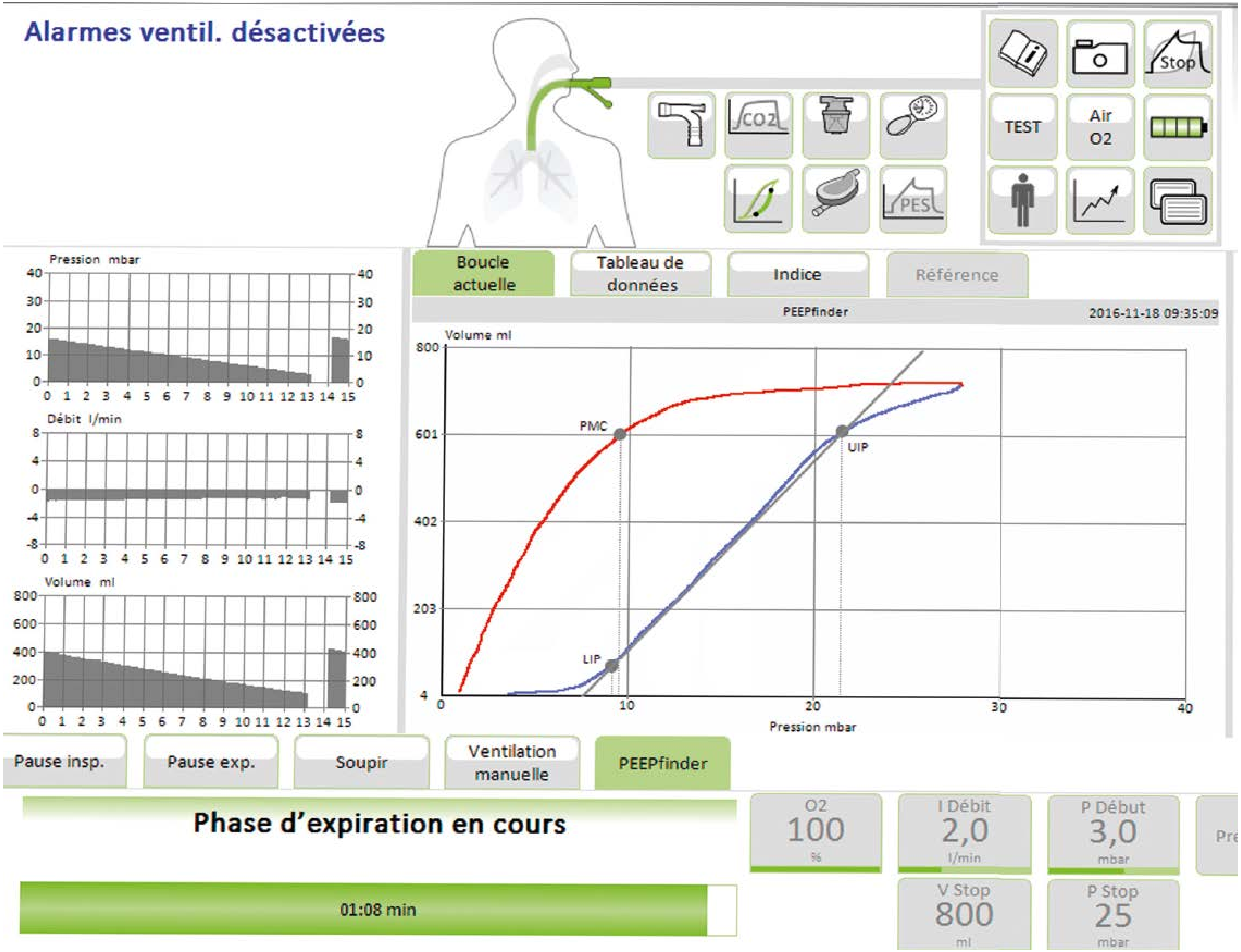
Mercat *et al.* JAMA 2008

PEEP[b]	
Minimal distension group[c]	Total PEEP between 5 and 9 cm H_2O
Increased recruitment group[d]	Plateau pressure between 28 and 30 cm H_2O

Recruitment and P/V curve



Pelosi *et al.* AJRCCM 2001


Alarmes ventil. désactivées
TEST
Air
O2
Pression mbar
Débit l/min
Volume ml
Boucle actuelle
Tableau de données
Indice
Référence
PEEPfinder
2016-11-18 09:35:09
Volume ml
PMC
UIP
LIP
Pression mbar
Pause insp.
Pause exp.
Soupir
Ventilation manuelle
PEEPfinder
Phase d'expiration en cours
01:08 min
O2
100
%
I Débit
2,0
l/min
P Début
3,0
mbar
V Stop
800
ml
P Stop
25
mbar

ANESTHESIOLOGY

Prevalence of Complete Airway Closure According to Body Mass Index in Acute Respiratory Distress Syndrome

Pooled Cohort Analysis

Rémi Coudroy, M.D., Ph.D., Damien Vimpere, M.D., Nadia Aissaoui, M.D., Ph.D., Romy Younan, M.D., Clotilde Bailleul, M.D., Amélie Couteau-Chardon, M.D., Aymeric Lancelot, M.D., Emmanuel Guerot, M.D., Lu Chen, M.D., Laurent Brochard, M.D., Jean-Luc Diehl, M.D., Ph.D.

ANESTHESIOLOGY 2020; 133:867–78

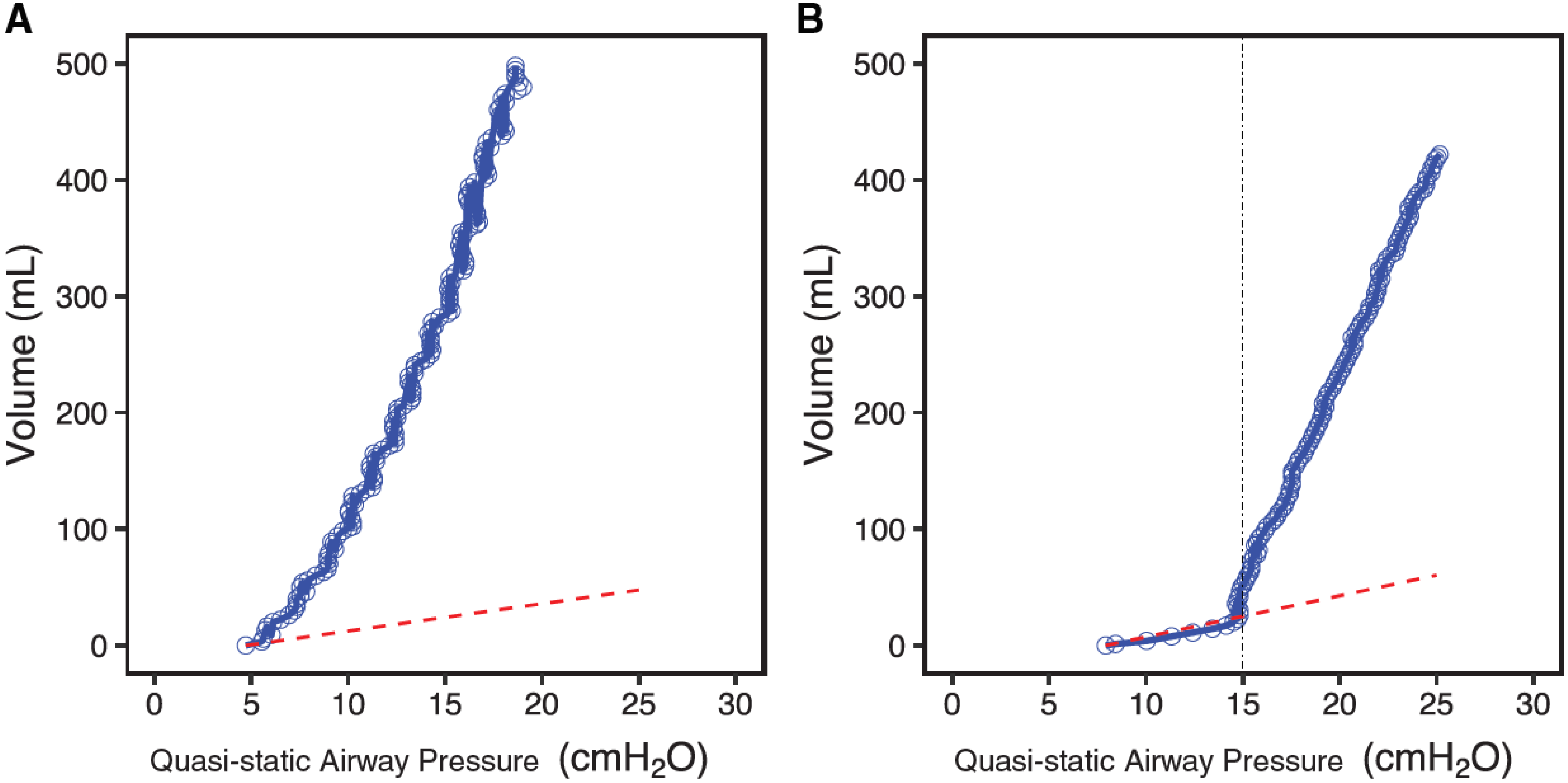
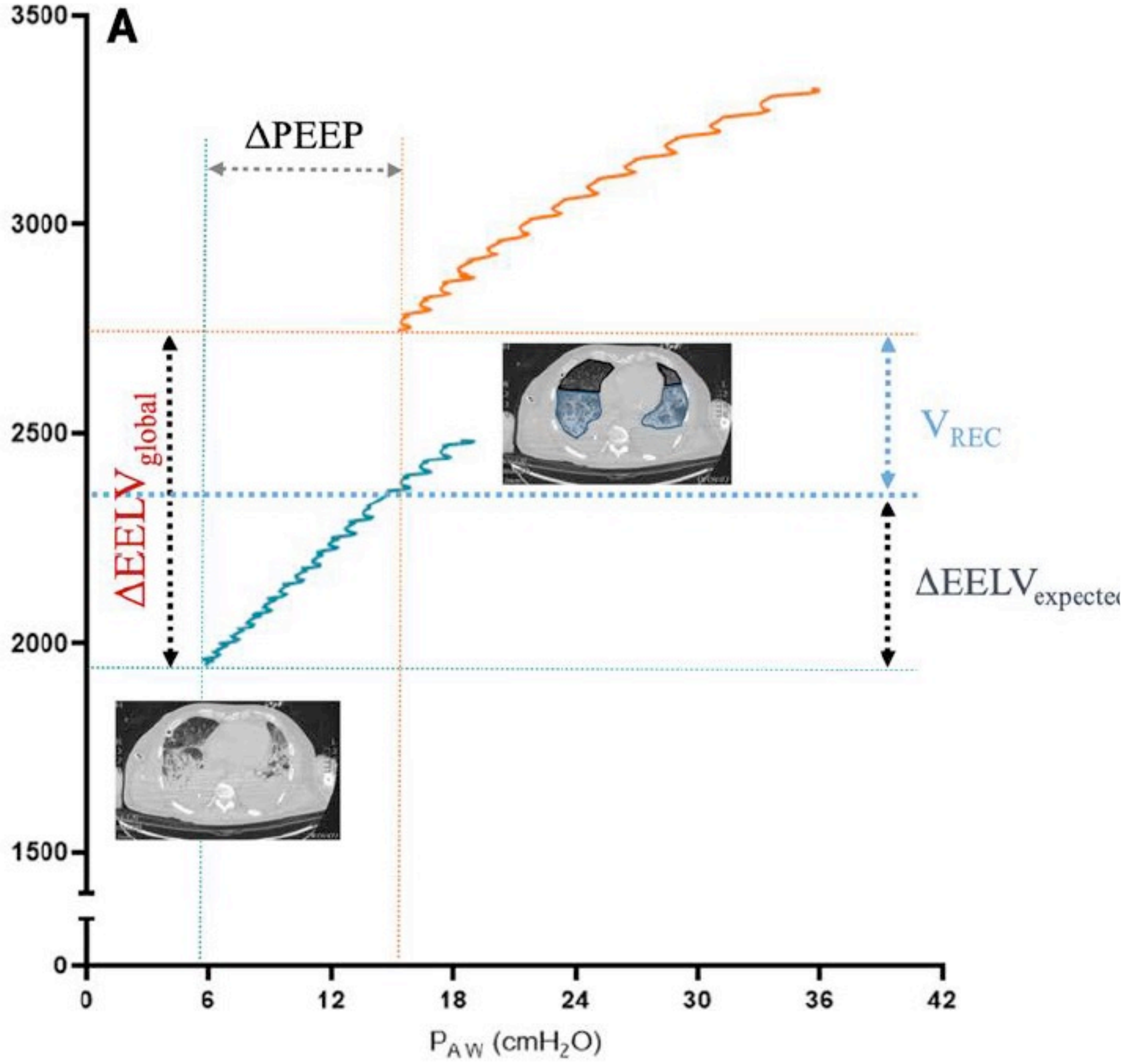


