

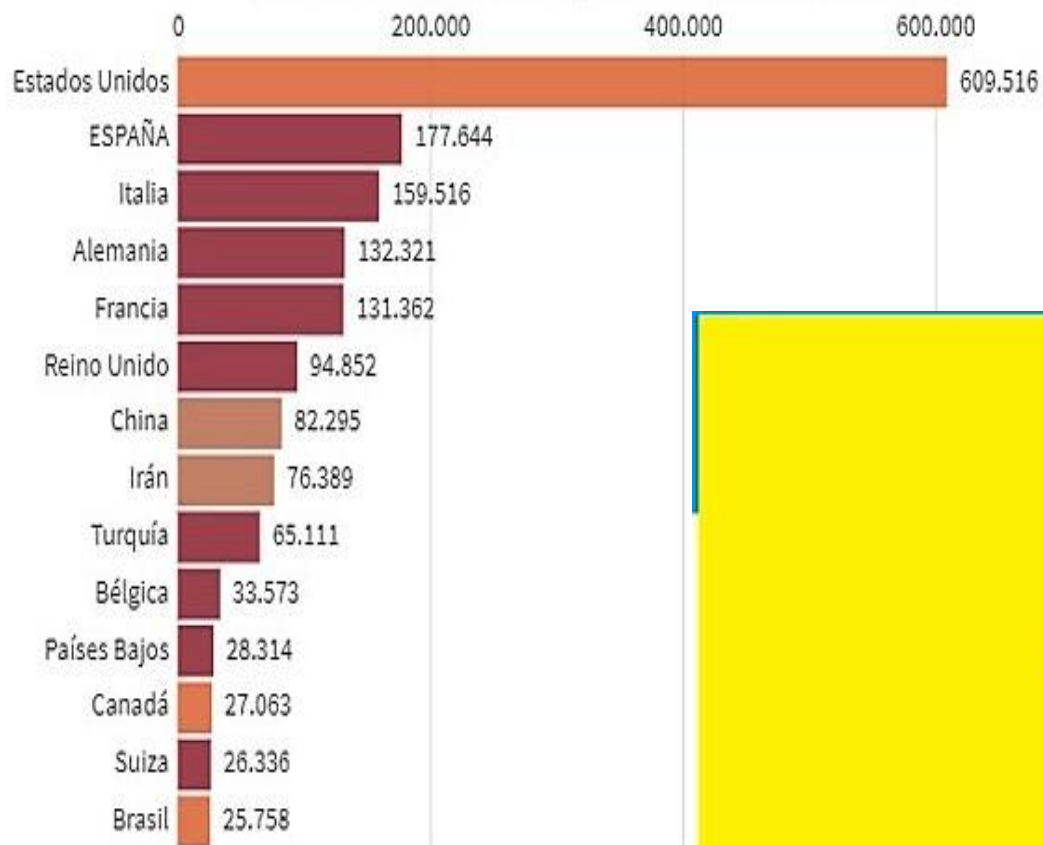
Soporte ventilatorio en pacientes con falla respiratoria aguda COVID 19

TF Norberto Tiribelli

Unidad de Terapia Intensiva

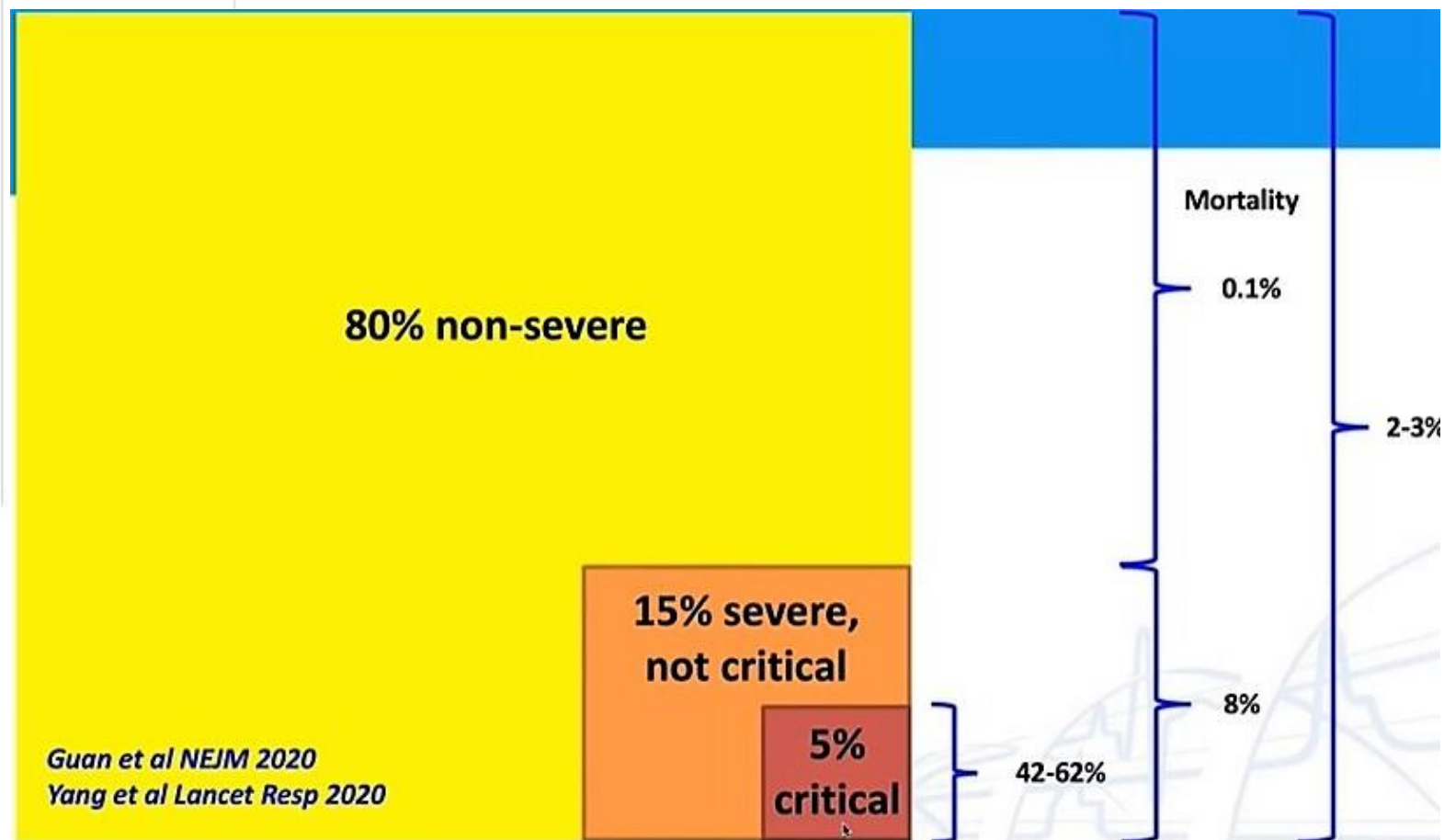
CMPFA Churruca Visca

Buenos Aires, Argentina



Total de contagiados al
15/04/20

2.000.048



Clinical course and outcomes of critically ill patients with
SARS-CoV-2 pneumonia in Wuhan, China: a single-centered,
retrospective, observational study

Yang Lancet 2020

Clinical Characteristics of 138 Hospitalized Patients
With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China

Wang JAMA 2020

Covid-19 in Critically Ill Patients
in the Seattle Region — Case Series

Bhatraju NEJM 2020

Baseline Characteristics and Outcomes of 1591 Patients Infected
With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy

Grasselli JAMA 2020

Lung Recruitability in SARS-CoV-2 Associated Acute Respiratory Distress Syndrome: A

Single-center, Observational Study

Pan AJRCCM 2020

COVID 19

	Yang Lancet 2020	Wang Lancet 2020	Bhatraju NEJM 2020	Graselli JAMA 2020
n	52	138 (36 en UCI)	24	1591
Soporte ventilatorio	37 (71%)			
<i>VNI</i>	29 (56%)	15 (44%)	0	137 (11)
<i>HFNC</i>	33 (63.5%)	4 (11%)	10/24 (42)	
<i>VMI</i>	22 (42%)	17 (47.2%)	18/24 (75)	1150 (88)
Edad	59.7 (13.3)	66 (57-78)	64 (18)	63 (56-70)
Sexo	35 (67) H	22 (61.1) H	15 (63)	1304 (82)
APACHE II	17 (14–19)	17 (10-22)		
PaO2/FiO2	100 (66-126)	136 (103-234)	142 (94–177)	160 (114-220)
Días VM			9 (4–14)	
Días UCI			10 (7–12)	
Mortalidad	30/37 (81)		12 (50)	405 (26) (920 aún en UCI)

COVID 19

	Bhatraju NEJM 2020	Graselli JAMA 2020	Gattinoni AJRCCM 2020	Pan AJRCCM 2020
FiO2	0.6 (0.5–0.7)	0.7 (0.5-0.8)		0.7 (0.21)
PEEP		14 (12-16)		5 a 10
Pplateau	22 (19–28)			30 (8)
DeltaP	12 (10–14)			22 (9)
Compliance	37 (25–42)		50.2 (14.3)	20 (8)
BNM	7/18 (39)			
Pprona	5/18 (28)	240/875 (27)		7 (58)

Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected.

Interim guidance
13 March 2020



8. Management of critical COVID-19: acute respiratory distress syndrome (ARDS)

- ✓ Implement mechanical ventilation using lower tidal volumes (4–8 mL/kg predicted body weight, PBW) and lower inspiratory pressures (plateau pressure < 30 cmH₂O).
- ✓ In adult patients with severe ARDS, prone ventilation for 12–16 hours per day is recommended.
- ! In patients with moderate or severe ARDS, higher PEEP instead of lower PEEP is suggested.
- ! In patients with moderate-severe ARDS ($\text{PaO}_2/\text{FiO}_2 < 150$), neuromuscular blockade by continuous infusion should not be routinely used.

Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19)

Recommendation:

30. In mechanically ventilated adults with COVID-19 and ARDS, we **recommend** using low tidal volume (V_t) ventilation (V_t 4-8 mL/kg of predicted body weight), over higher tidal volumes ($V_t > 8$ mL/kg) (strong recommendation, moderate quality evidence).

Recommendation:

31. For mechanically ventilated adults with COVID-19 and **ARDS**, we **recommend** targeting plateau pressures (P_{plat}) of < 30 cm H_2O (strong recommendation, moderate quality evidence).

Recommendation:

32. For mechanically ventilated adults with COVID-19 and moderate to severe ARDS, we **suggest** using a higher PEEP strategy, over a lower PEEP strategy (weak recommendation, low quality evidence).

Remarks: If using a higher PEEP strategy (i.e., $PEEP > 10$ cm H_2O), clinicians should monitor patients for barotrauma.

Recommendation:

34. For mechanically ventilated adults with COVID-19 and **moderate to severe ARDS**, we **suggest** prone ventilation for **12 to 16 hours**, over no prone ventilation (weak recommendation, low quality evidence).

Epidemiology, Patterns of Care, and Mortality for Patients With Acute Respiratory Distress Syndrome in Intensive Care Units in 50 Countries

- De 29144 pacientes, 3022 (10.4%) desarrolló SDRA.
- Mortalidad en UCI 35.3% (29.7, 35, 42.9).
- Reconocido en 64.2% de los casos (51.3, 65.3, 78.5).
- VT 7.6 ml/kg (7.8, 7.6, 7.5).
 - 35.1% VT > 8 ml/kg
- Pplat 23.2 cmH₂O (20.5, 23.1, 26.2).
 - Medida en 40.1% de los pacientes.
- PEEP 8.4cmH₂O (7.4, 8.3, 10.1)
 - 82.6% PEEP < 12 cmH₂O.

VM en pacientes con SDRA

Recomendaciones

- Programación inicial:
 - VC-CMV
 - VT 6 ml/kg Peso Predicho
 - FR para mantener $\text{pH} > 7.25$
 - PEEP?
- Monitoreo de la VM:
 - $\text{P}_{\text{plateau}} < 30 \text{ cmH}_2\text{O}$
 - $\Delta P < 15 \text{ cmH}_2\text{O}$
 - PEEP total
 - Sincronía P-V

COVID-19 pneumonia: different respiratory treatment for different phenotypes?



Fenotipo Low



- Baja elastancia
 - Baja relación V/Q
 - Bajo peso pulmonar
 - Baja reclutabilidad
-
- Alteración en la perfusión pulmonar

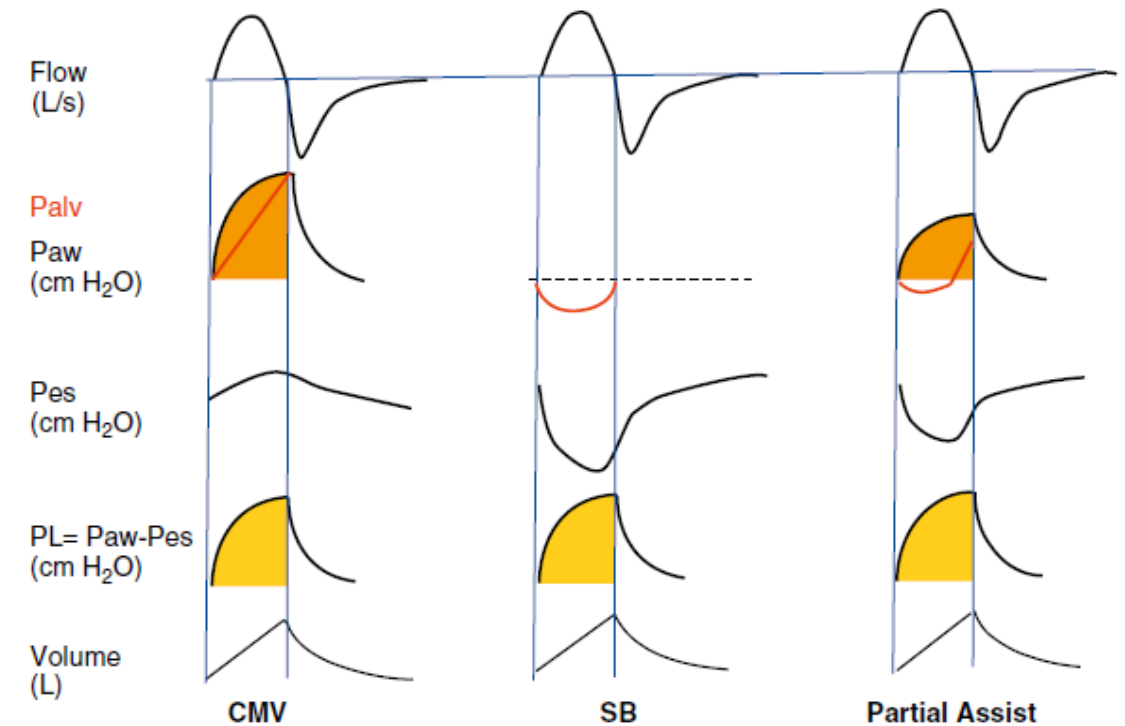
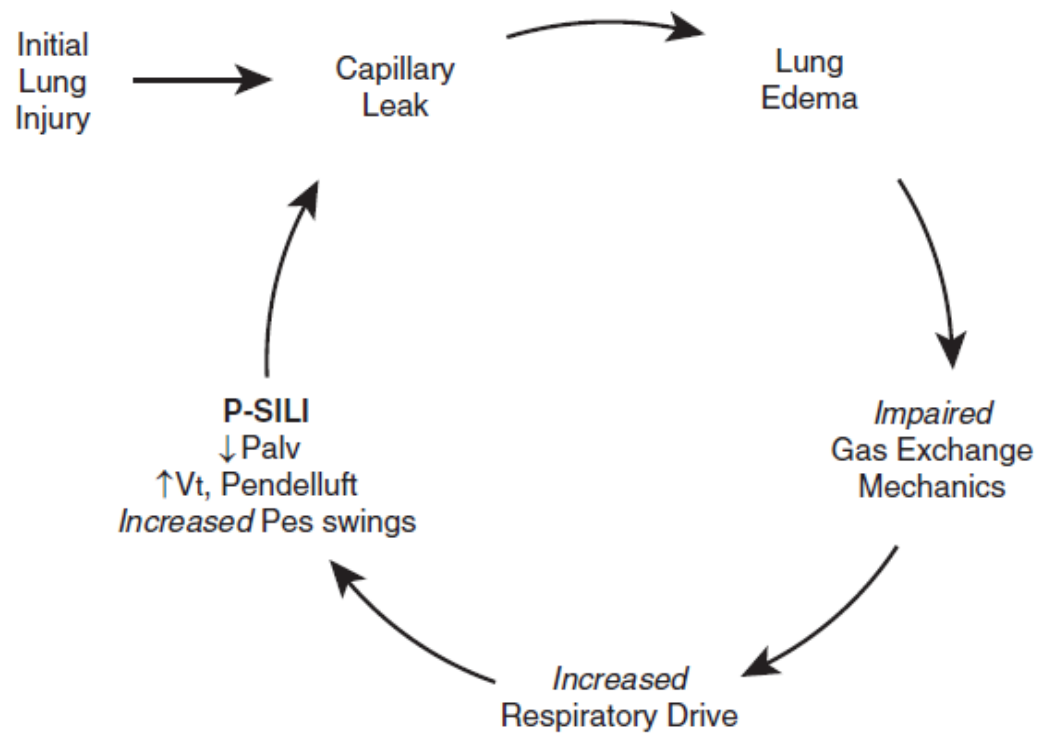
Fenotipo High



- Alta elastancia
 - Alto shunt
 - Alto peso pulmonar
 - Alta reclutabilidad
-
- Edema y colapso pulmonar

Progresión de fenotipo L a fenotipo H

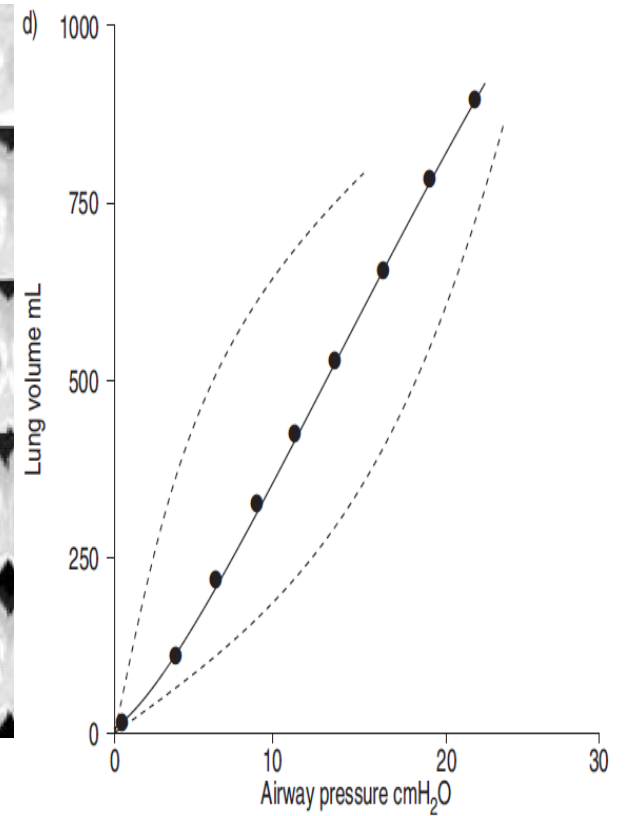
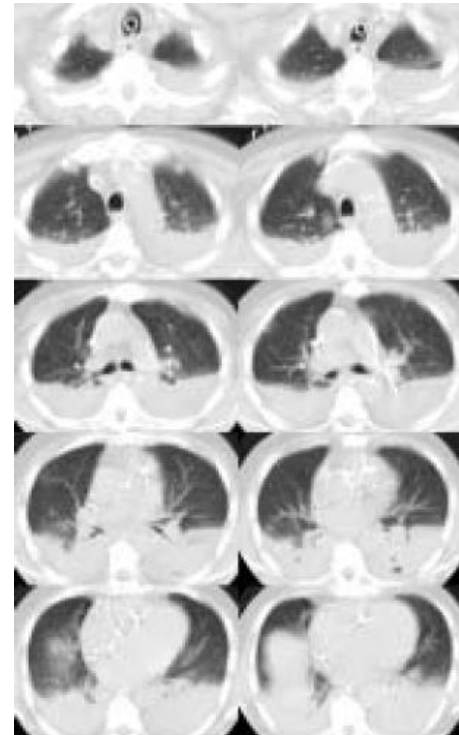
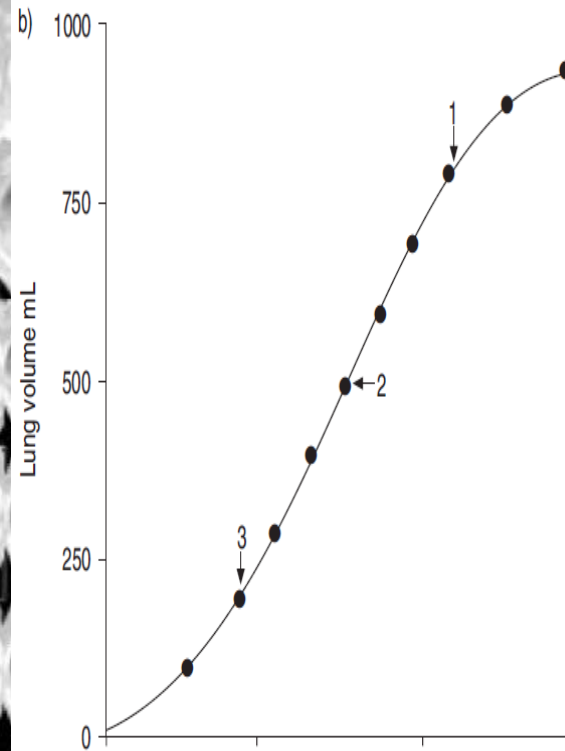
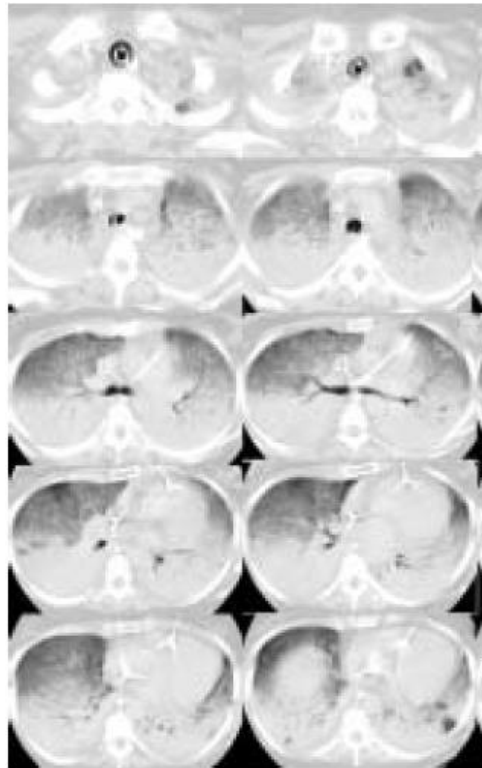
Injuria pulmonar auto infligida (P-SILI)



Lung Recruitment in Patients with the Acute Respiratory Distress Syndrome

	Lower Percentage of Potentially Recrutable Lung (N=34)	Higher Percentage of Potentially Recrutable Lung (N=34)	
Age — yr	56±16	53±18	0.01
SAPS II score¶	37±12	36±9	0.18
Total lung weight — g	1266±327**	1735±547‡‡‡	<0.001
Nonaerated lung tissue — % of total lung weight§§	30±12**	44±17‡‡‡	<0.001
Aerated lung tissue — % of total lung weight§§	70±12**	56±17‡‡‡	<0.001
PaO ₂ :FiO ₂ ¶¶	194±65**	135±60‡‡‡	0.01
PaCO ₂ — mm Hg ¶¶	39±7	44±10	0.50
Respiratory-system compliance — ml/cm of water***	51±19	38±15	0.002
Dead space — % of tidal volume†††	51±12	63±13	0.002
Shunt — % of cardiac output‡‡‡	34±12	45±17	0.008
Mortality — no. (%) of patients§§§	5 (15)	14 (41)¶¶¶	0.25

Pressure/volume curves and lung computed tomography in acute respiratory distress syndrome

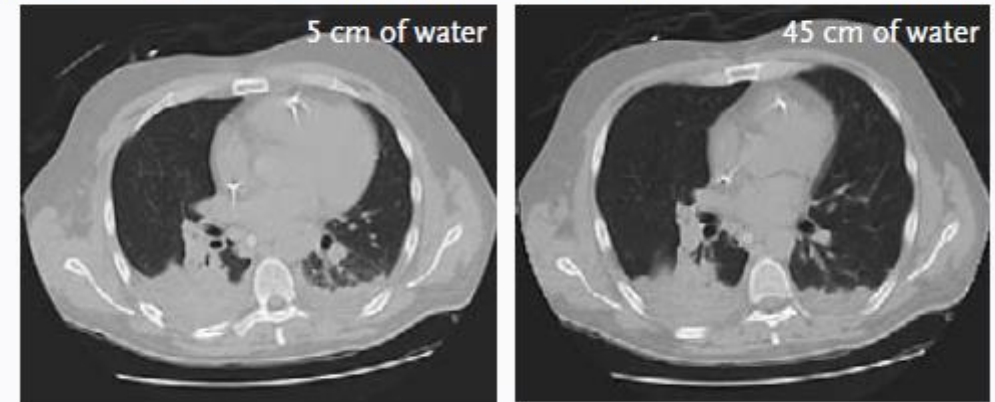


VM en pacientes con SDRA

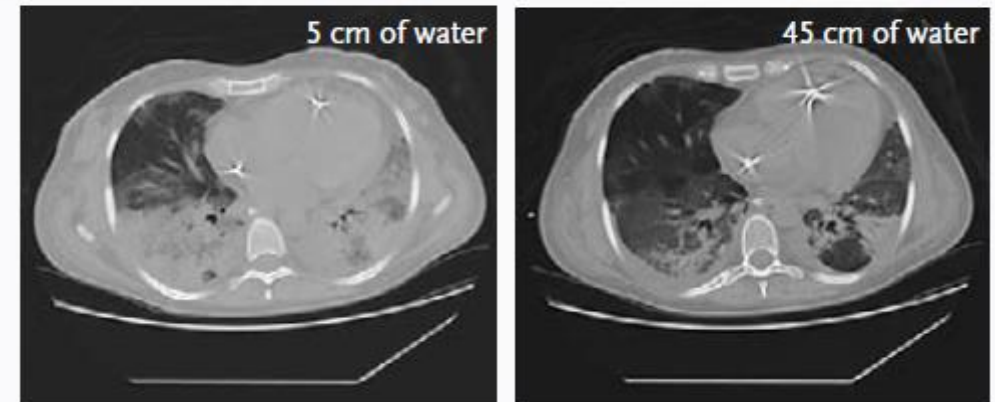
Recomendaciones...?

- Si con la programación inicial:
 - $P_{plateau} > 30$ cmH₂O
 - $\Delta P > 15$ cmH₂O
 - SDRA moderado / severo
- Considerar “individualizar” la VM

Lower Percentage of Potentially Recrutable Lung



Higher Percentage of Potentially Recrutable Lung



VM “individualizada”

Fenotipo Low

- Baja elastancia
- Baja relación V/Q
- Bajo peso pulmonar
- Baja reclutabilidad
- VT 6-8 ml/Kg
- PEEP 8-10
- PProna como maniobra de rescate

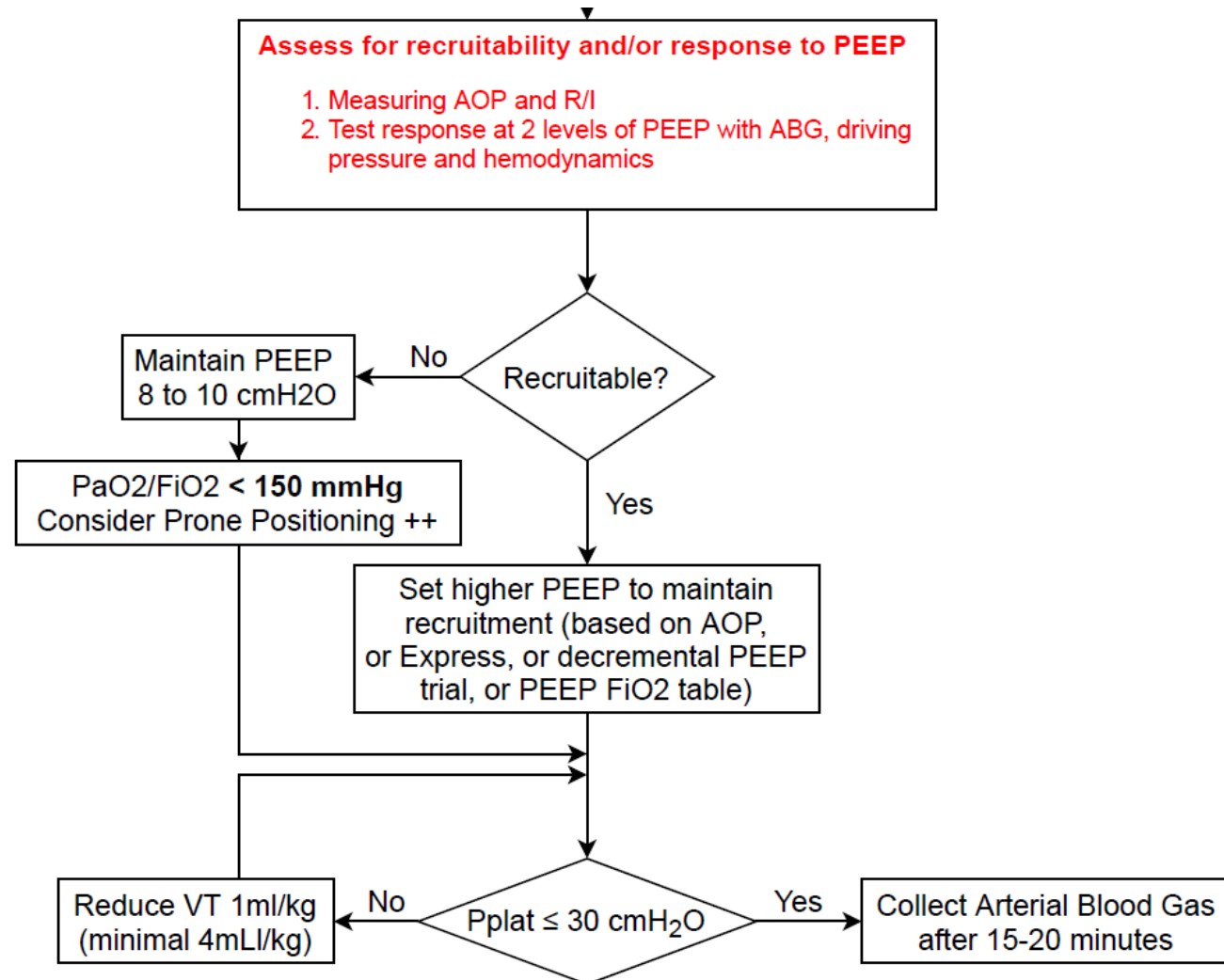


Fenotipo High

- Alta elastancia
- Alto shunt
- Alto peso pulmonar
- Alta reclutabilidad
- VT 6 ml/kg
- PEEP elevada
- PProna



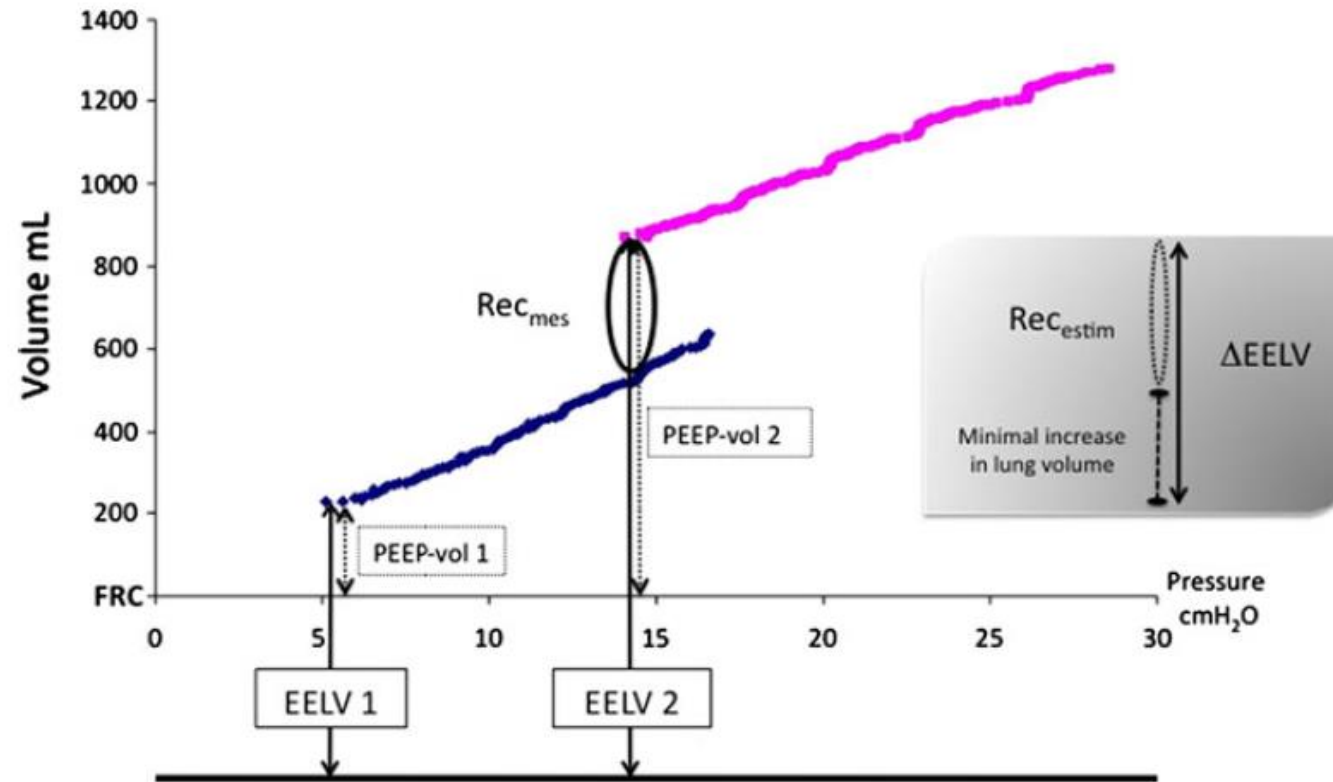
The Toronto Centre of Excellence in Mechanical Ventilation