Table 2. Respiratory System Mechanics at Low PEEP According to Body Mass Index and Respective to Airway Closure Consideration

		Body Mass Index			
	Pooled Cohort (n = 51)	< 30 kg/m² (n = 18)	≥ 30 and < 40 kg/m² (n = 16)	≥ 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

Personalized Positive End-Expiratory Pressure and Tidal Volume in Acute Respiratory Distress Syndrome: Bedside Physiology-Based Approach

Mauri T. Crit Care Explor. 2021; 3(7): e0486.



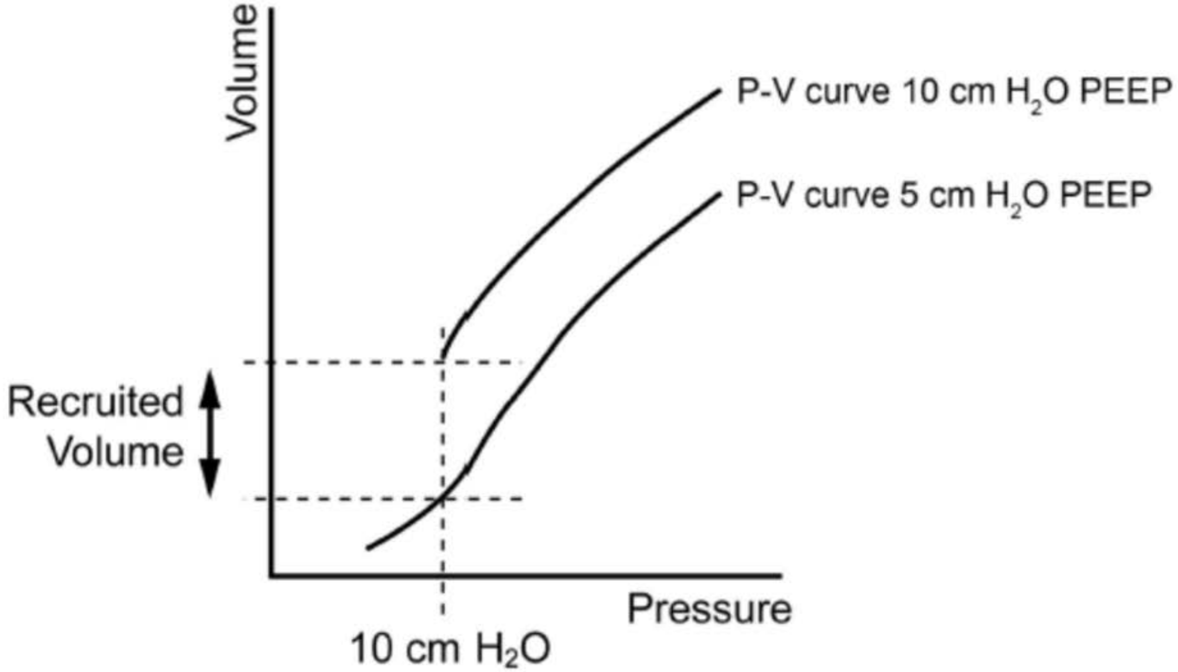


Fig. 20. Pressure-volume (P-V) curve technique to determine recruited lung volume with 2 levels of PEEP.

Didier Demory
Jean-Michel Arnal
Marc Wysocki
Stéphane Donati
Isabelle Granier
Gaëlle Corno
Jacques Durand-Gasselin

Recruitability of the lung estimated by the pressure volume curve hysteresis in ARDS patients

Demory, Arnal *et al.* Intensive Care Med 2008

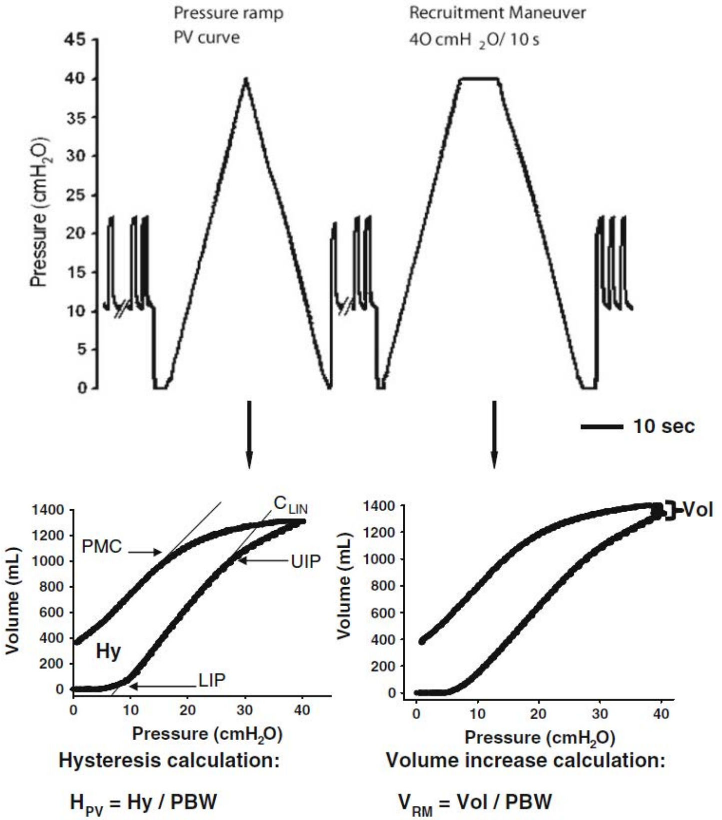
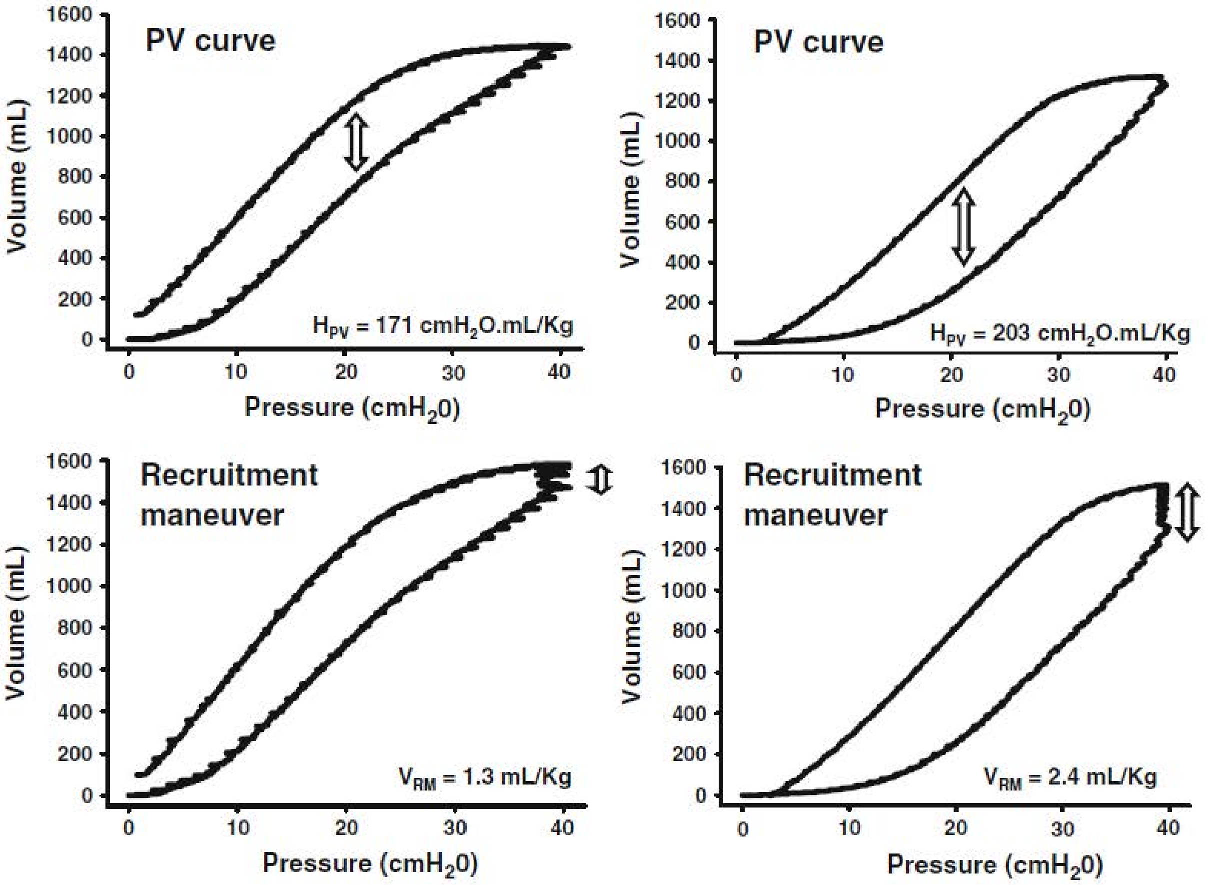
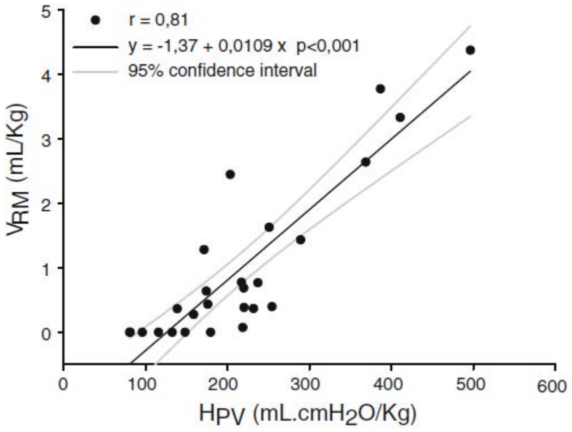


Fig. 2 Illustrative examples of pressure volume curve recorded from ZEEP to 40 cmH_2O (*upper panel*) and 10 s/ 40 cmH_2O recruitment maneuver (*lower panel*) in representative patients showing a low hysteresis (*left panel*) and a large hysteresis (*right panel*)





Recruitment-to-inflation ratio (R/I)

Beloncle *et al. Ann. Intensive Care* (2020) 10:55
https://doi.org/10.1186/s13613-020-00675-7

Annals of Intensive Care

RESEARCH Open Access

Recruitability and effect of PEEP in SARS-Cov-2-associated acute respiratory distress syndrome

François M. Beloncle[1*], Bertrand Pavlovsky[1], Christophe Desprez[1], Nicolas Fage[1], Pierre-Yves Olivier[1], Pierre Asfar[1], Jean-Christophe Richard[1,2] and Alain Mercat[1]

Lung Recruitability in COVID-19–associated Acute Respiratory Distress Syndrome: A Single-Center Observational Study

Chun Pan, M.D.

American Journal of Respiratory and Critical Care Medicine Volume 201 Number 10 | May 15 2020

Potential for Lung Recruitment Estimated by the Recruitment-to-Inflation Ratio in Acute Respiratory Distress Syndrome. A Clinical Trial.

Chen L, Del Sorbo L, Grieco DL, Junhasavasdikul D, Rittayamai N, Soliman I, Sklar MC, Rauseo M, Ferguson ND, Fan E, Richard JM, **Brochard L.**

Am J Respir Crit Care Med. 2020 Jan 15;201(2):178-187. doi: 10.1164/rccm.201902-0334OC.

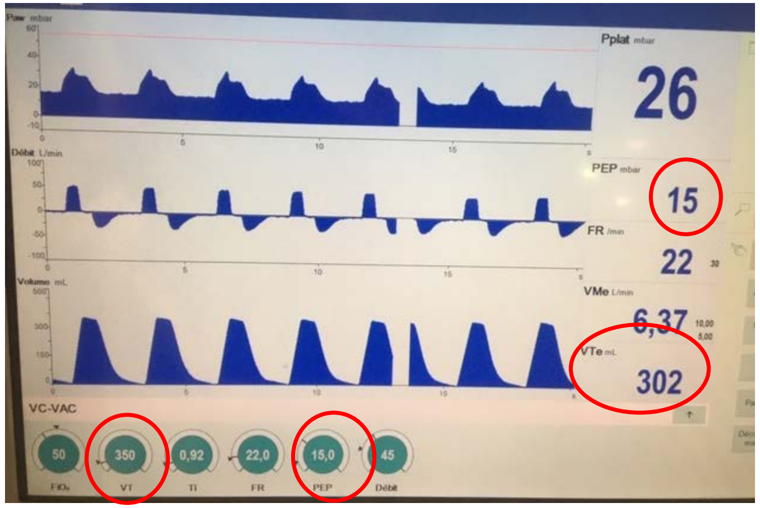
Methods: Patients with acute respiratory distress syndrome were ventilated at 15 and 5 cm H_2O of PEEP. Multiple pressure–volume curves were compared with a single-breath technique. Abruptly releasing PEEP (from 15 to 5 cm H_2O) increases expired volume: the difference between this volume and the volume predicted by compliance at low PEEP (or above airway opening pressure) estimated the recruited volume by PEEP. This recruited volume divided by the effective pressure change gave the compliance of the recruited lung; the ratio of this compliance to the compliance at low PEEP gave the recruitment-to-inflation ratio. Response to PEEP was compared between high and low recruiters based on this ratio.

crec.coemv.ca

$$R/I \text{ ratio} = \frac{VTe_{H\rightarrow L} - VTe_{H}}{VTi} \times \frac{Pplat_{L} - PEEP_{L}}{PEEP_{H} - PEEP_{L}} - 1$$

> 0.5 → Recrutabilité

Baseline



Étape 1: diminution FR <10/min → 0 autoPEEP

Etape 2 : diminution de la PEEP sur un cycle → ↗ VT_E

Etape 3 : mesurer Pplat à PEEP basse

cm H2O

High PEEP

15

cm H2O

Set Tidal Volume (VT)

350

ml

VT exhaled @ high PEEP

300

ml

Low PEEP

5

cm H2O

VT exhaled from high to low PEEP

775

ml

Plateau Pressure (at low PEEP)

13

cm H2O

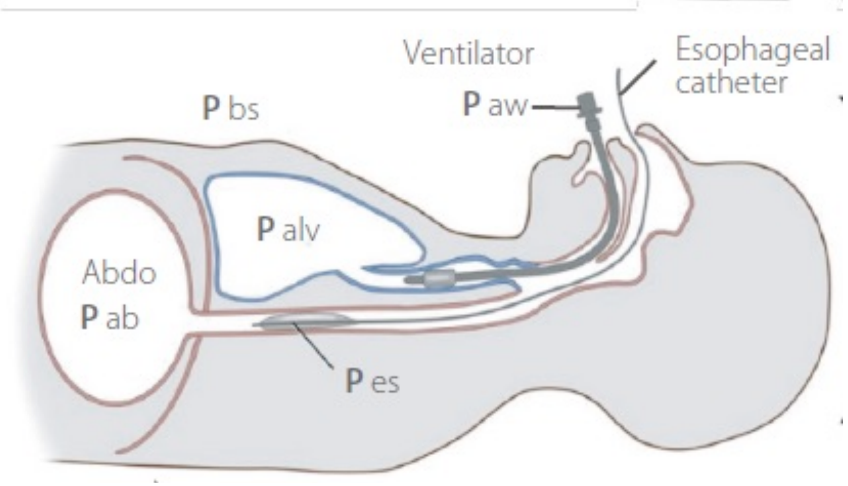
Calculate

0.09

Recruitment to Inflation Ratio

crec.coemv.ca

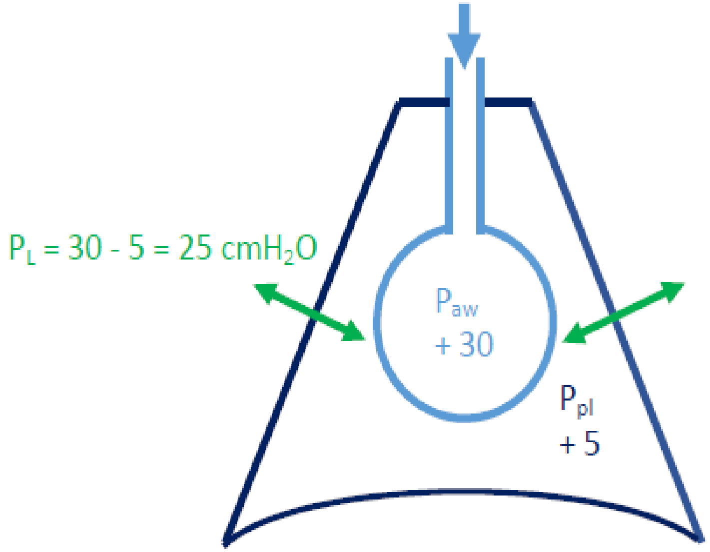
Pression transpulmonaire (PTP)