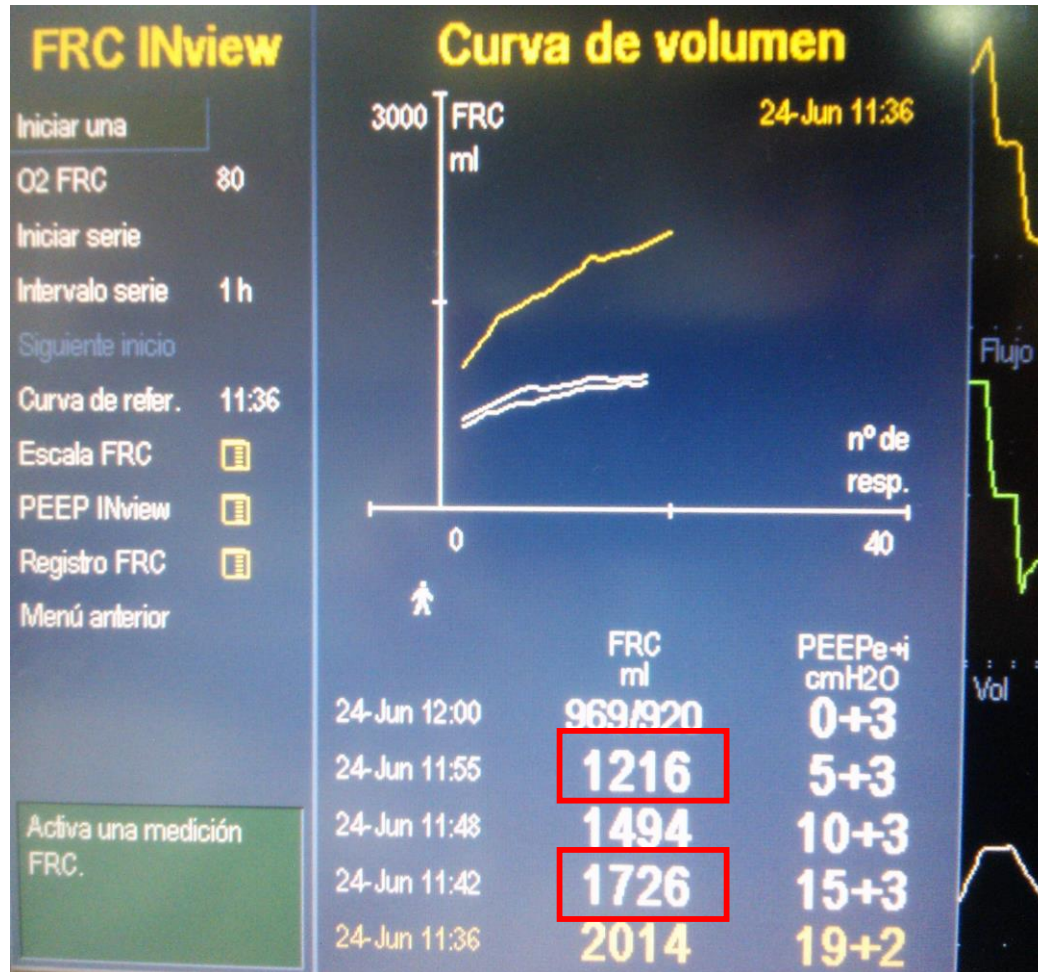
VM “individualizada”

- Período de soporte ventilatorio total:
 - Evaluación de la reclutabilidad
 - Volumen pulmonar
 - Maniobra de dereclutamiento / RI ratio
 - Evaluación de la presión transpulmonar
 - Presión esofágica
- Período de soporte ventilatorio parcial:
 - Evaluación de asincronías P-V, riesgo de P-SILI y carga de trabajo muscular
 - Presión esofágica

PEEP-induced changes in lung volume in acute respiratory distress syndrome. Two methods to estimate alveolar recruitment



Reclutamiento estimado



Δ EELV medido

=

EELV (PEEP alta) – EELV (PEEP baja)

Δ EELV predicho

=

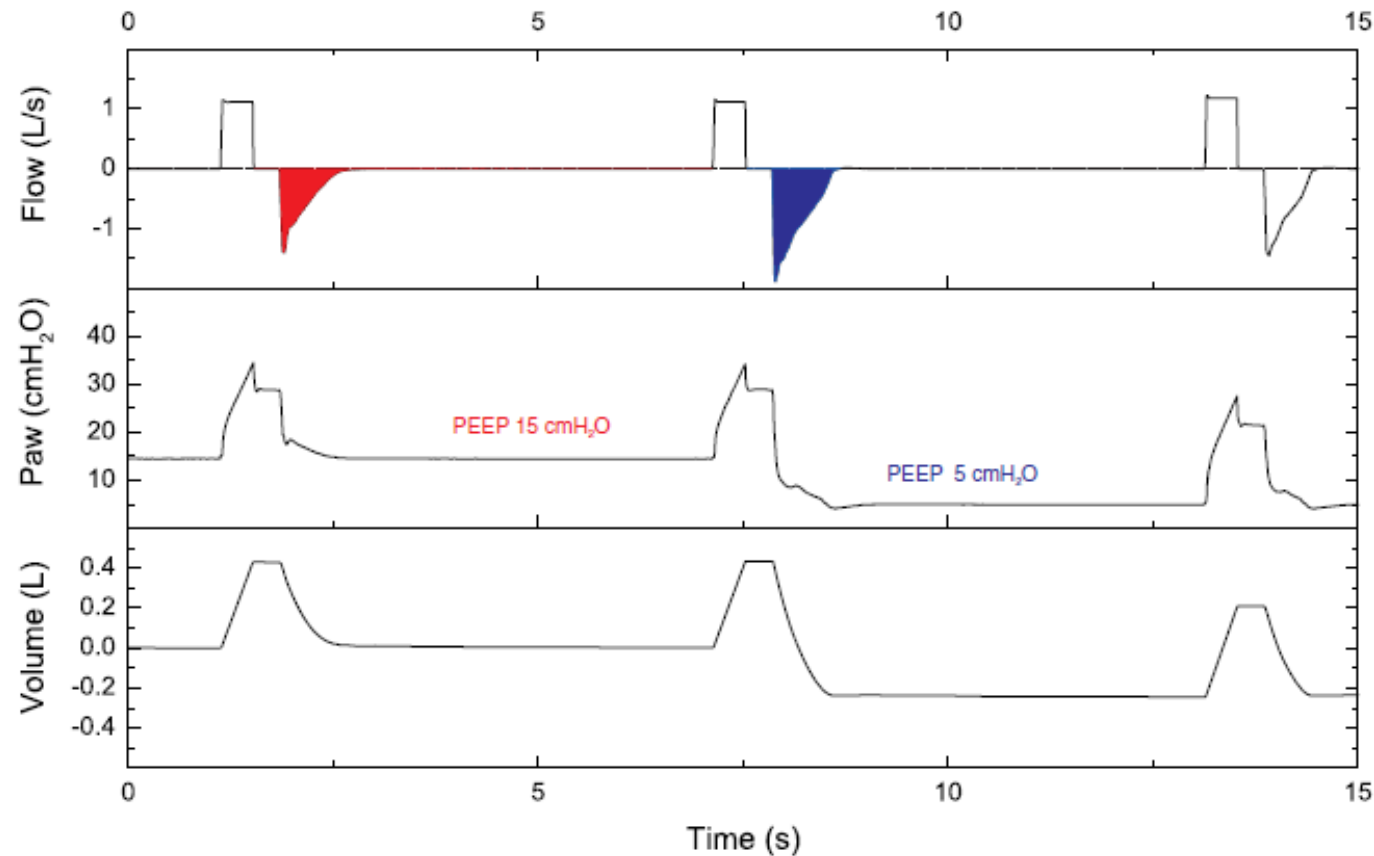
CE PEEP baja x Δ PEEP

Reclutamiento estimado

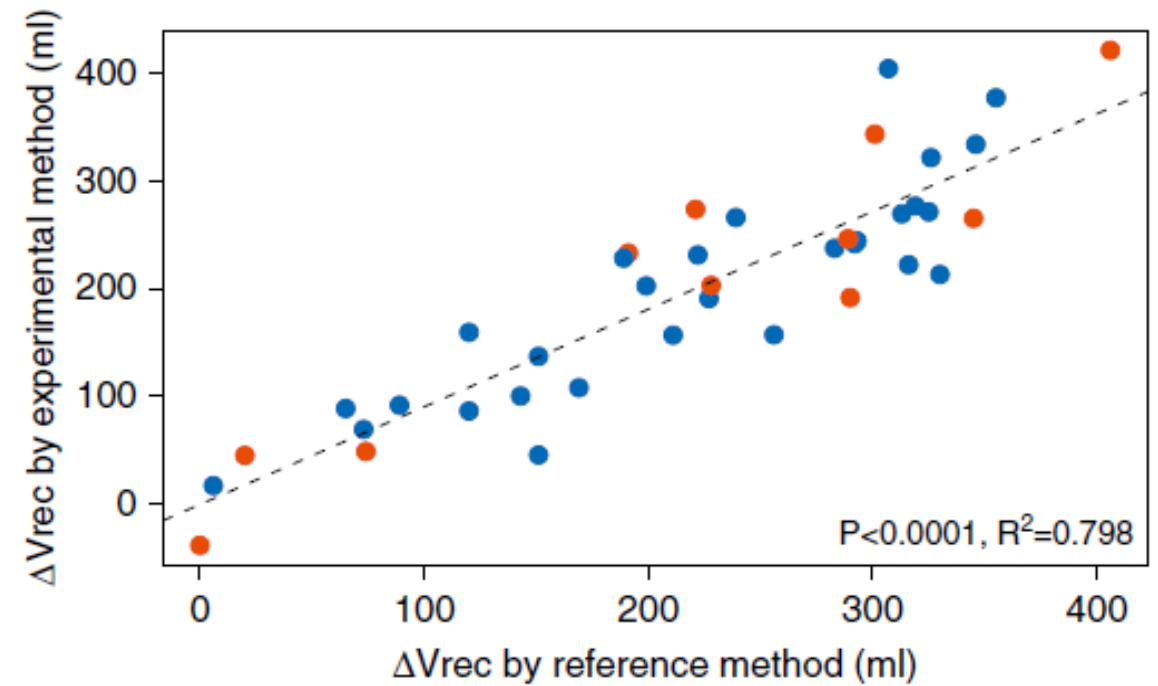
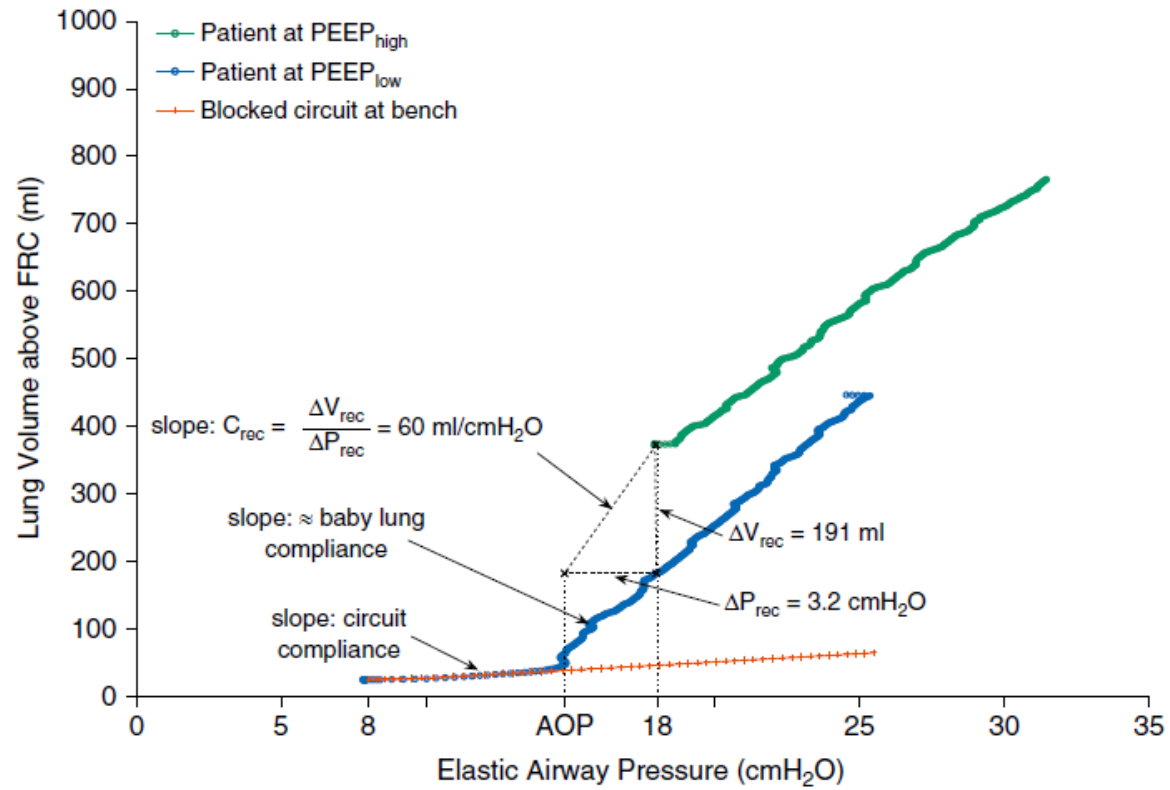
=

Δ EELV med - Δ EELV pred

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

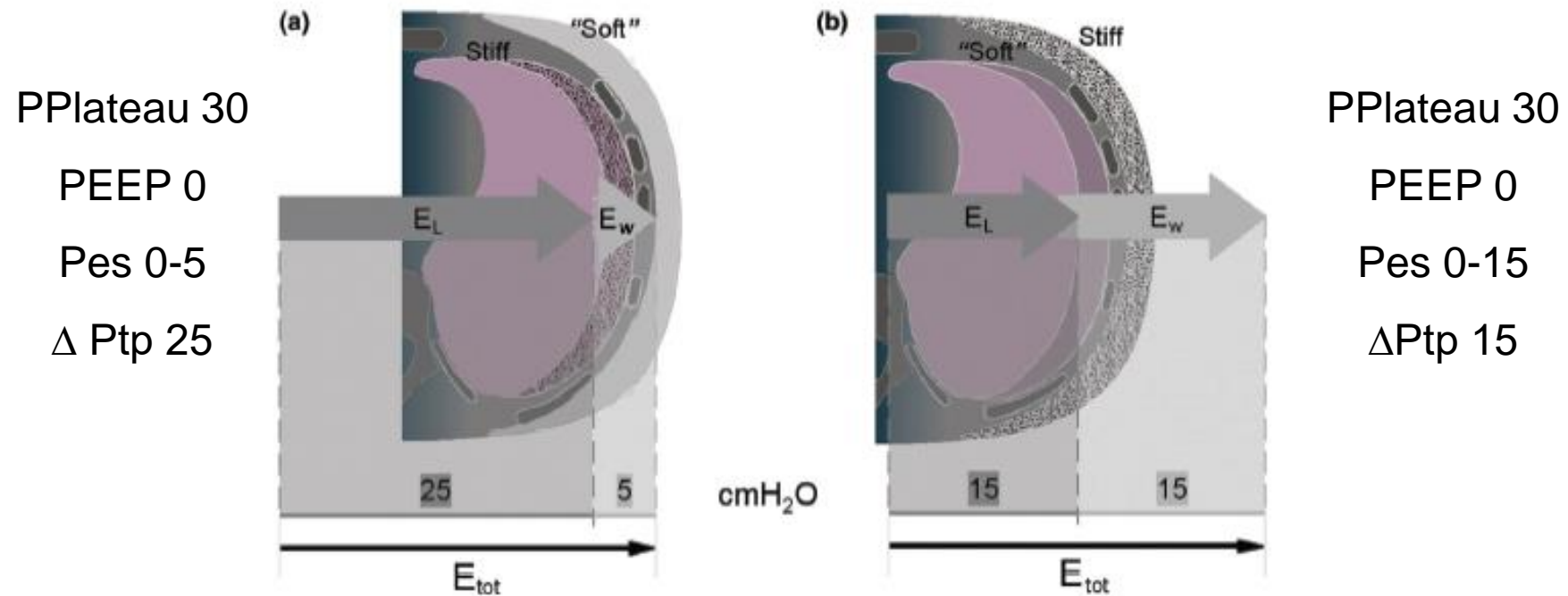


$$\frac{R}{I} \text{ ratio} = \frac{C_{rec}}{C_{rs \text{ at PEEP}_{low} \text{ or above AOP}}}$$