Somme des pressions agissant sur l'alvéole

$$PTPexp = PEEP - P_{PL}$$

$$PTPinsp = P_{PLAT} - P_{PL}$$

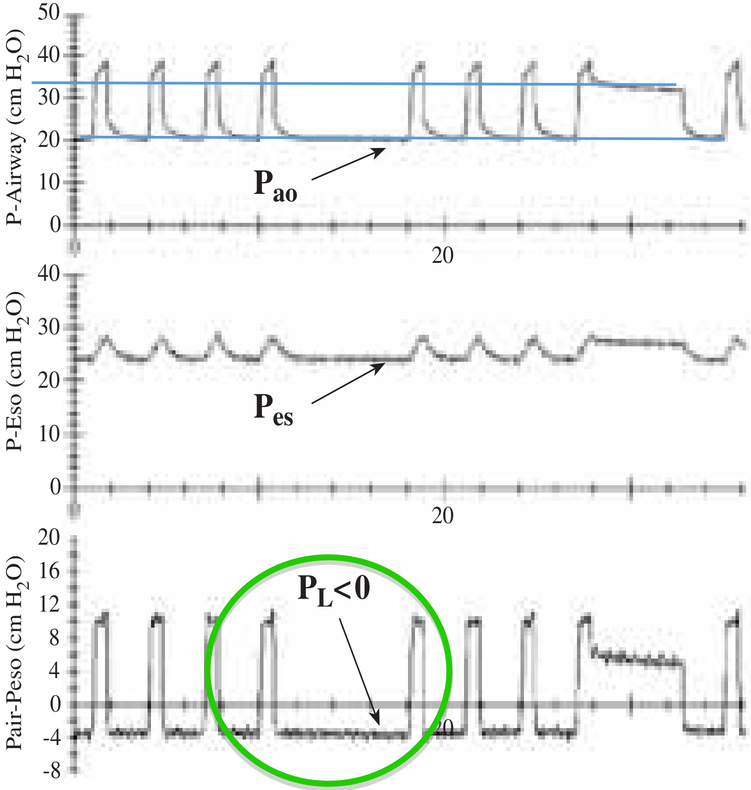


$P_L = P_{aw} - P_{pl}$

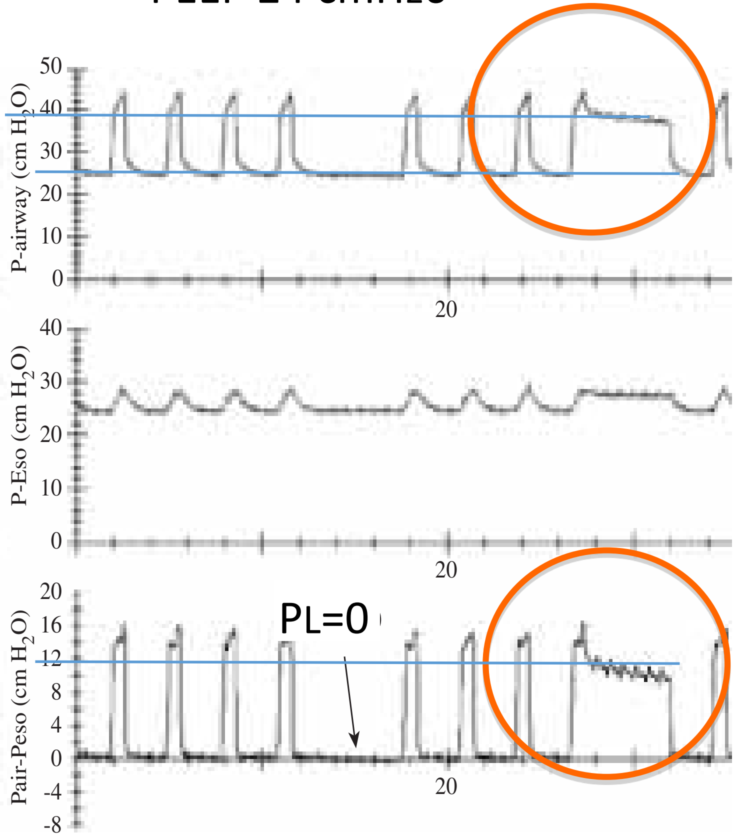
PTP= pression de distension alvéolaire

- Prévenir l'atelectrauma
- Optimiser le recrutement, limiter surdistension

PEEP 20 cmH20



PEEP 24 cmH20



PTP_{inspi} < 20-25 cmH_2O

ANESTHESIOLOGY

Prevalence of Complete Airway Closure According to Body Mass Index in Acute Respiratory Distress Syndrome

Pooled Cohort Analysis

Rémi Coudroy, M.D., Ph.D., Damien Vimpere, M.D.,
Nadia Aissaoui, M.D., Ph.D., Romy Younan, M.D.,
Clotilde Bailleul, M.D., Amélie Couteau-Chardon, M.D.,
Aymeric Lancelot, M.D., Emmanuel Guerot, M.D.,
Lu Chen, M.D., Laurent Brochard, M.D.,
Jean-Luc Diehl, M.D., Ph.D.

ANESTHESIOLOGY 2020; 133:867–78

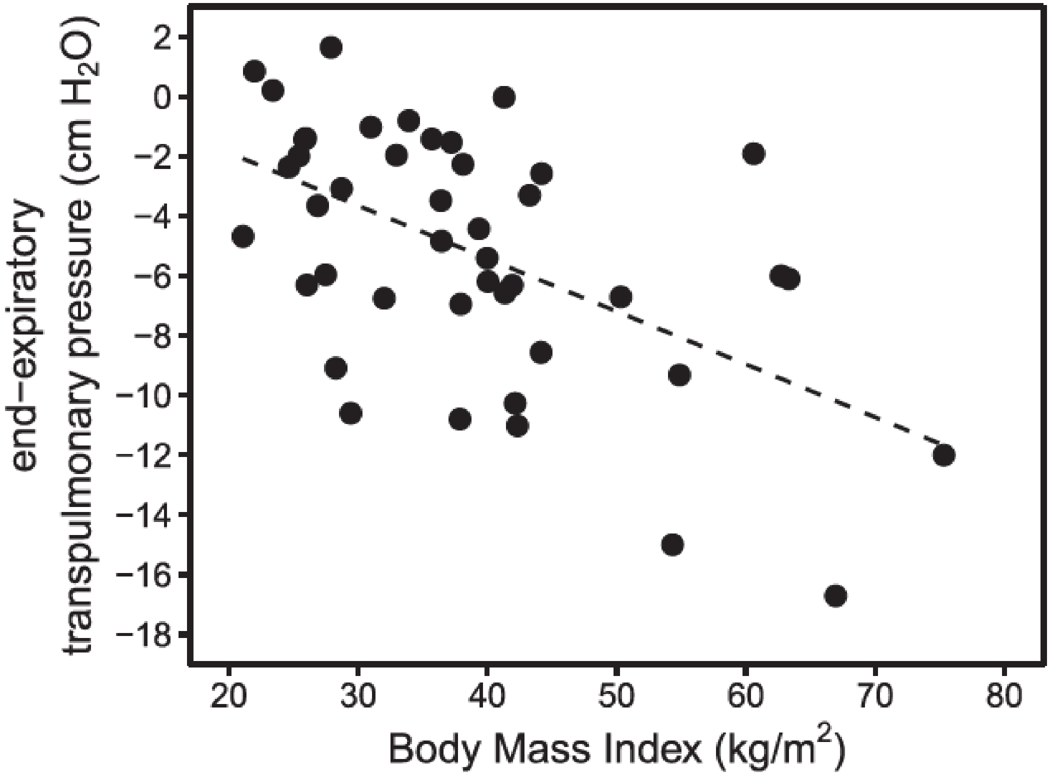


Fig. 3. Relationship between individual values of end-expiratory transpulmonary pressure considering complete airway closure at low positive end-expiratory pressure and body mass index (Spearman $\rho = -0.52$ [95% CI, –0.72 to –0.28]). The *dotted line* represents the regression line (end-expiratory transpulmonary pressure = 1.65 – 0.18 × body mass index; $R^2 = 0.28$; $P < 0.001$).

Randomisation

Groupe contrôle (31 patients)	Groupe interventionnel (30 patients)
Vt=6 ml/kg IBW; FR 30-35 (VC ou PC) Réglage PEEP selon FiO2 (ARDSNet)	Vt=6 ml/kg IBW (PTP_{inspi} < 25 cmH_20) FR 30-35 (VC ou PC) Réglage PEEP pour PTP_{expi} entre 0 et 10 cmH_20 selon FiO2

Esophageal-Pressure–Guided Group

F_{IO_2}	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0
P_{Lexp}	0	0	2	2	4	4	6	6	8	8	10	10

Control Group

F_{IO_2}	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	20–24

Talmor et al. NEJM 2008;359:2095

Table 2. Measurements of Ventilatory Function at Baseline and 72 Hours.*

Measurement	Baseline			72 Hr†		
	Esophageal-Pressure–Guided (N=30)	Conventional Treatment (N=31)	P Value	Esophageal-Pressure–Guided (N=29)	Conventional Treatment (N=29)	P Value
$PaO_2:FIO_2$	147±56	145±57	0.89	280±126	191±71	0.002
Respiratory-system compliance (ml/cm of water)	36±12	36±10	0.94	45±14	35±9	0.005
Ratio of physiological dead space to tidal volume	0.67±0.11	0.67±0.09	0.95	0.61±0.09	0.64±0.10	0.27
PaO_2 (mm Hg)	91±25	107±44	0.09	124±44	101±33	0.03
FIO_2	0.66±0.17	0.77±0.18	0.02	0.49±0.17	0.57±0.18	0.07
PEEP (cm of water)	13±5	13±3	0.73	17±6	10±4	<0.001
Tidal volume (ml)	484±98	491±105	0.80	472±98	418±80	0.03
Tidal volume (ml per kg of predicted body weight)	7.3±1.3	7.9±1.4	0.12	7.1 ±1.3	6.8±1	0.31
Respiratory rate (breaths/min)	26±6	24±6	0.32	26±6	28±5	0.20
Inspiratory time (sec)	0.8±0.1	0.9±0.2	0.19	0.8±0.1	0.8±0.1	0.27
$PEEP_{total}$ (cm of water)	14±5	15±4	0.67	18±5	12±5	<0.001
Peak inspiratory pressure (cm of water)	35±8	35±7	0.85	32±8	28±7	0.007
Mean airway pressure (cm of water)	20±6	20±4	0.88	22±6	16±5	0.001
Plateau pressure (cm of water)	29±7	29±5	0.79	28±7	25±6	0.07
Transpulmonary end-inspiratory pressure (cm of water)	7.9±6.0	8.6±5.4	0.61	7.4±4.4	6.7±4.9	0.58
Transpulmonary end-expiratory pressure (cm of water)	−2.8±5.0	−1.9±4.7	0.49	0.1±2.6	−2.0±4.7	0.06
Esophageal end-inspiratory pressure (cm of water)	21.2±4.9	20.7±5.1	0.68	21.7±7.2	17.9±5.2	0.03
Esophageal end-expiratory pressure (cm of water)	17.2±4.4	16.9±5.0	0.79	18.4±5.9	14.3±4.9	0.008

Talmor et al. NEJM 2008;359:2095

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

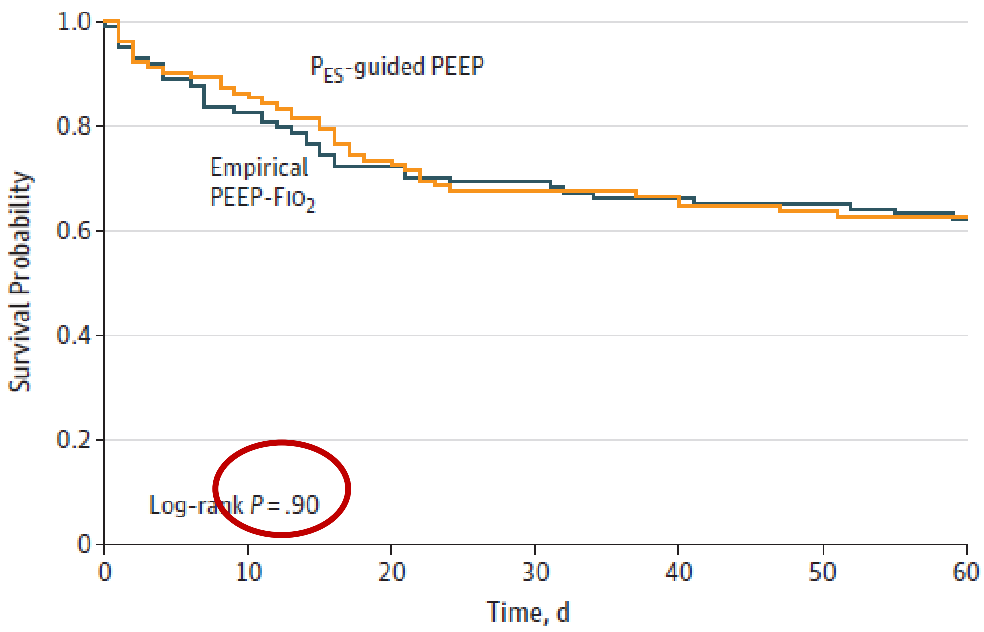
Effect of Titrating Positive End-Expiratory Pressure (PEEP) With an Esophageal Pressure–Guided Strategy vs an Empirical High PEEP-FIO_2 Strategy on Death and Days Free From Mechanical Ventilation Among Patients With Acute Respiratory Distress Syndrome

A Randomized Clinical Trial

Jeremy R. Beitler, MD, MPH; Todd Sarge, MD; Valerie M. Banner-Goodspeed, MPH; Michelle N. Gong, MD, MSc; Deborah Cook, MD; Victor Novack, MD, PhD; Stephen H. Loring, MD; Daniel Talmor, MD, MPH; for the EPVent-2 Study Group

JAMA February 2019; DOI:10.1001/jama.2019.0555

Figure 3. Kaplan-Meier Survival Analysis Through Day 60



No. at risk

	0	10	20	30	40	50	60
P_{ES}-guided PEEP	102	88	75	68	67	64	63
Empirical PEEP-FIO_2	98	81	71	68	65	64	61

Bedside Selection of Positive End-Expiratory Pressure in Mild, Moderate, and Severe Acute Respiratory Distress Syndrome

www.ccmjournal.org February 2014 • Volume 42 • Number 2

Davide Chiumello, MD[1,2]; Massimo Cressoni, MD[2]; Eleonora Carlesso, MSc[2]; Maria L. Caspani, MD[1]; Antonella Marino, MD[2]; Elisabetta Gallazzi, MD[2]; Pietro Caironi, MD[1,2]; Marco Lazzerini, MD[3]; Onnen Moerer, MD[4]; Michael Quintel, MD[4]; Luciano Gattinoni, MD, FRCP[1,2]

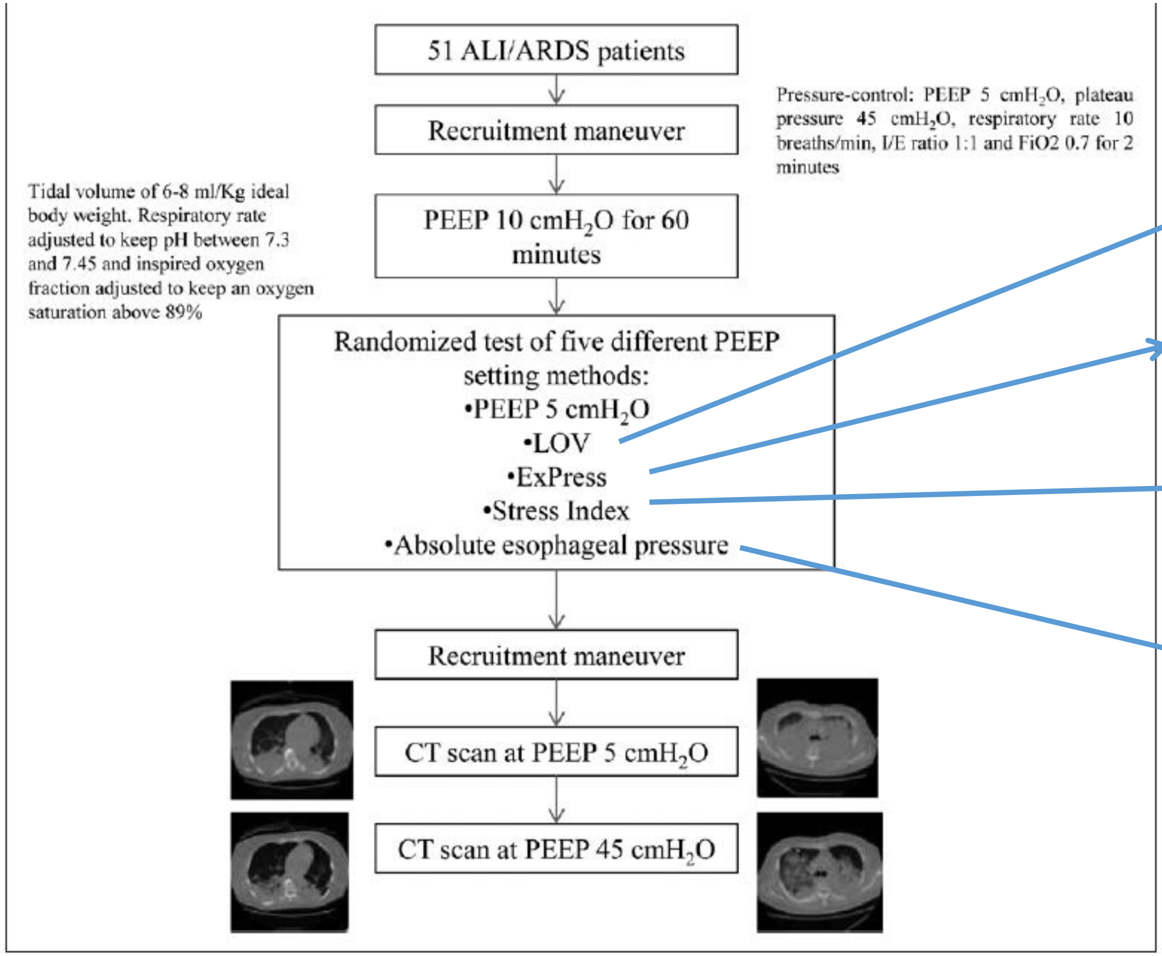
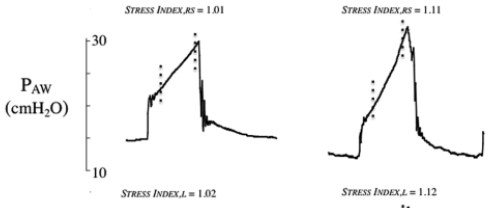
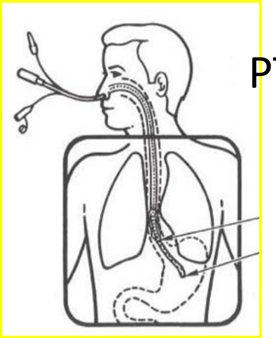


TABLE 1. Positive End-Expiratory Pressure/ FIO_2 Table

FIO_2	Positive End-Expiratory Pressure ($cm\ H_2O$)
0.3	5–10
0.4	10–18
0.5	18–20
0.6	20
0.7	20
0.8	20–22
0.9	22
1	22–24

VT 6 mL, PEEP qsp Pplat 28-30

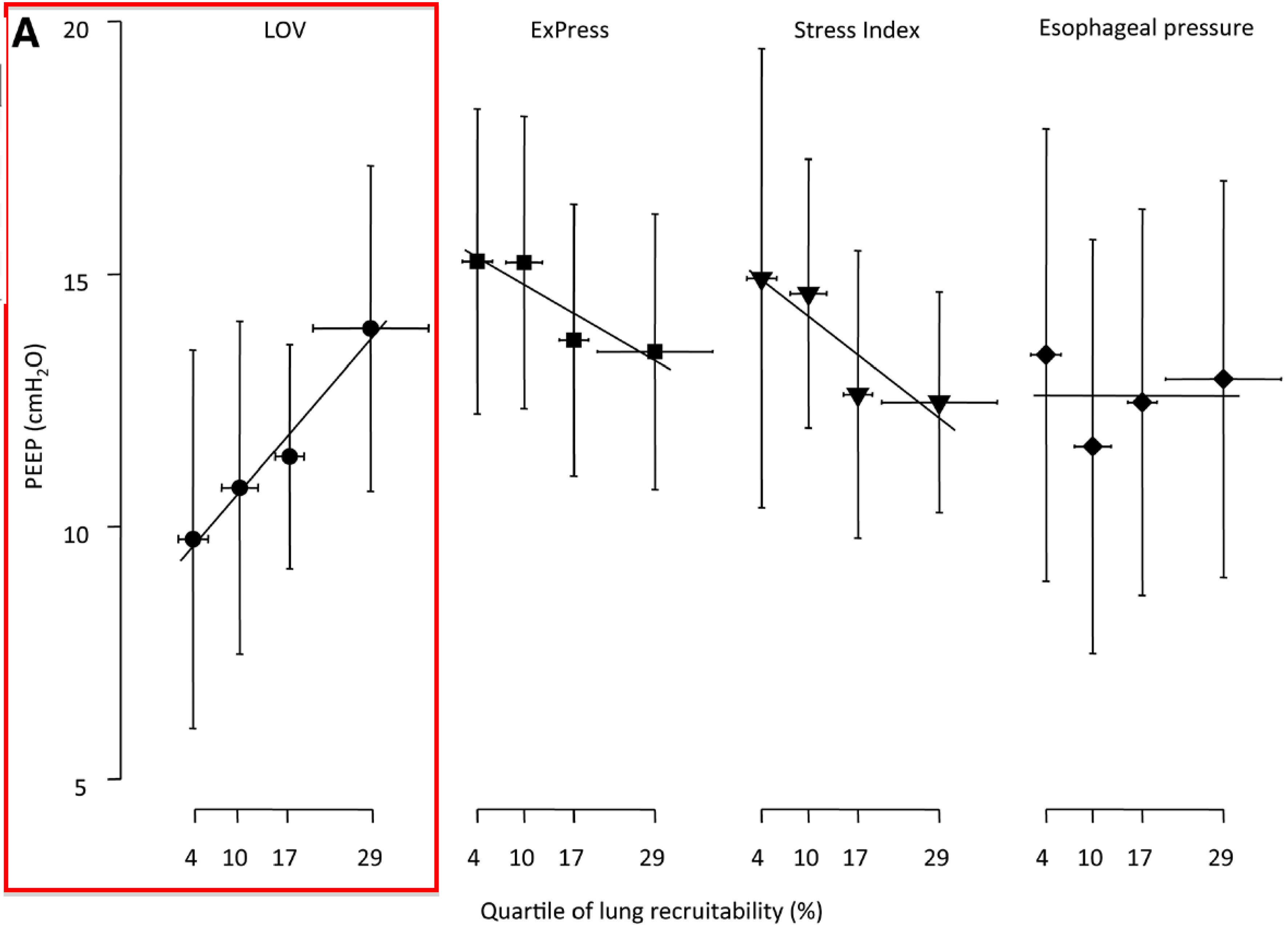




PTP expi ≥ 0

TABLE 1. Positive End-Expiratory Pressure/ FIO_2 Table

FIO_2	Positive End-Expiratory Pressure (cm H_2O)
0.3	5–10
0.4	10–18
0.5	18–20
0.6	20
0.7	20
0.8	20–22
0.9	22
1	22–24