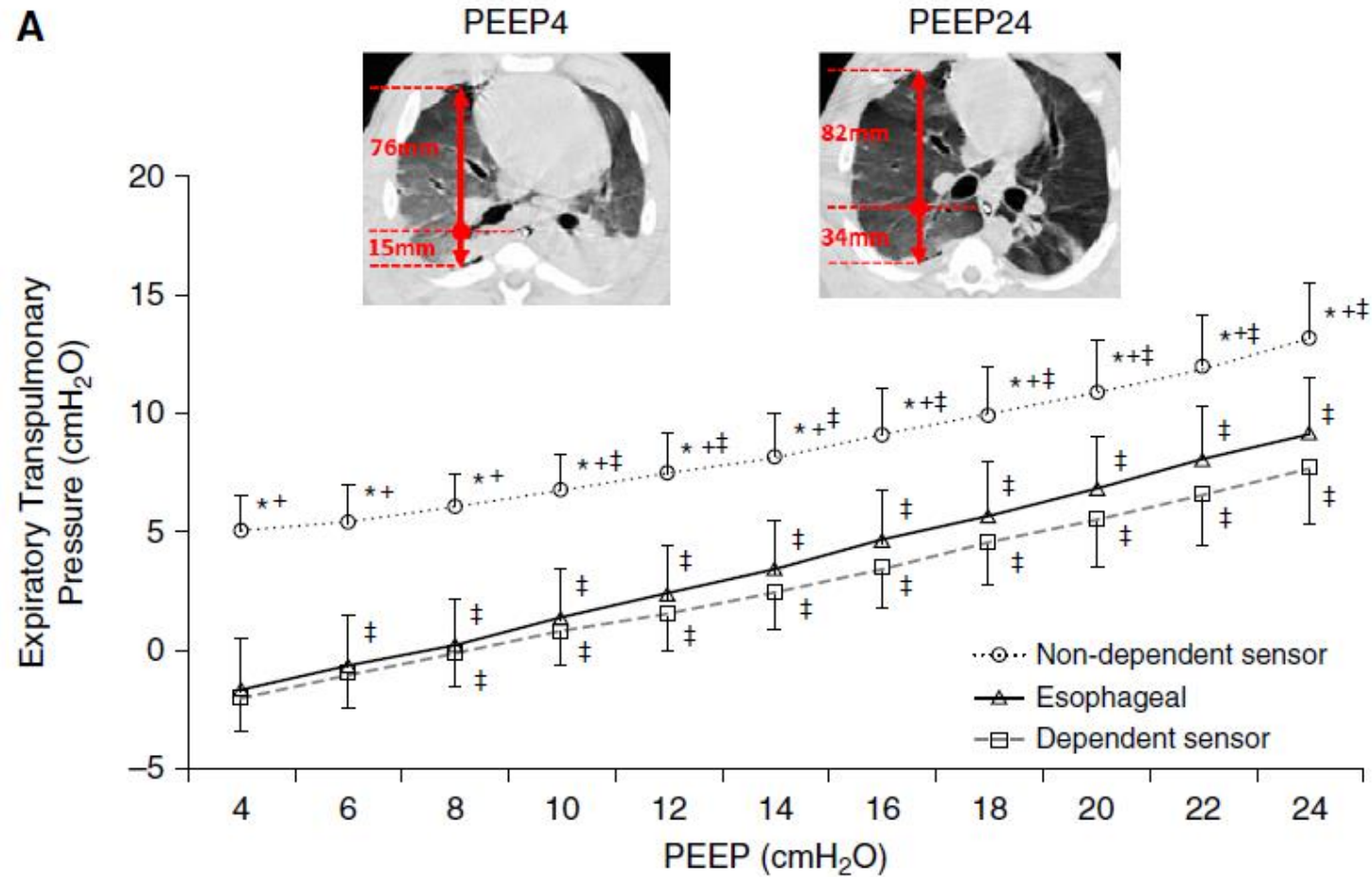
Stress = Δ Presión transpulmonar

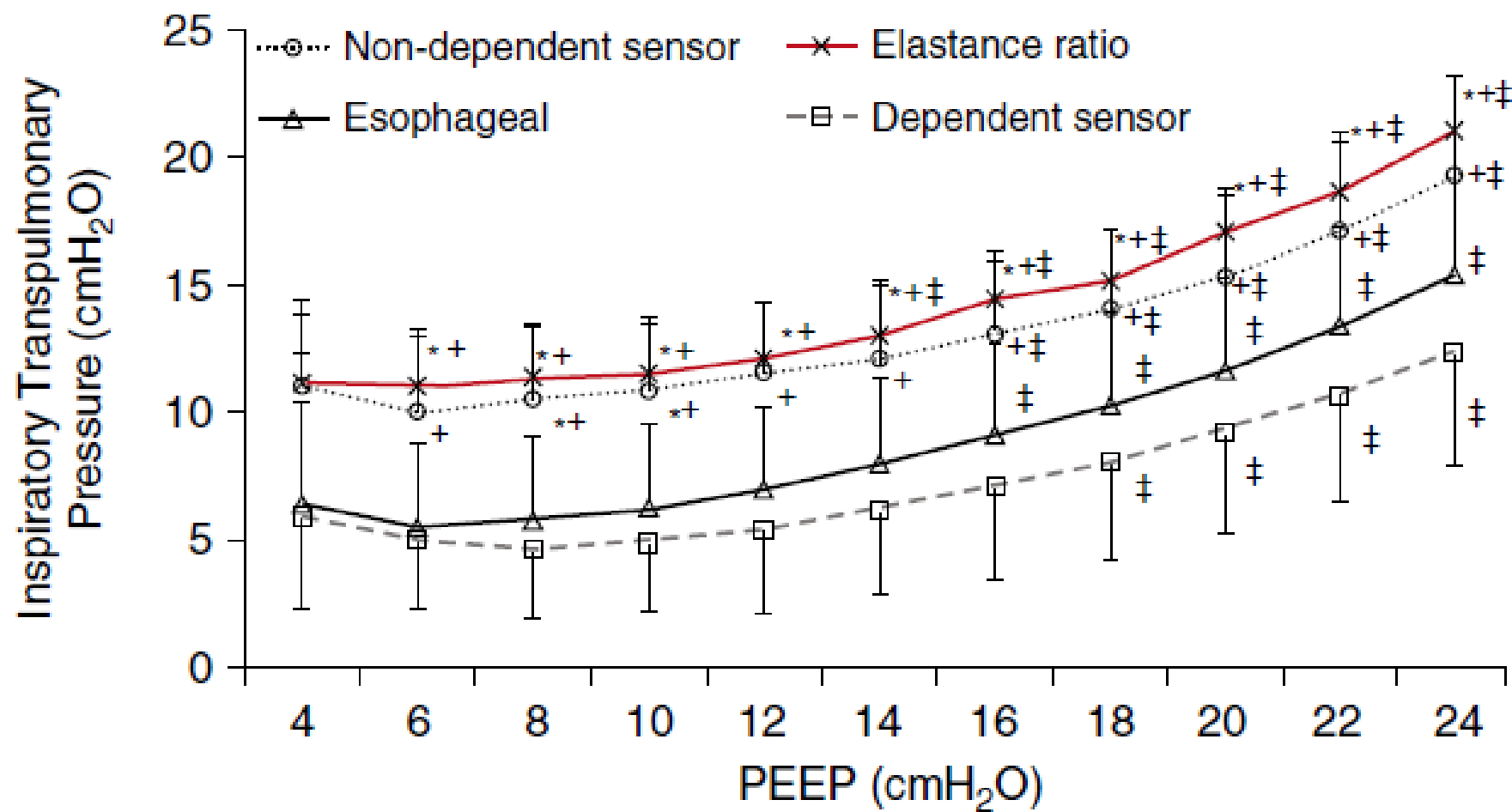
Figure 1

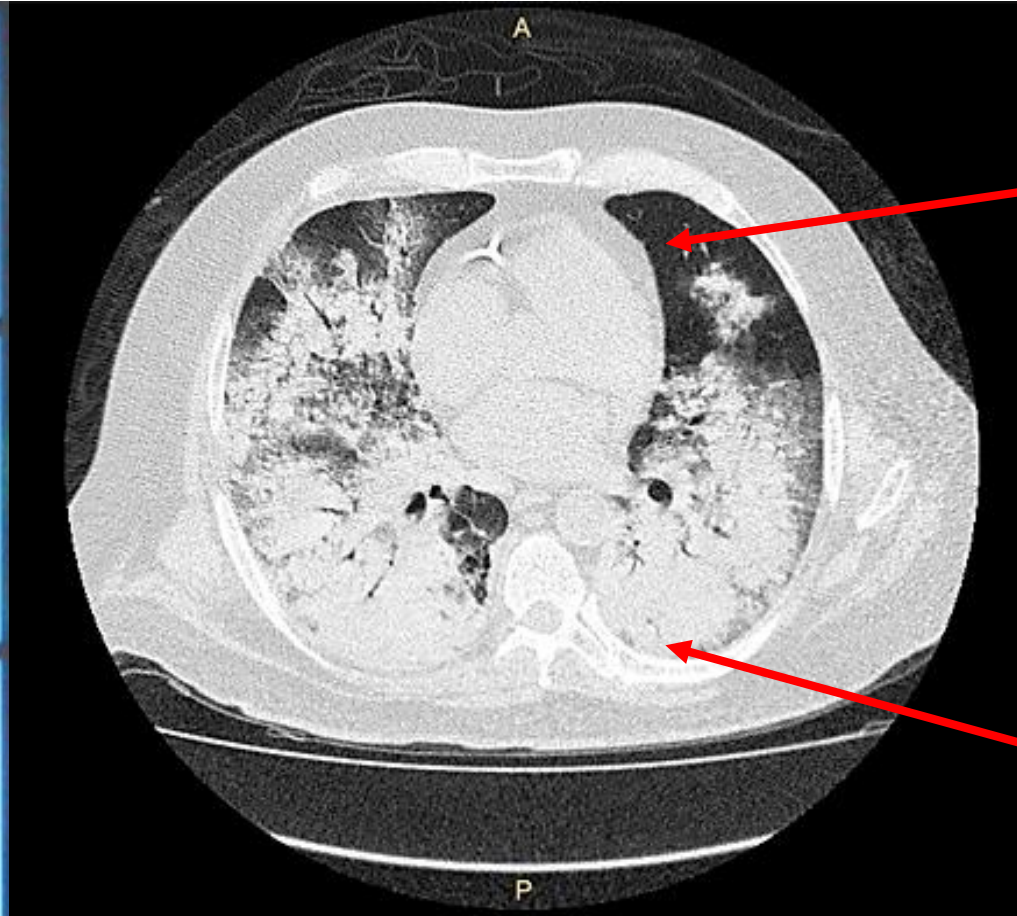
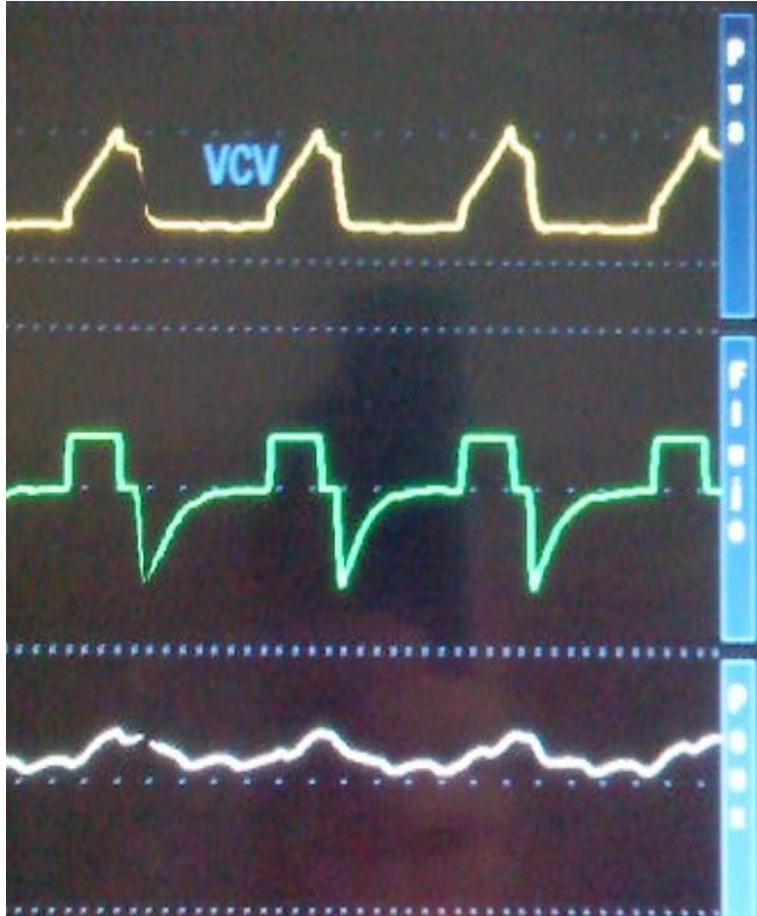


Effect of different lung elastance (E_L) and chest wall elastance (E_w) on the total elastance (E_{tot}) of the respiratory system. An equal total elastance of the respiratory system may arise (a) from a high lung elastance and a low chest wall elastance or (b) from identical lung elastance and chest wall elastance.