Imagerie

ZEEP

↑↑ PEEP

Personalised mechanical ventilation tailored to lung morphology versus low positive end-expiratory pressure for patients with acute respiratory distress syndrome in France (the LIVE study): a multicentre, single-blind, randomised controlled trial

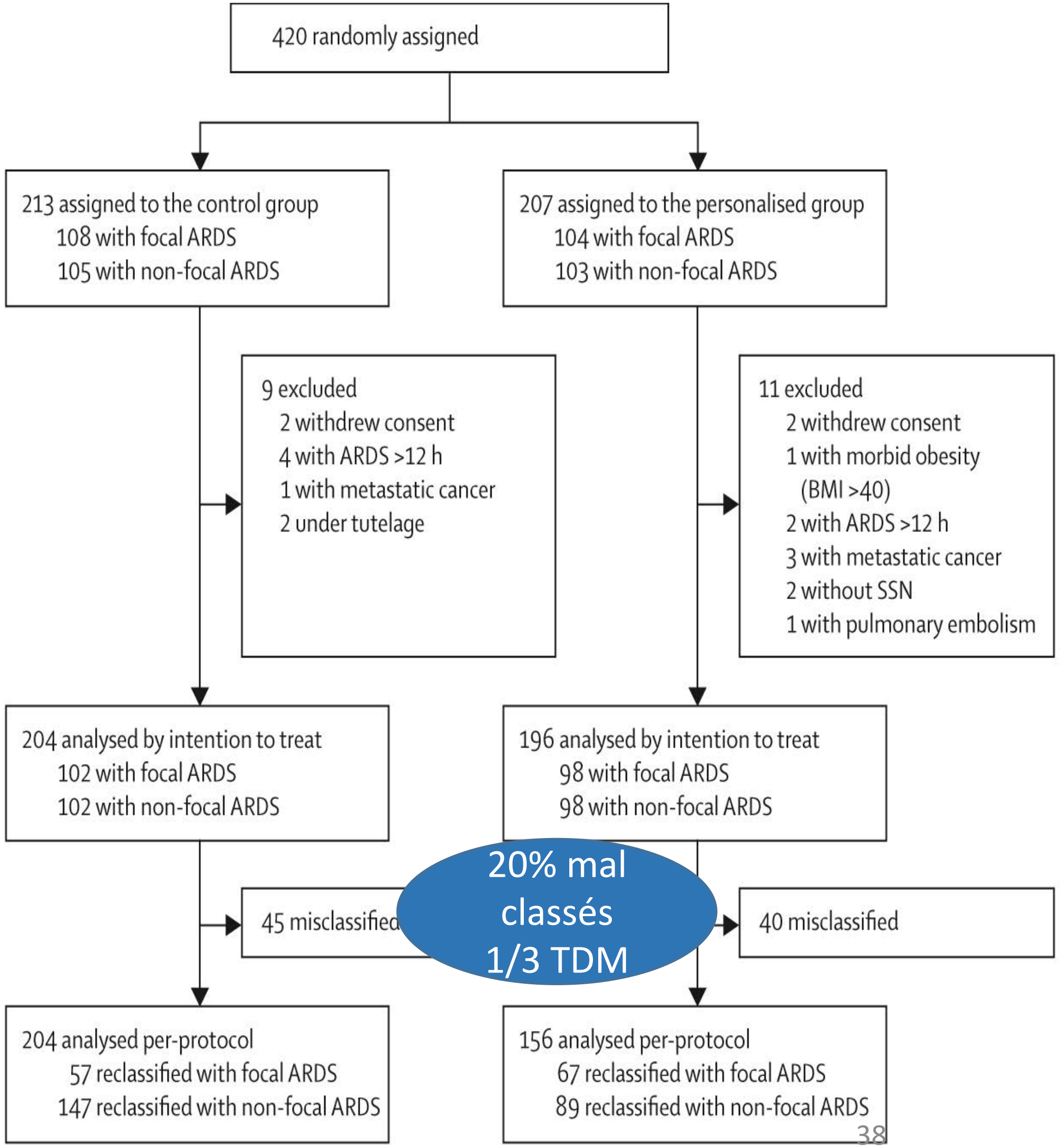
Lancet Respiratory medicine, 2019, 7 (10),870-880

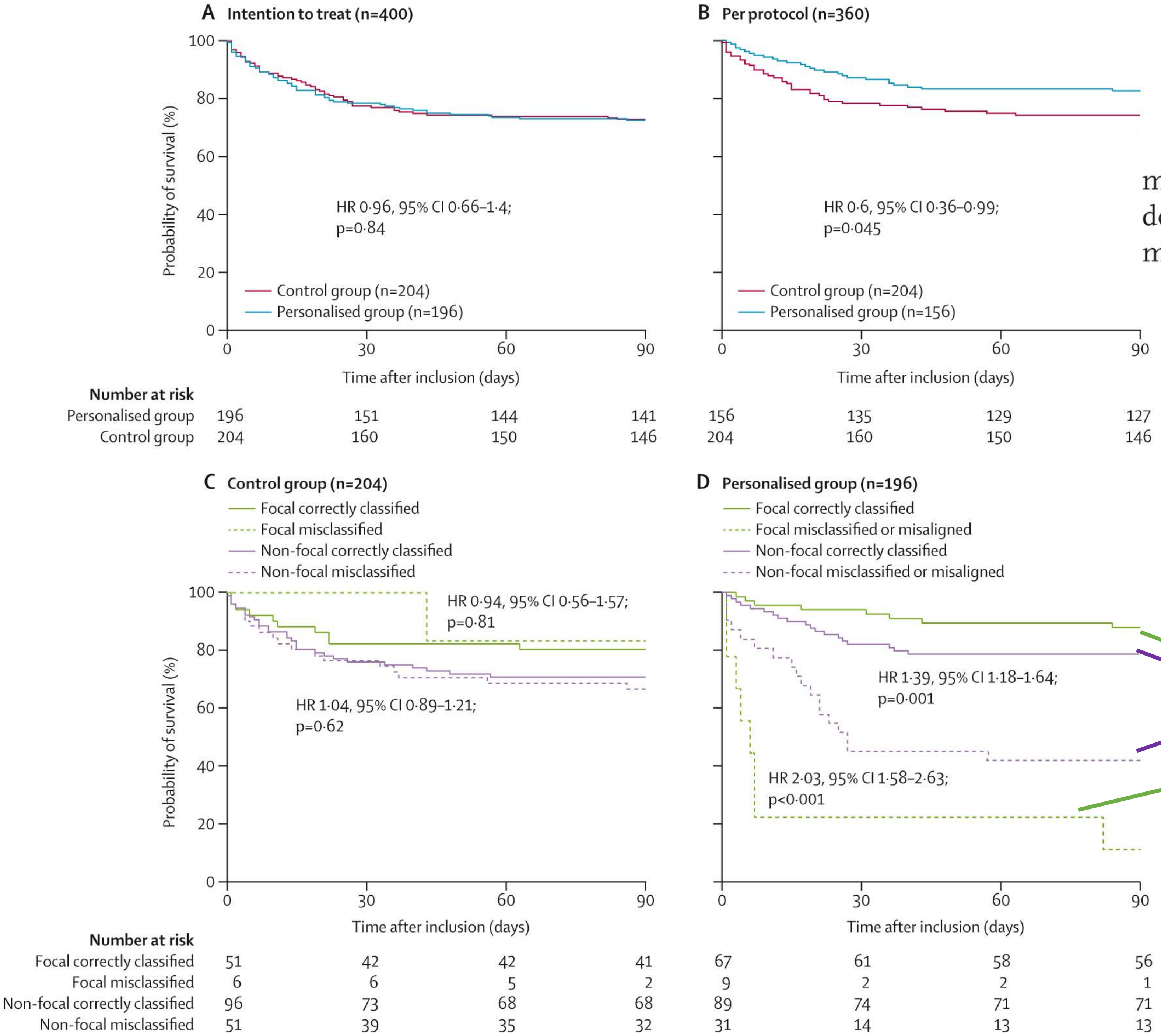
*Jean-Michel Constantin, Matthieu Jabaudon, Jean-Yves Lefrant, Samir Jaber, Jean-Pierre Quenot, Olivier Langeron, Martine Ferrandière, Fabien Grelon, Philippe Seguin, Carole Ichai, Benoit Veber, Bertrand Souweine, Thomas Uberti, Sigismond Lasocki, François Legay, Marc Leone, Nathanael Eisenmann, Claire Dahyot-Fizelier, Hervé Dupont, Karim Asehnoune, Achille Sossou, Gérald Chanques, Laurent Muller, Jean-Etienne Bazin, Antoine Monsel, Lucile Borao, Jean-Marc Garcier, Jean-Jacques Rouby, Bruno Pereira, Emmanuel Futier, for the AZUREA Network**

	Control group (n=204)	Personalised group (n=196)	
		Focal lung morphology	Non-focal lung morphology
Mode of ventilation	Volume control	Volume control	Volume control
Tidal volume	6 mL/kg IBW	8 mL/kg IBW	6 mL/kg IBW
PEEP	PEEP/FiO_2	5–9 cm H_2O	To reach Pplat of 30 cm H_2O
PEEP-PSV	Free	5–9 cm H_2O	≥10 cm H_2O
Recruitment manoeuvre	Rescue	Rescue	Mandatory
Prone position	Encouraged	Mandatory	Rescue

IBW=ideal body weight. PEEP=positive-end expiratory pressure. FiO_2=fraction of inspired oxygen. Pplat=end-inspiratory plateau pressure. PEEP-PSV=positive-end expiratory pressure used during pressure support ventilation.

Table 1: **Summary of ventilator settings according to lung morphology and randomisation group**



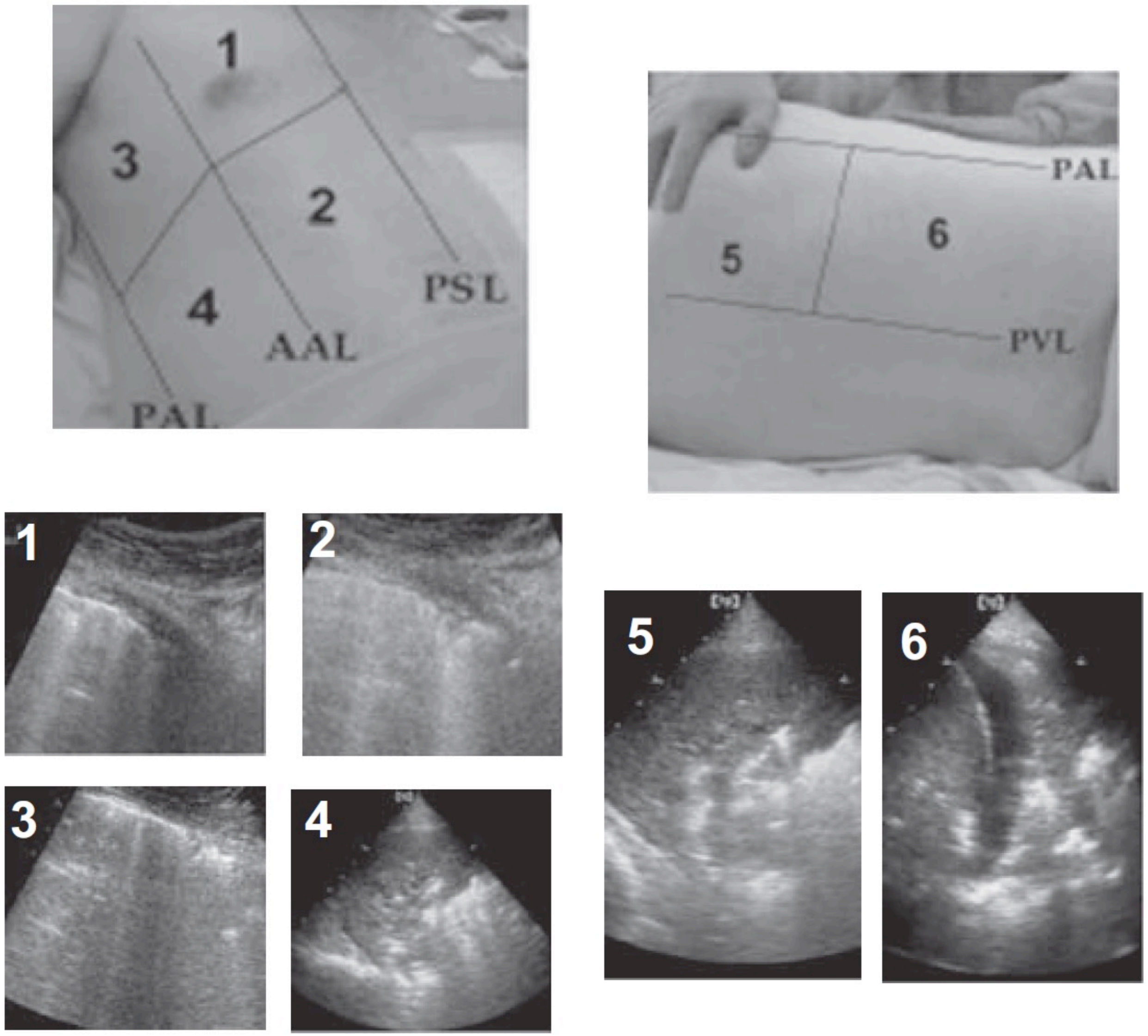


When lung morphology is correctly assessed, mortality might decrease with personalised strategies in patients with moderate-to-severe ARDS. However, when personal-

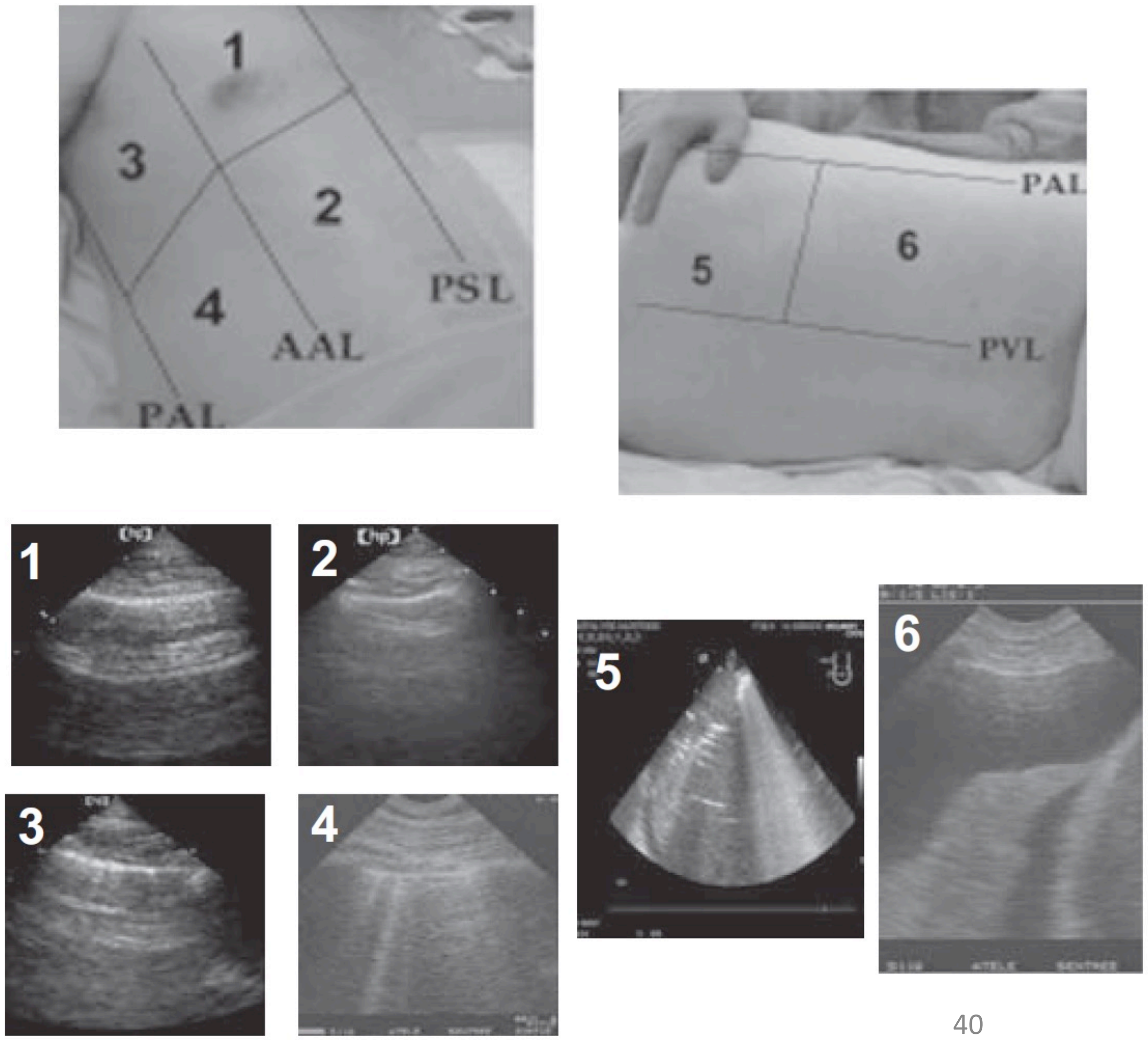
However, when personalised ventilation is misaligned with lung morphology, mortality increases substantially, suggesting a harmful effect of open-lung ventilation in patients without alveolar recruitment.