Esophageal Manometry and Regional Transpulmonary Pressure in Lung Injury



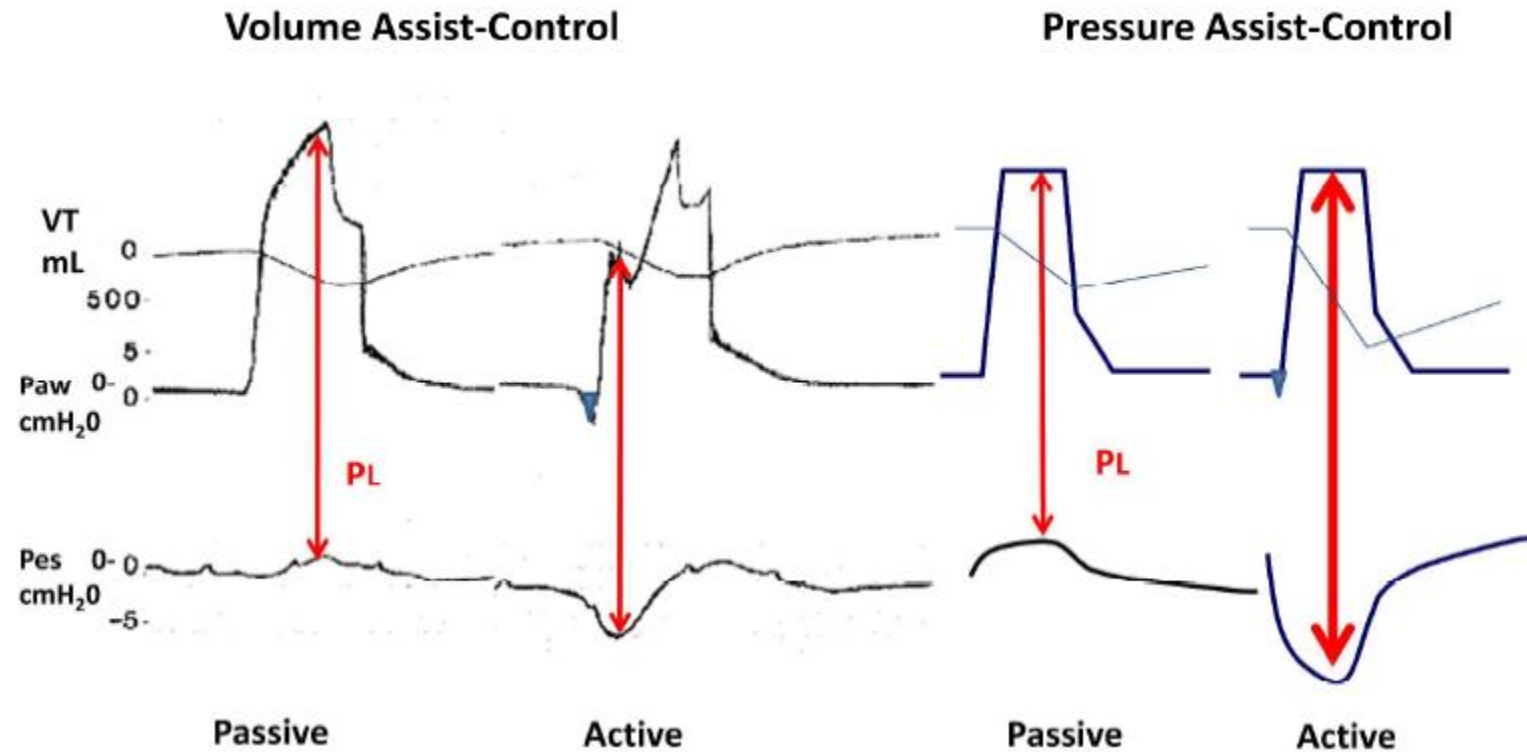
A



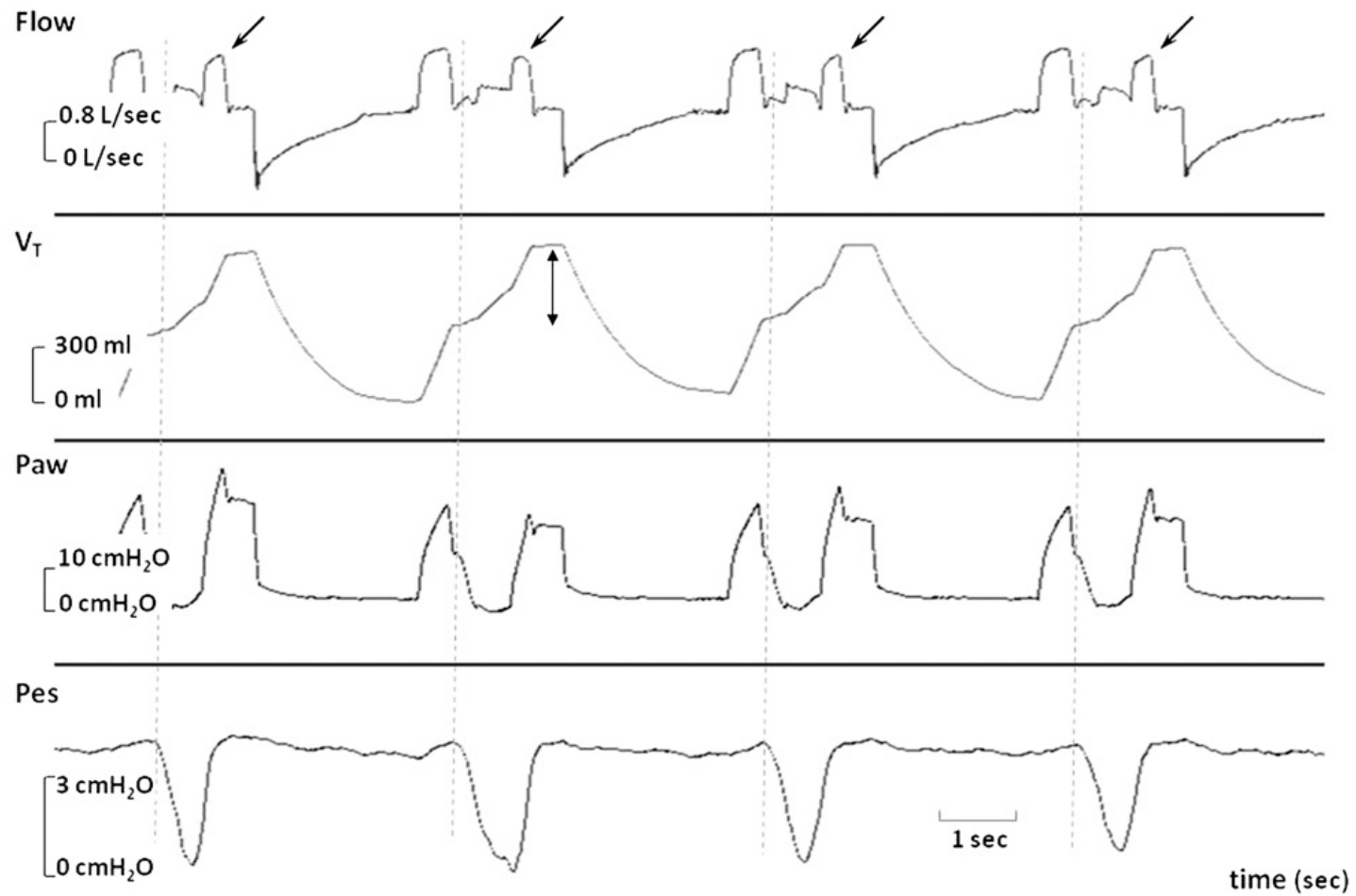
PTPi
(basada en el
método derivado de
la elastancia)

PTPe
(basada en el
método derivado del
valor absoluto)

THE APPLICATION OF ESOPHAGEAL PRESSURE MEASUREMENT IN PATIENTS WITH RESPIRATORY FAILURE.

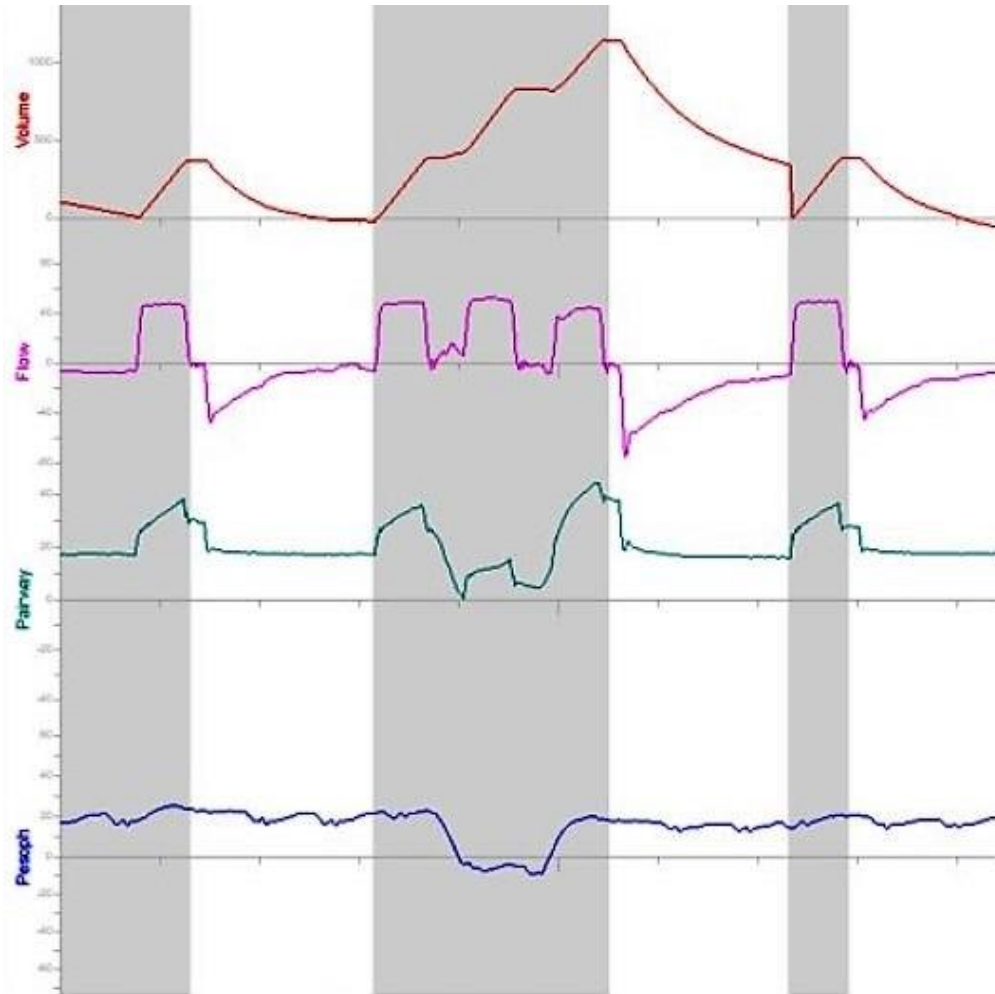


Mechanical Ventilation-Induced Reverse-Triggered Breaths



Sincronía P-V

Trigger reverso



VT programado 350 ml

PEEP 18 cmH2O

VT acumulado 1050 ml

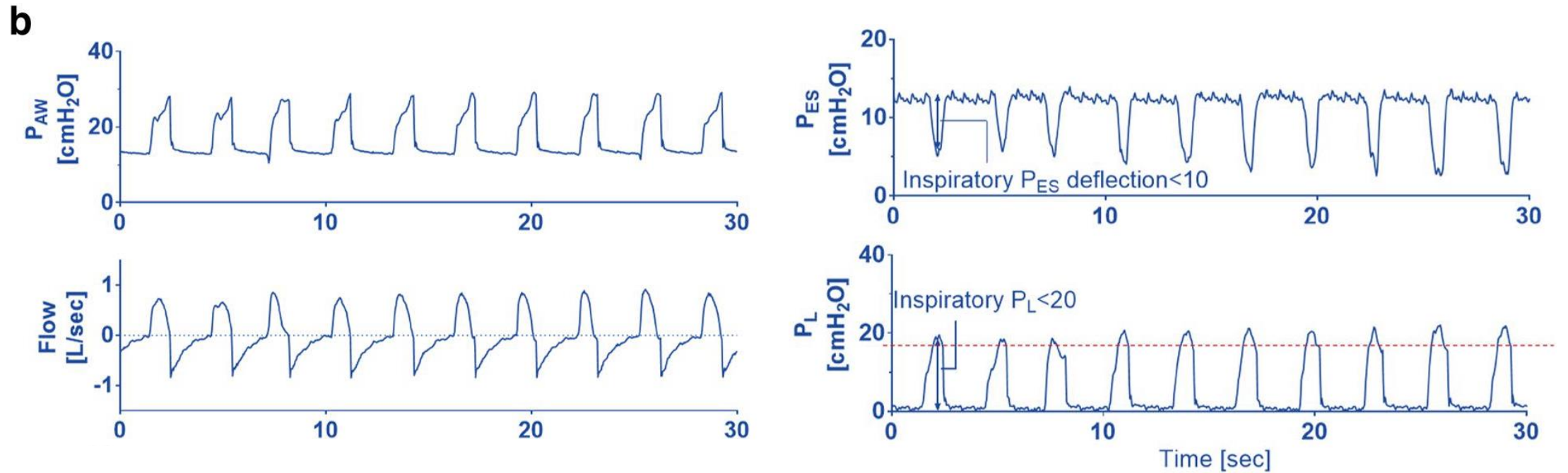
Pplateau 38 cmH2O

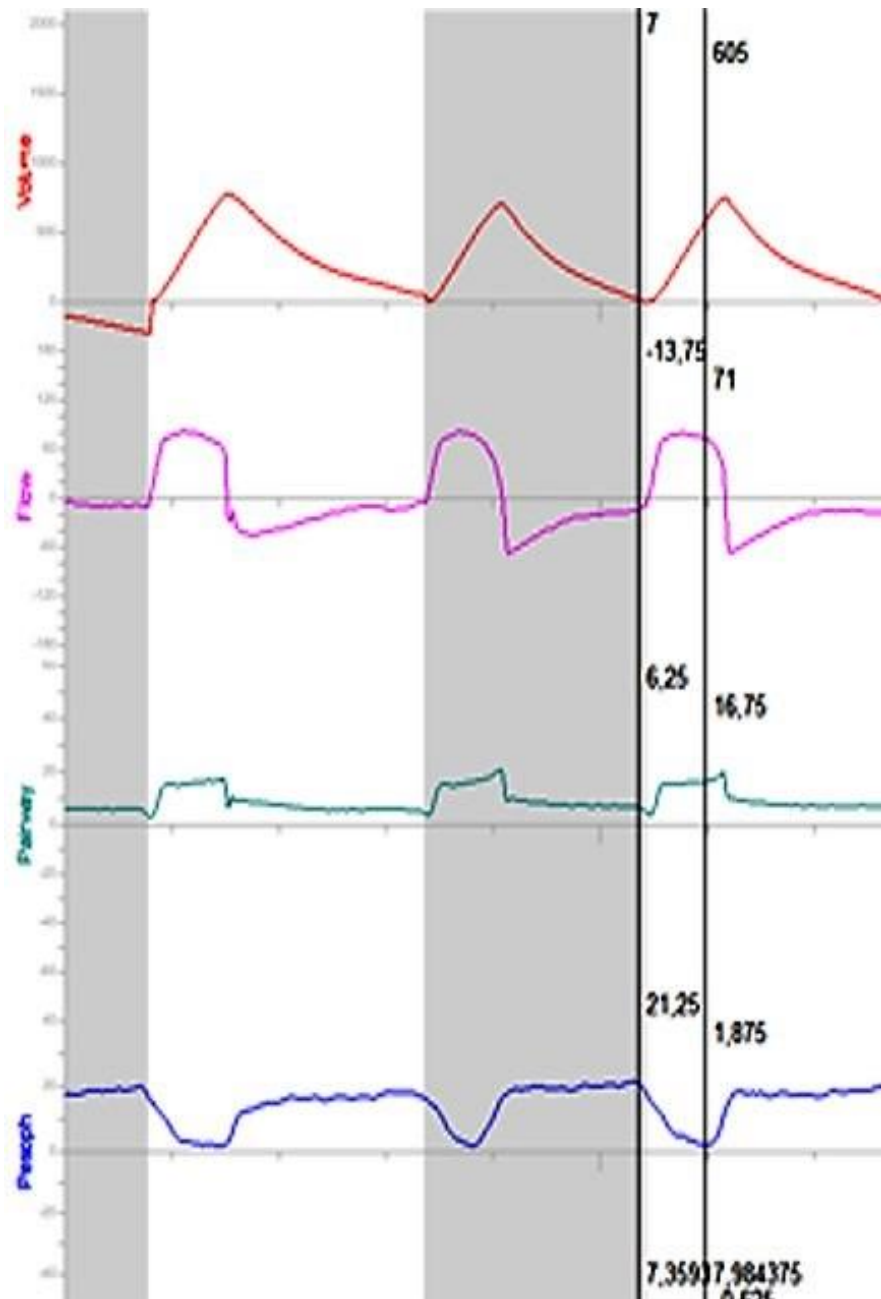
ΔP_{aw} 20 cmH2O

ΔP_{es} -35 cmH2O

ΔP_{tp} 28 cmH2O

Esfuerzo muscular y presión transpulmonar





PSV 10 PEEP 6
FR 25
VT 650 (10 ml/kg)

Δ Pes 20

Δ Ptp 30

Conclusiones.

- La pandemia de COVID 19 nos desafía a tener que manejar numerosos pacientes con insuficiencia respiratoria severa.
- La utilización correcta de los conceptos básicos de la VM protectora es de fundamental importancia.
- En los casos más complejos, el ajuste individualizado de la VM podría adaptarla mejor a la fisiología de cada paciente.
- Para ello puede ser necesario el uso de herramientas o maniobras de monitoreo adicionales a las que utilizamos en la práctica cotidiana.

Muchas gracias por su atención.

Ventilación Mecánica en Prono:

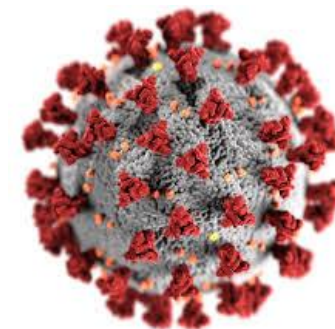
Fundamentos y Manejo en COVID-19

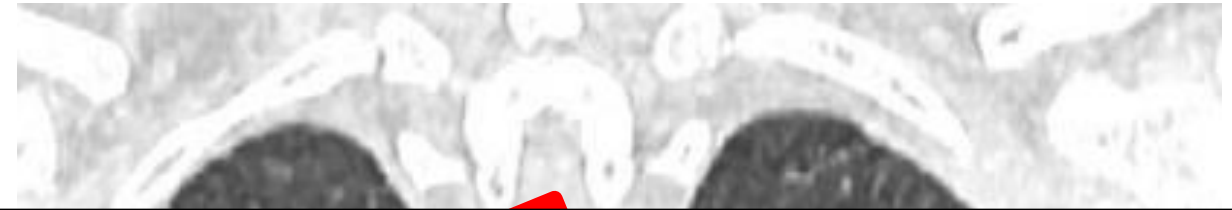
Dr. Rodrigo Cornejo

Jefe Unidad de Pacientes Críticos

Hospital Clínico Universidad de Chile

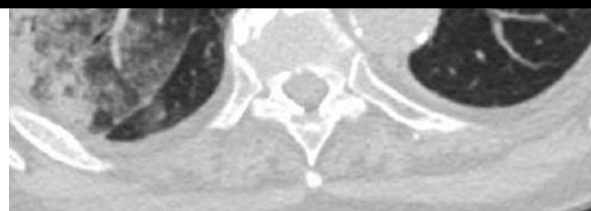
Abril 2020





Findings and manifestations of chest CT

Consistent with viral pneumonia (positive)	888 (88)
Ground-glass opacity	409/888 (46)
Consolidation	447/888 (50)
Reticulation/thickened interlobular septa	8/888 (1)
Nodular lesions	24/888 (3)
No CT findings of viral pneumonia	126 (12)



Manejo de Falla Respiratoria en COVID-19

Según Fenotipos L y H

(Gattinoni L. et al. *Am J Respir Crit Care Med* 2020 10.1164/rccm.202003-0817LE)



Low elastance
Low V/Q
Low lung weight
Low recruitment

COVID-19 Pneumonitis (L)

- VM Protectora
- PRONE responsive
- INO – ILOPROST ?