Utilisation des ultra-sons

Diffuse loss of aeration



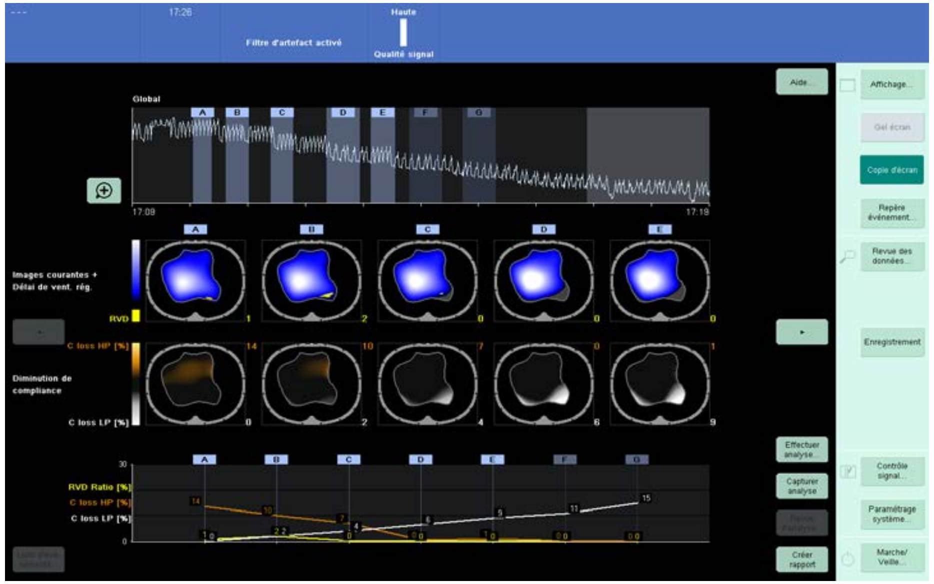
Focal loss of aeration

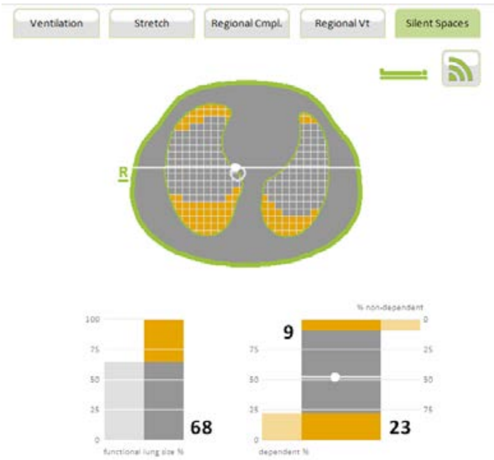


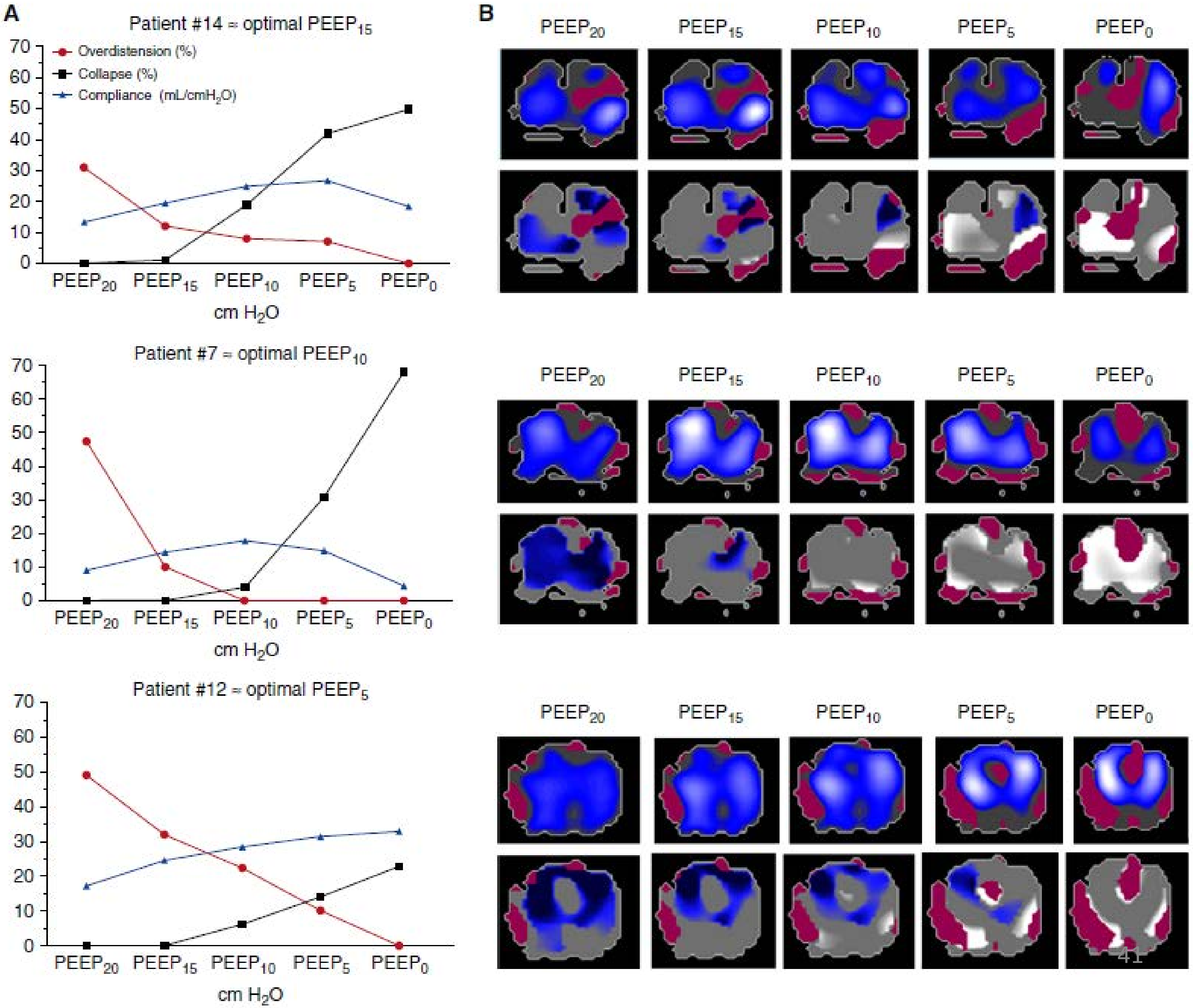
Bedside Contribution of Electrical Impedance Tomography to Setting Positive End-Expiratory Pressure for Extracorporeal Membrane Oxygenation–treated Patients with Severe Acute Respiratory Distress Syndrome

Am J Respir Crit Care Med Vol 196, Iss 4, pp 447–457, Aug 15, 2017

Guillaume Franchineau[1,2], Nicolas Bréchot[1,2], Guillaume Lebreton[1,3], Guillaume I
Jean-Louis Trouillet[1,2], Pascal Leprince[1,3], Jean Chastre[1,2], Charles-Edouard Lu
Matthieu Schmidt[1,2]

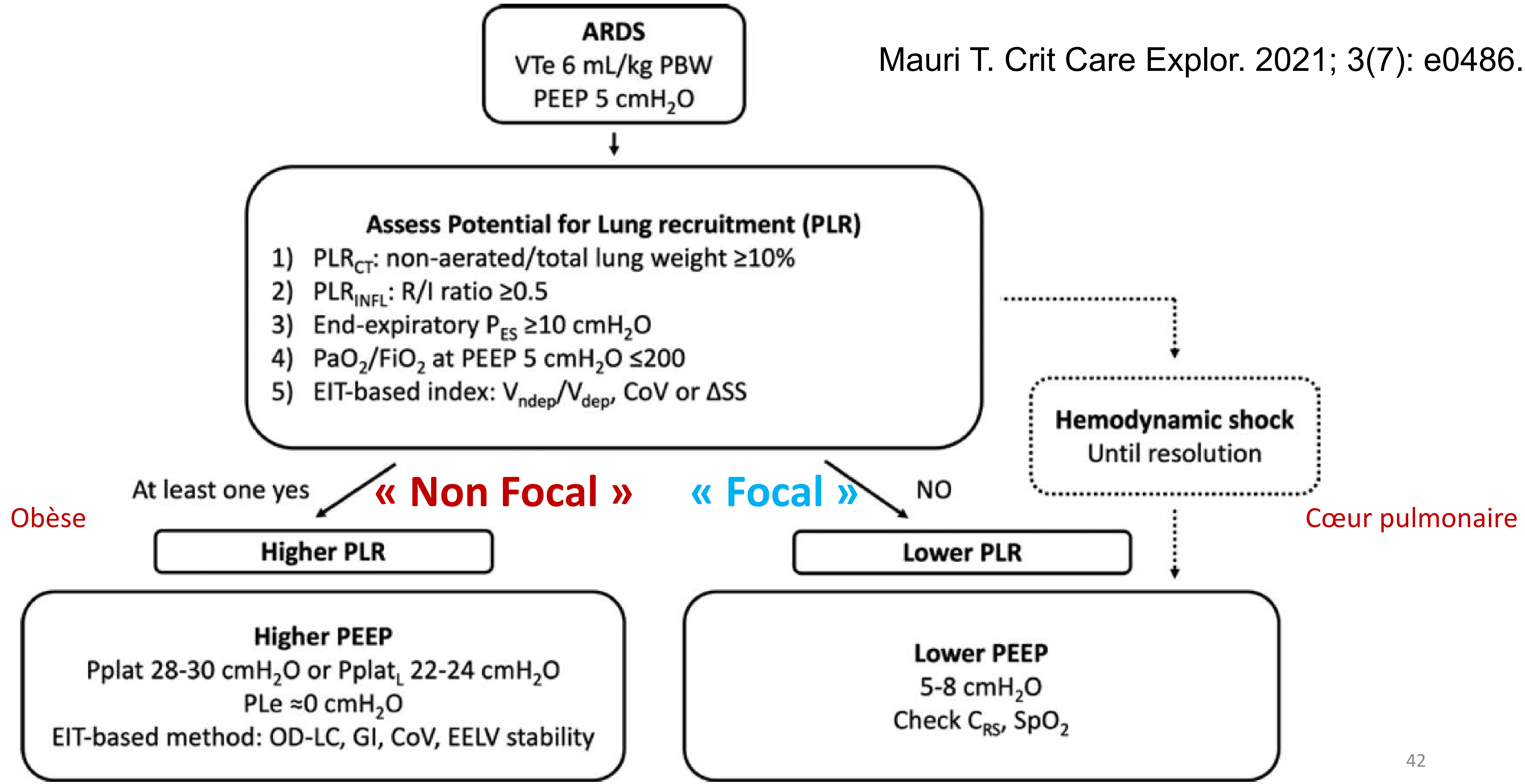






Personnaliser la PEEP

Mauri T. Crit Care Explor. 2021; 3(7): e0486.



Crédit photo Robina Weermeijer / Unsplash

Un logiciel pour personnaliser la ventilation des malades atteints de syndrome de détresse respiratoire aigüe

22 avril 2020 RÉSULTATS SCIENTIFIQUES IMAGE

Le syndrome de détresse respiratoire aiguë (SDRA), qui peut être un des résultats, entre autres, du Covid-19, nécessite une ventilation mécanique pour contrôler l'hypoxémie (diminution de quantité d'oxygène dans le sang). Cependant, des réglages ventilatoires inadéquats peuvent aggraver les lésions pulmonaires du SDRA. Un logiciel développé par le Centre de Recherche en Acquisition et Traitement d'Images pour la Santé (CREATIS - CNRS/Inserm/Université Claude Bernard Lyon 1/Université Jean Monnet/INSA Lyon) permet d'analyser semi-automatiquement des images de scanner afin d'adapter au plus juste la ventilation aux besoins du patient.

Le syndrome de détresse respiratoire aiguë (SDRA) est une forme particulièrement grave d'insuffisance respiratoire aiguë. La prise en charge thérapeutique repose actuellement sur le traitement de la cause du SDRA, et sur la ventilation mécanique avec une pression expiratoire positive (PEP) pour tenter de contrôler l'hypoxémie. Or il a été démontré à de multiples reprises

A - / A+

Contact(s)

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Imprimer

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3 points à retenir

1. Volume courant

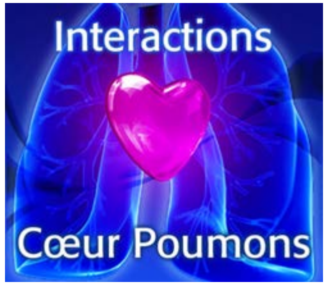
- Vt = 6 ml/Kg PBW
- Pression motrice = Vt / Compliance RS
- Si Pplat > 28-30 et/ou ΔP > 14-15 cmH_20

2. $PEEP_{SDRA}$

- PEEPmini 5-8 cmH_2O
- Evaluer Recrutabilité par la technique que l'on maitrise
- Au minimum Focal (PEEP 5-8) vs Diffus (PEEP QSP Pplat 28-30)
- Au minimum Table PEEP/FIO_2
- PEEP ou Vt changé = Pplat mesurée

3. Choc, cœur pulmonaire

PEEP 5-8 cmH_2O



Obèse

PEEP élevée

> P ouverture VA

PTP expi > 0 (Poeso)

AER
ACTUALITÉS EN RÉANIMATION

Personalized mechanical ventilation in acute respiratory distress syndrome

Pelosi et al. Crit Care (2021) 25:250
https://doi.org/10.1186/s13054-021-03686-3

Paolo Pelosi[1,2*], Lorenzo Ball[1,2], Carmen S. V. Barbas[3,4], Rinaldo Bellomo[5,6,7,8,9], Karen E. A. Burns[10,11], Sharon Einav[12], Luciano Gattinoni[13], John G. Laffey[14], John J. Marini[15], Sheila N. Myatra[16], Marcus J. Schultz[17,20,21], Jean Louis Teboul[18] and Patricia R. M. Rocco[19]