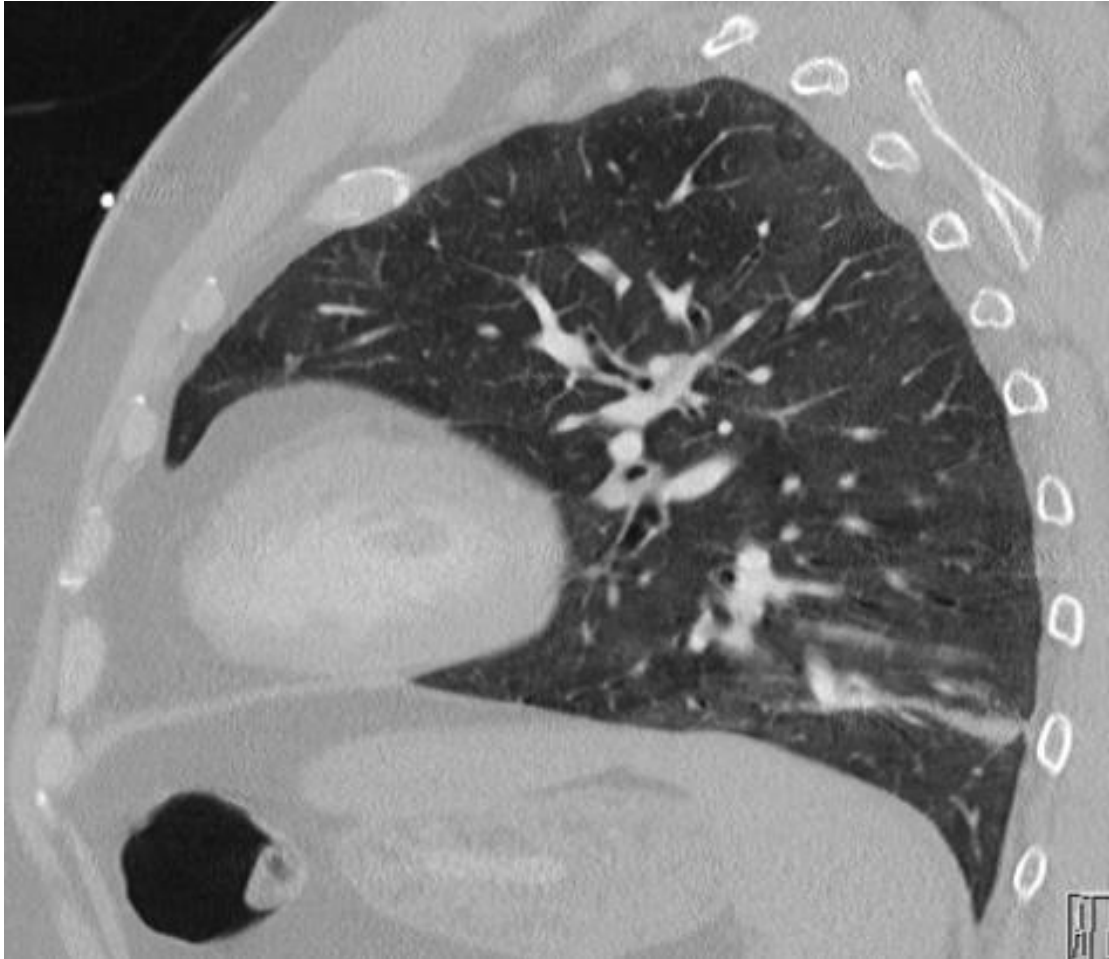
High elastance
High shunt
High lung weight
High recruitment

ADRS-like Phenotype (H)

- VM Protectora
- PEEP responsive
- PRONE responsive



COMPATIBLE CON FENOTIPO L



Pulmón Izquierdo

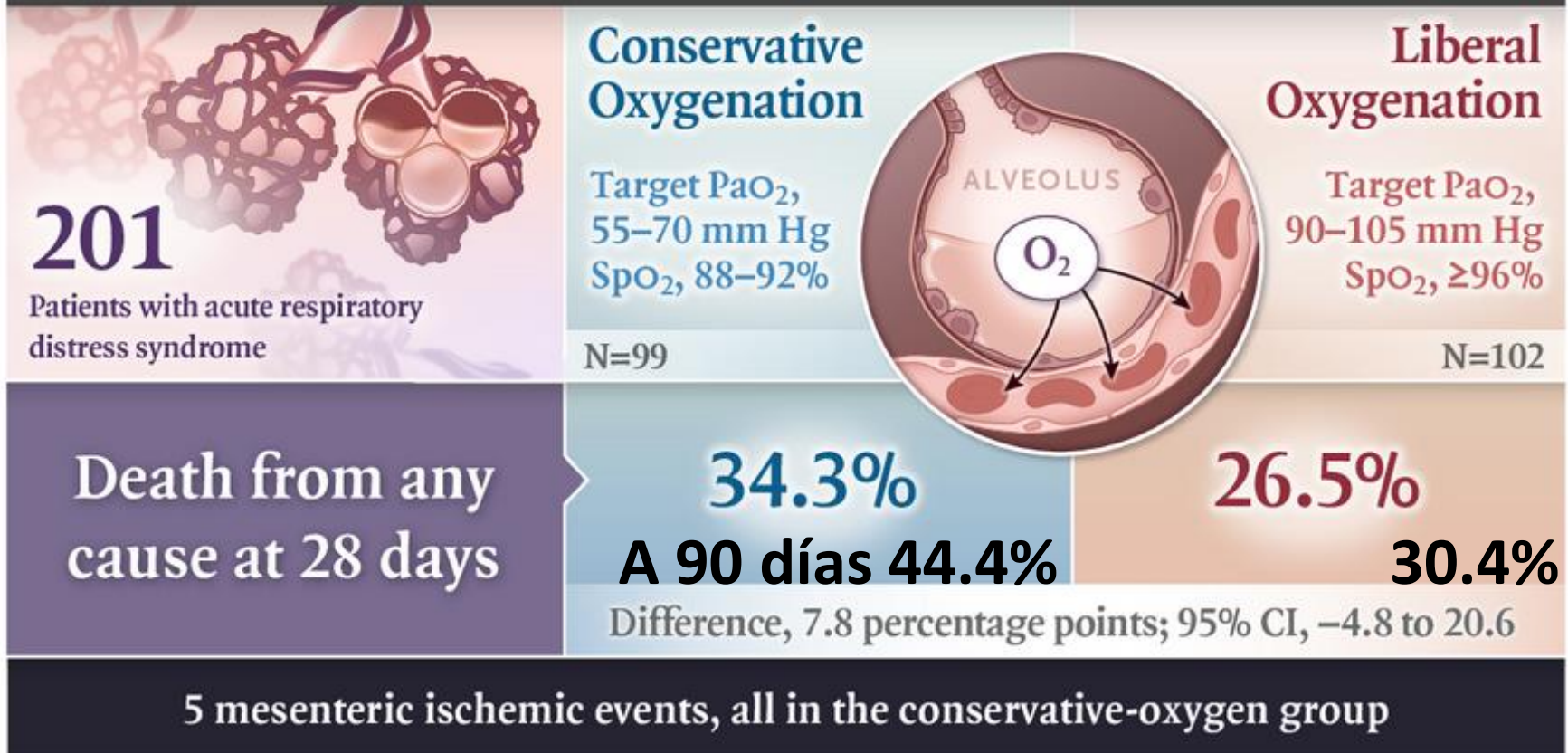
COMPATIBLE CON FENOTIPO H



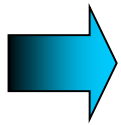
Pulmón Derecho

Oxygen Therapy in ARDS

MULTICENTER, RANDOMIZED TRIAL STOPPED EARLY FOR FUTILITY AND SAFETY CONCERNS



Ventilación en posición prono



Mecanismos que podrían explicar la mejoría de la oxigenación



Efecto de la ventilación en prono en protección del VILI



Estudios Clínicos y Experiencia local



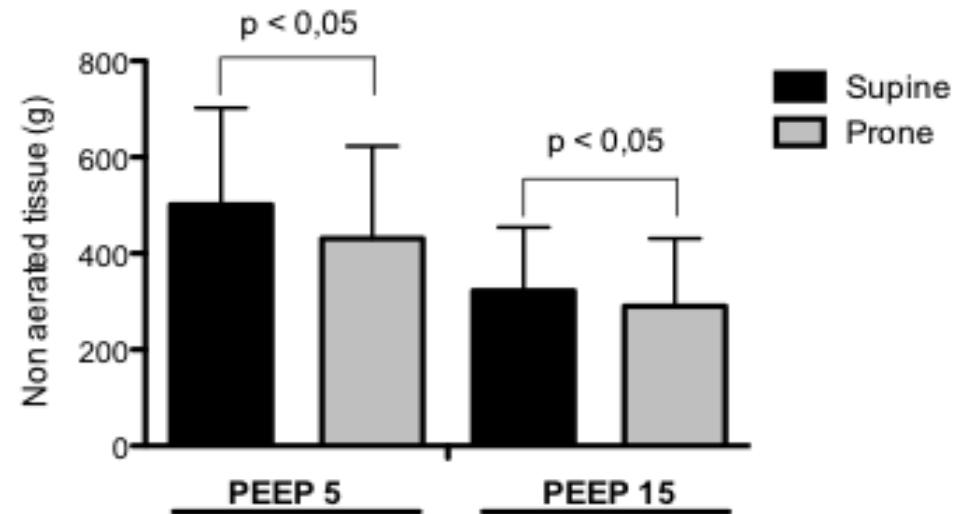
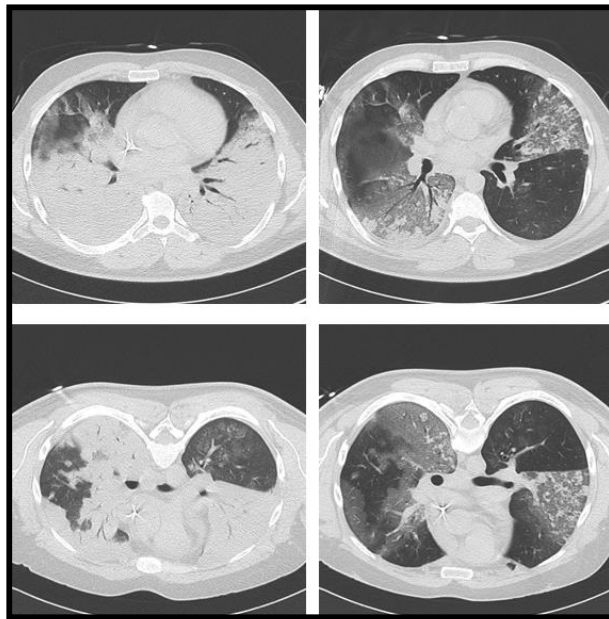
Sugerencias



Effects of Prone Positioning on Lung Protection in Patients with Acute Respiratory Distress Syndrome

Rodrigo A. Cornejo¹, Juan C. Díaz², Eduardo A. Tobar¹, Alejandro R. Bruhn³, Cristobal A. Ramos², Roberto A. González¹, Claudia A. Repetto¹, Carlos M. Romero¹, Luis R. Gálvez¹, Osvaldo Llanos¹, Daniel H. Arellano¹, Wilson R. Neira¹, Gonzalo A. Díaz¹, Aníbal J. Zamorano¹, and Gonzalo L. Pereira²

¹Unidad de Pacientes Críticos, Departamento de Medicina, Hospital Clínico Universidad de Chile; ²Departamento de Radiología, Hospital Clínico Universidad de Chile, Santiago, Chile; and ³Departamento de Medicina Intensiva, Facultad de Medicina, Pontificia Universidad Católica de Chile, Santiago, Chile

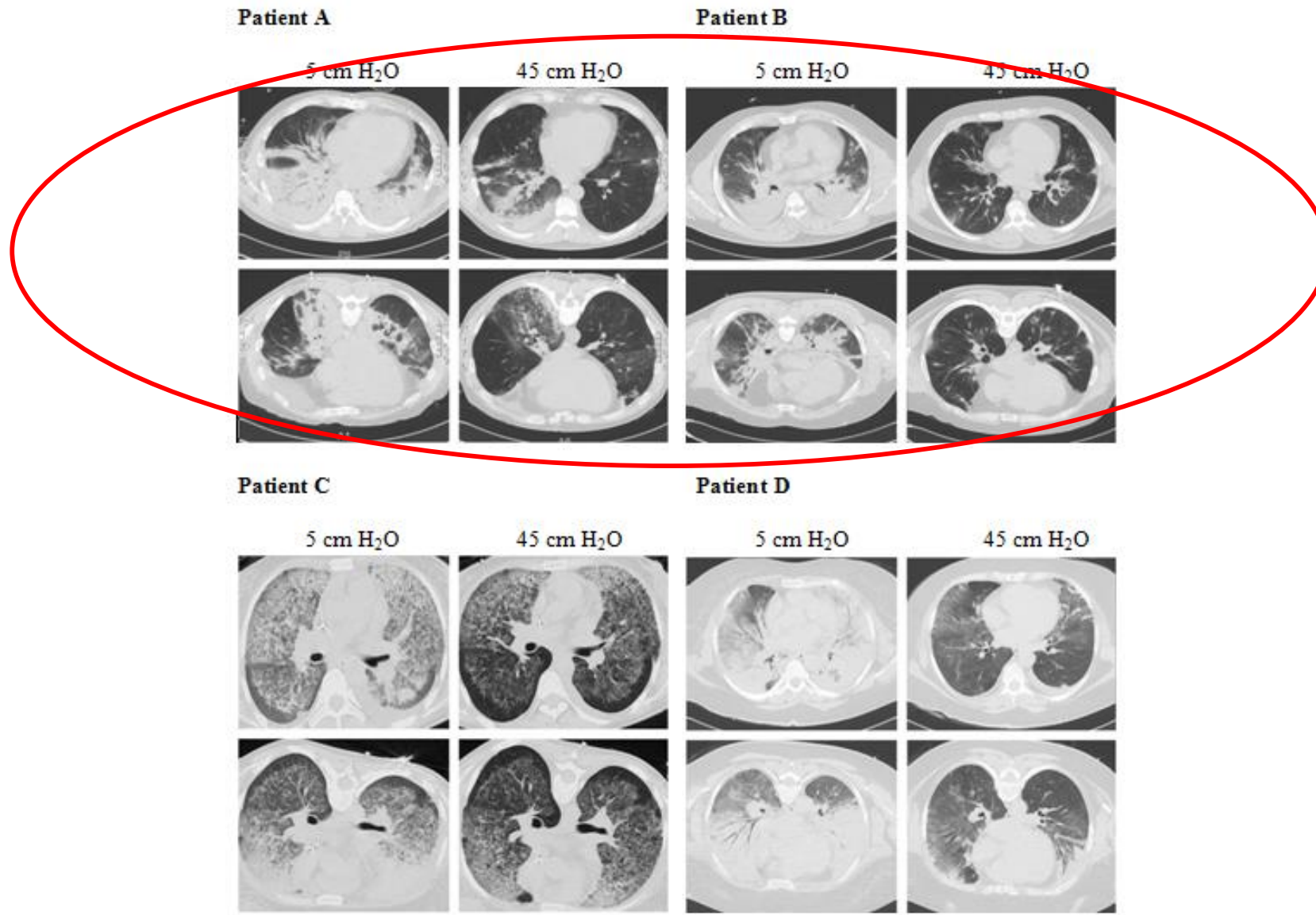


24 pacientes SDRA
P/F 149 ± 44 mmHg

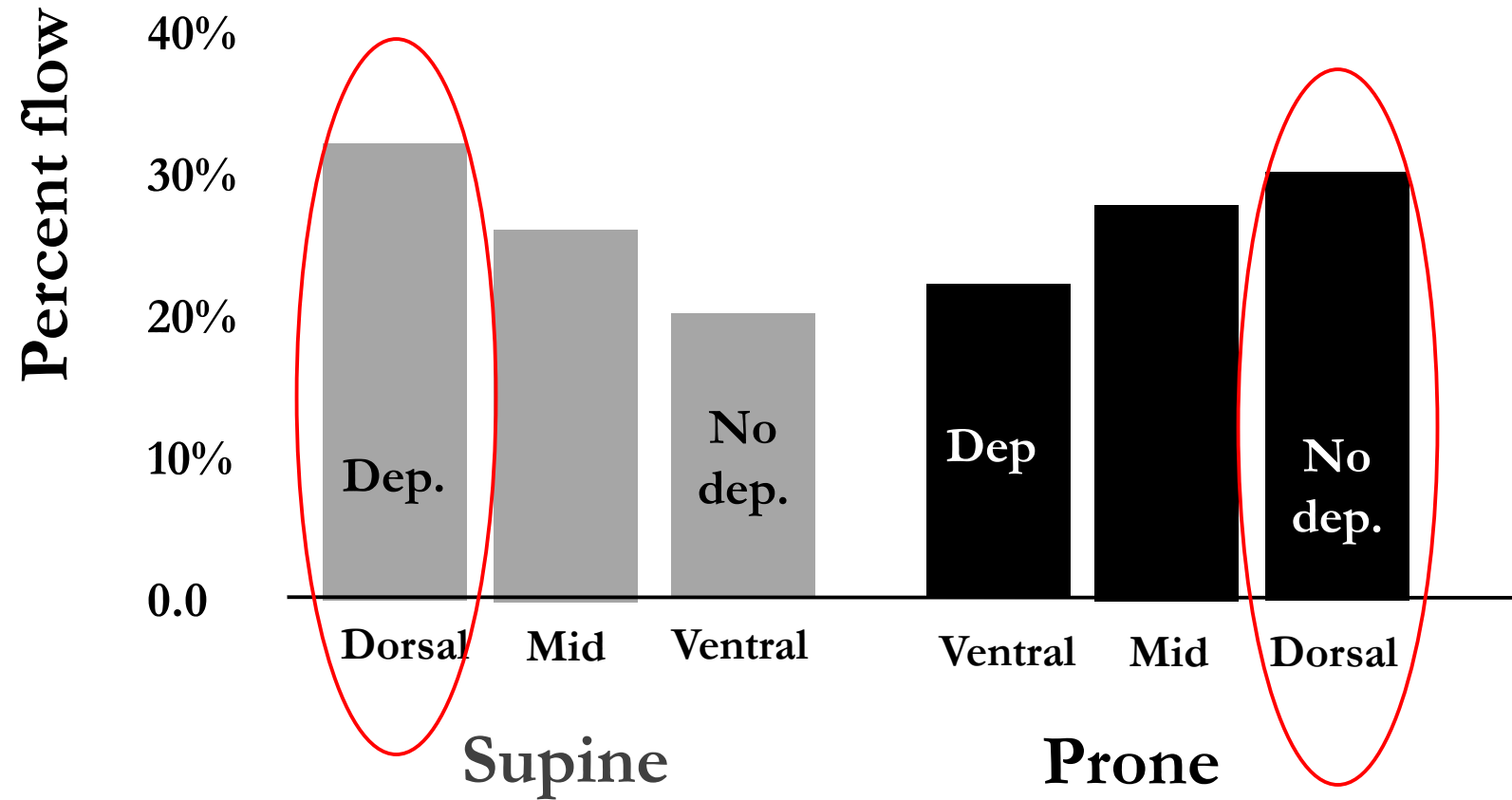
CT Pattern:
-14 Patchy
-6 Diffuse
-4 Lobar

		SUPINE 5	SUPINE 15	PRONE 5	PRONE 15
total lung volume	[ml]	2140 ± 643	3271 ± 900	2240 ± 614	3268 ± 821
total lung weight	[g]	1201 ± 307	1282 ± 316	1216 ± 341	1261 ± 321
volume of non-aerated compartment	[ml]	503 ± 201	324 ± 133*	431 ± 193‡	291 ± 143† §
weight of non-aerated tissue	[g]	501 ± 201	322 ± 132*	431 ± 192‡	290 ± 141† §
volume of poorly-aerated compartment	[ml]	623 ± 210	753 ± 314	657 ± 207	724 ± 289
weight of poorly-aerated tissue	[g]	446 ± 149	517 ± 216	467 ± 157	497 ± 203
volume of well-aerated compartment	[ml]	872 ± 406	1767 ± 661*	1027 ± 456‡	1893 ± 617†
weight of well-aerated tissue	[g]	254 ± 103	485 ± 148*	324 ± 148‡	535 ± 152†
volume of hyperinflated compartment	[ml]	144 ± 160	434 ± 318*	125 ± 105	362 ± 220† §
weight of hyperinflated tissue	[g]	5,6 ± 6	19 ± 15*	4,4 ± 4	14 ± 8†

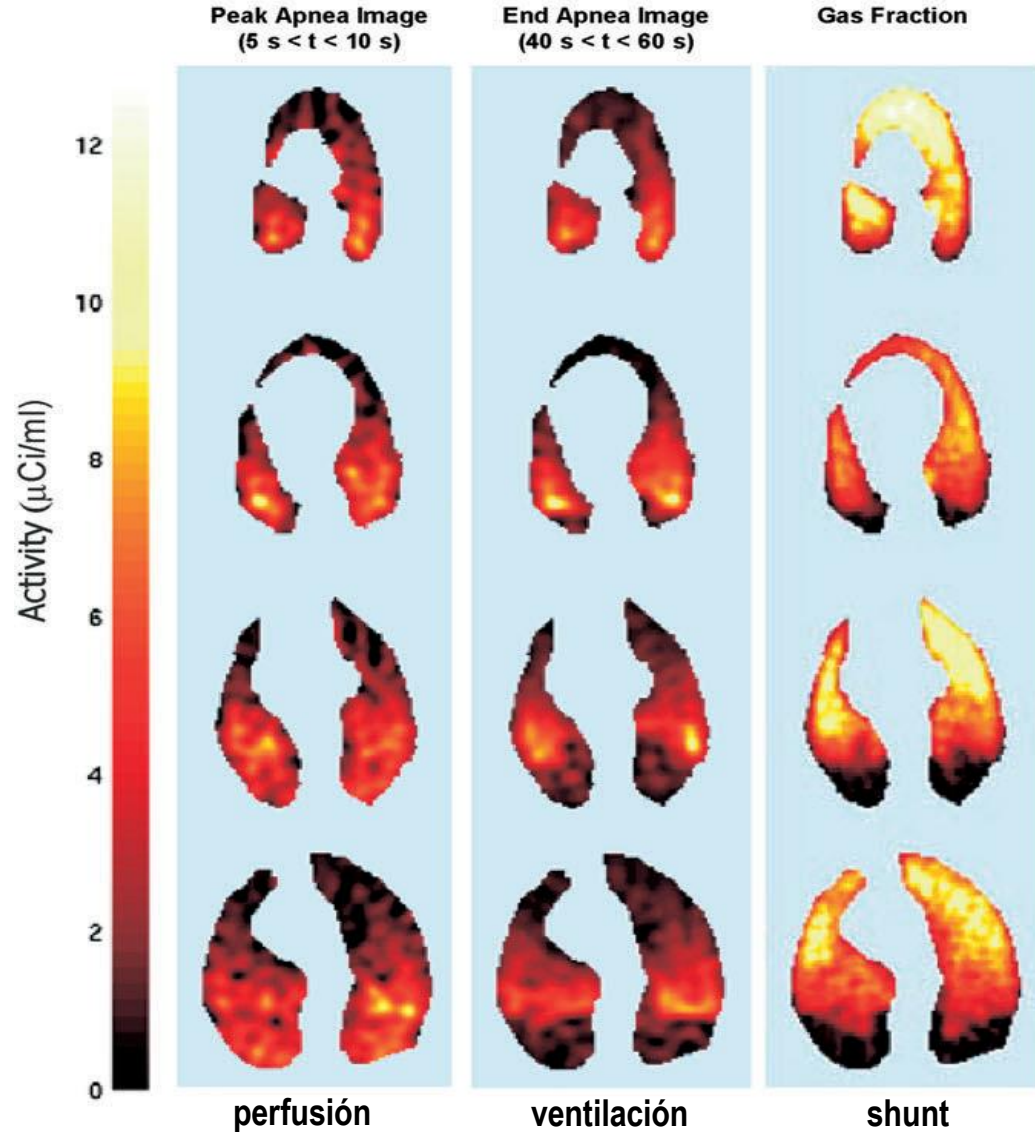
*P<0.05, between supine 5 and supine 15 cmH₂O; †P<0.05, between prone 5 and prone 15 cmH₂O
‡ P<0.05, between supine 5 and prone 5 cmH₂O; § P<0.05, between supine 15 and prone 15 cmH₂O



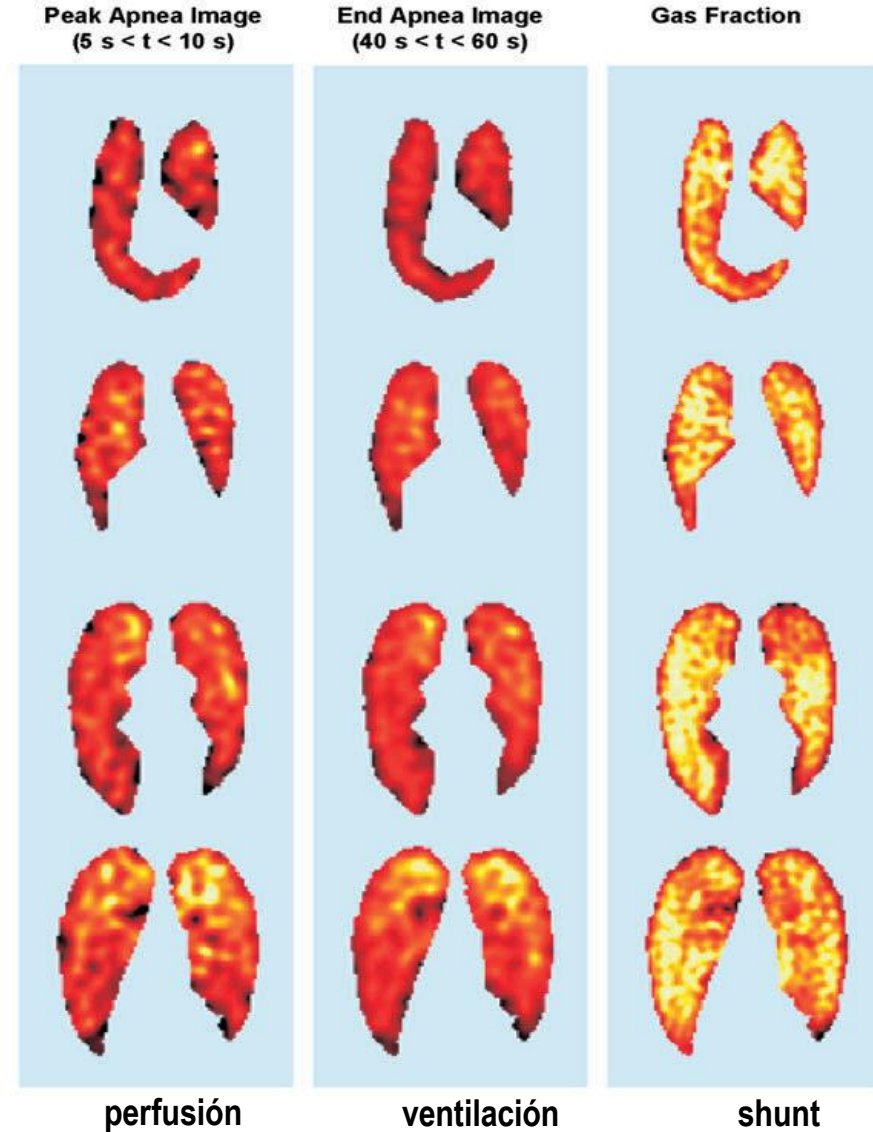
Perfusión en supino y prono



Supine Position



Prone Position

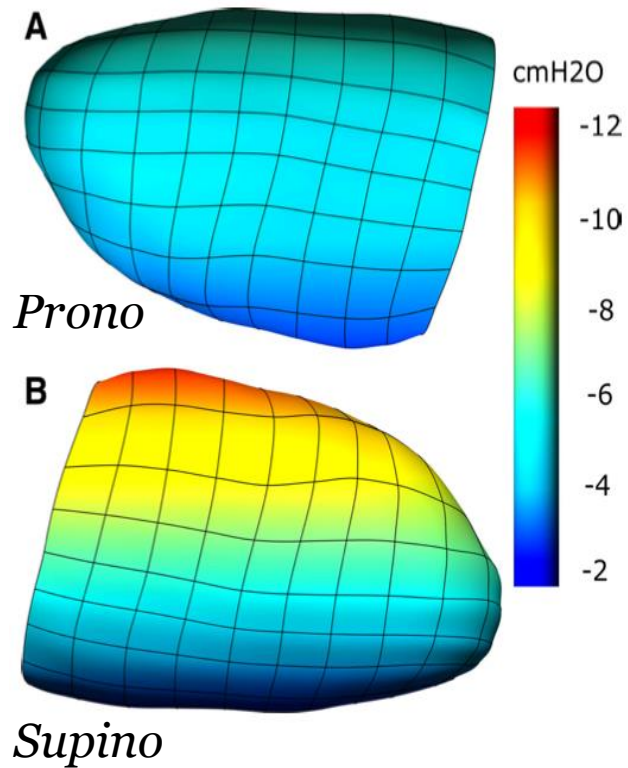


La Ventilación en Prono atenúa el VILI

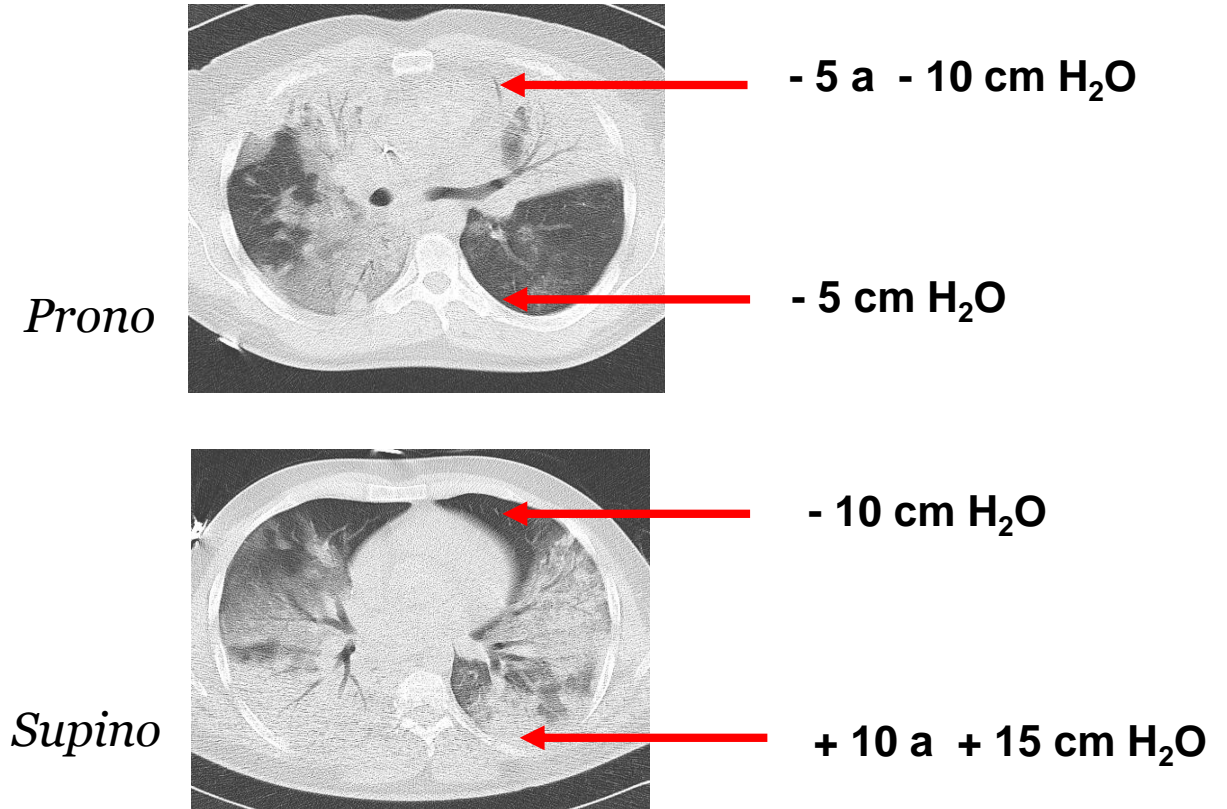
- Efectos del prono sobre la heterogeneidad
- Efectos del prono sobre los fenómenos cíclicos
- Efecto del prono sobre deformación estática inducida por PEEP

Gradientes de presión pleural en supino y prono

Normal lungs

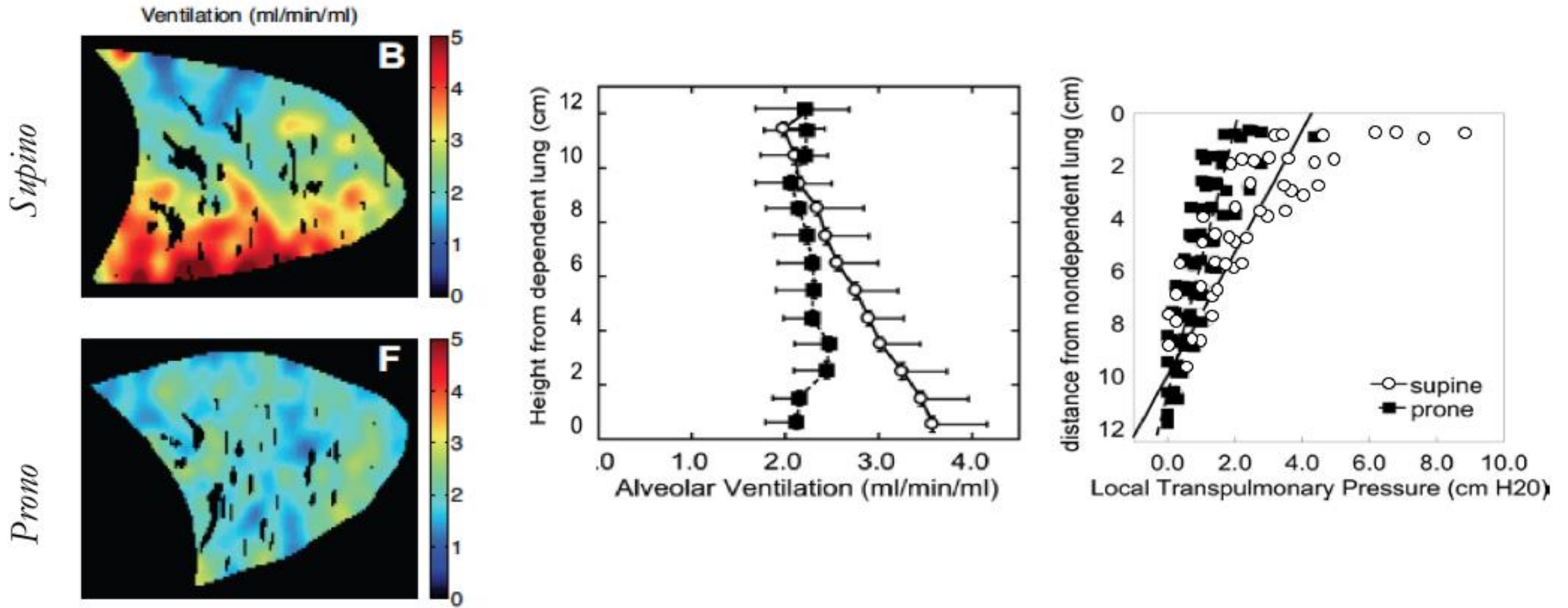


ARDS lungs

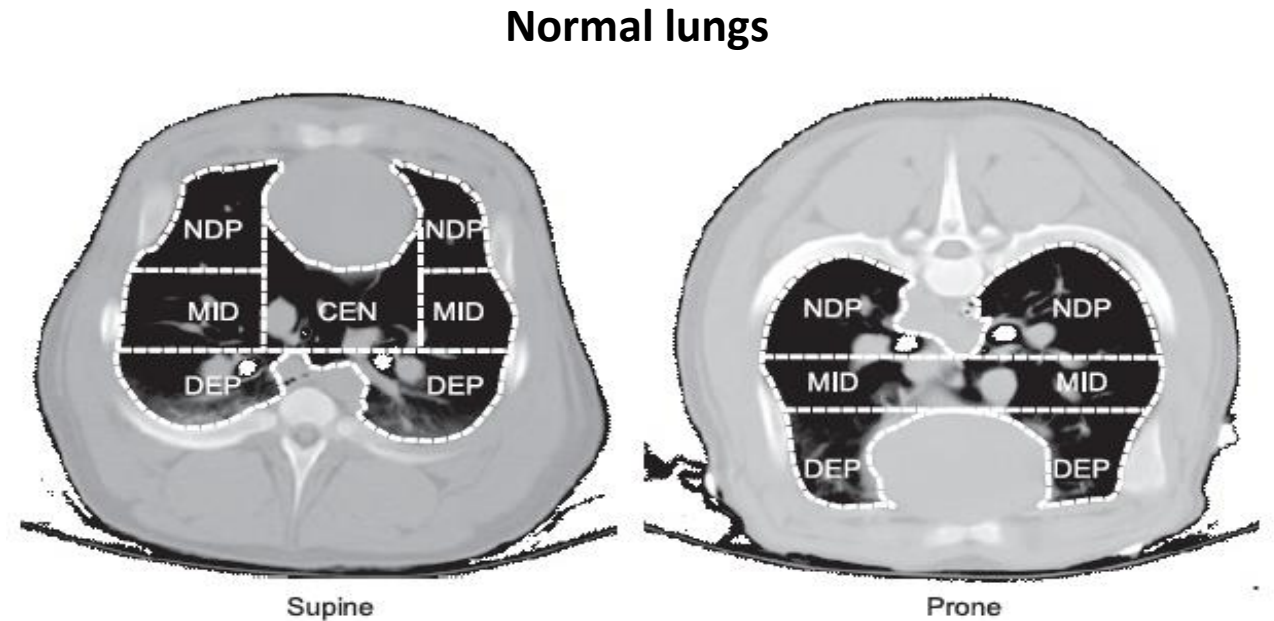
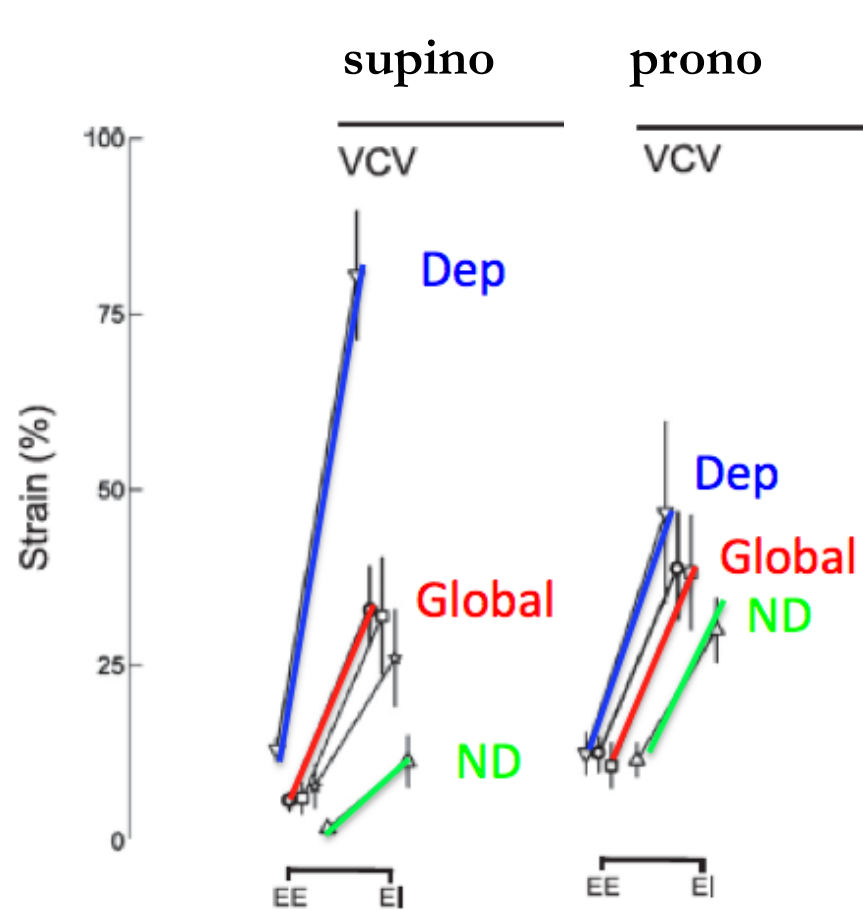


Efectos del prono sobre la heterogeneidad

Normal lungs

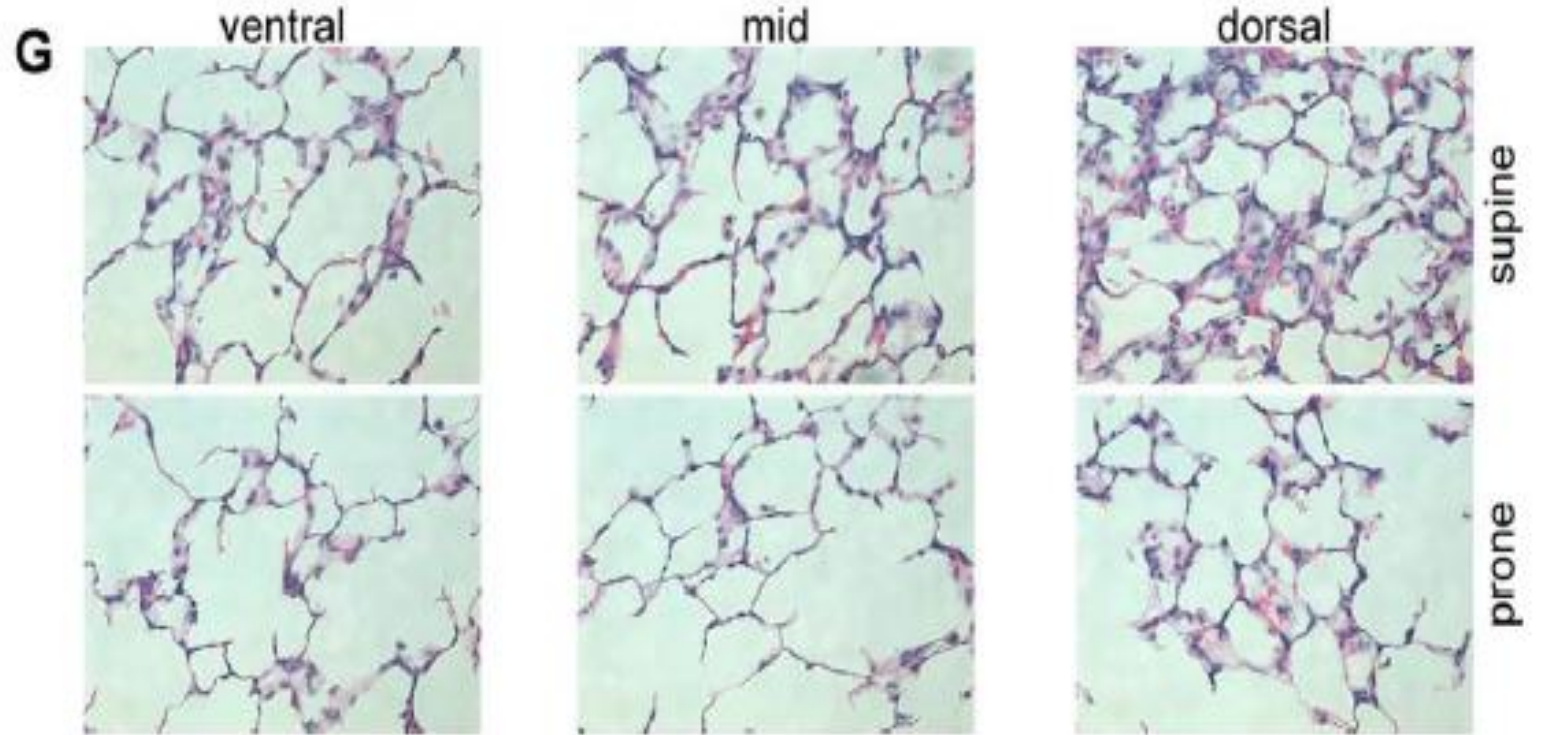
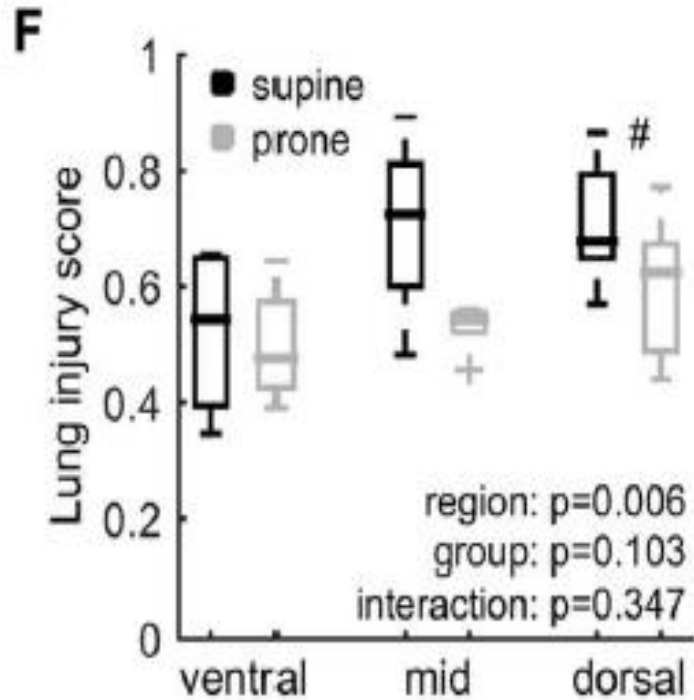


Strain cíclico en supino versus prono



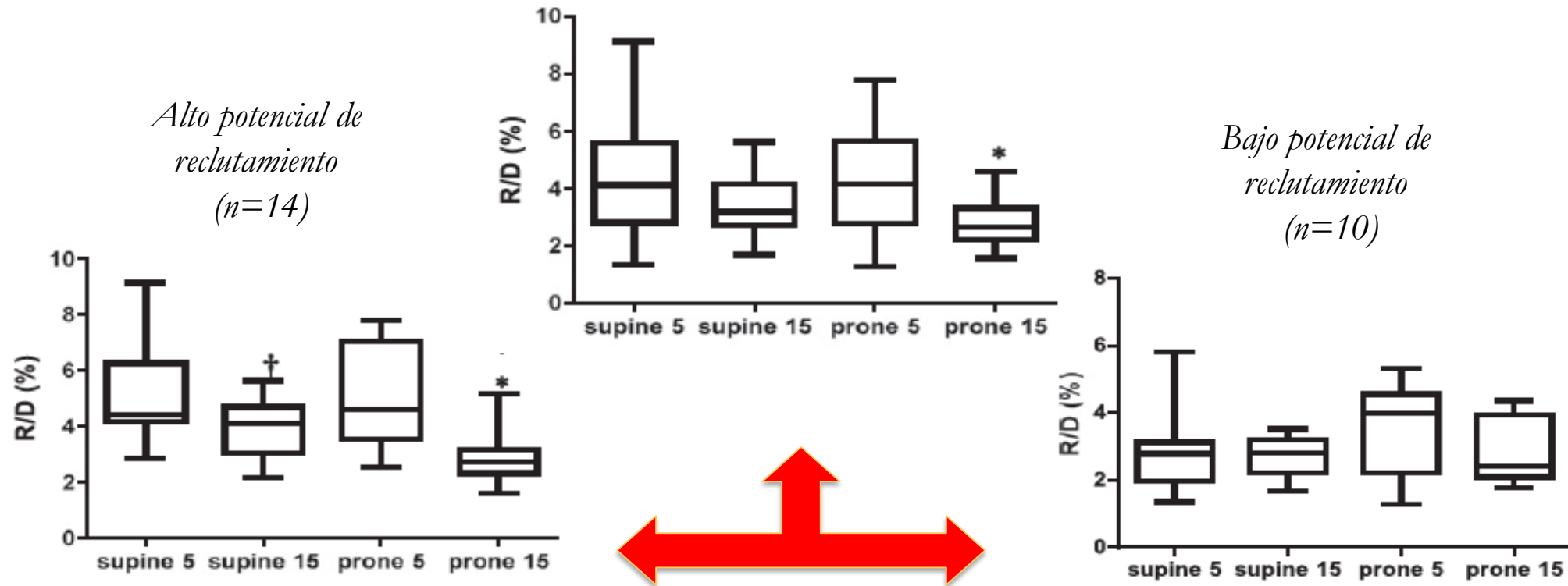
Evolución de *Strain* regional e Inflamación en supino y prono (ARDSnet protocol)

Normal lungs + Endotoxin



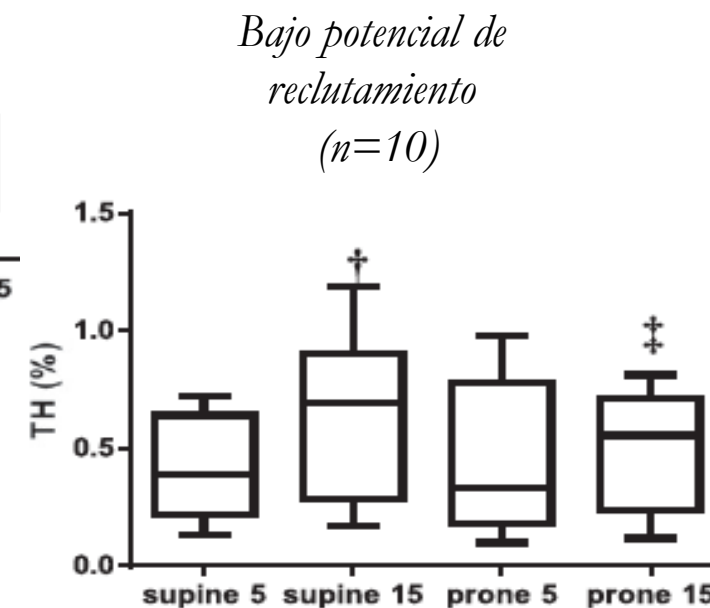
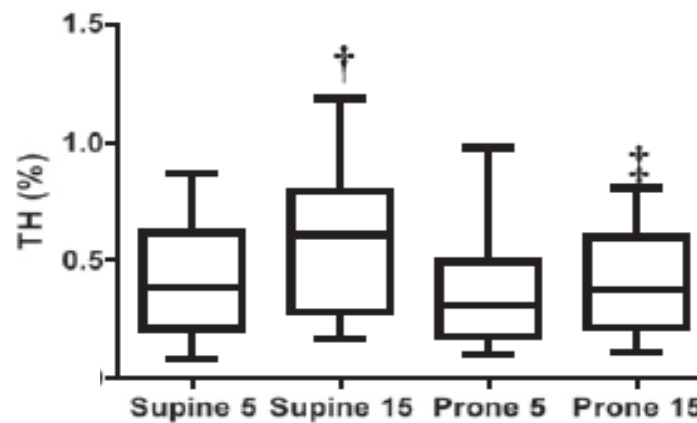
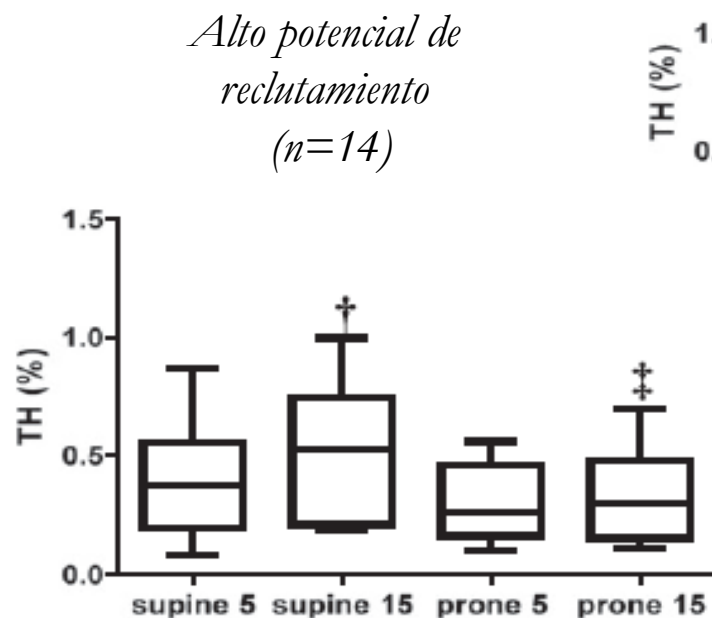
Prono y reclutamiento cíclico

Pacientes con SDR
Grupo total (n=24)



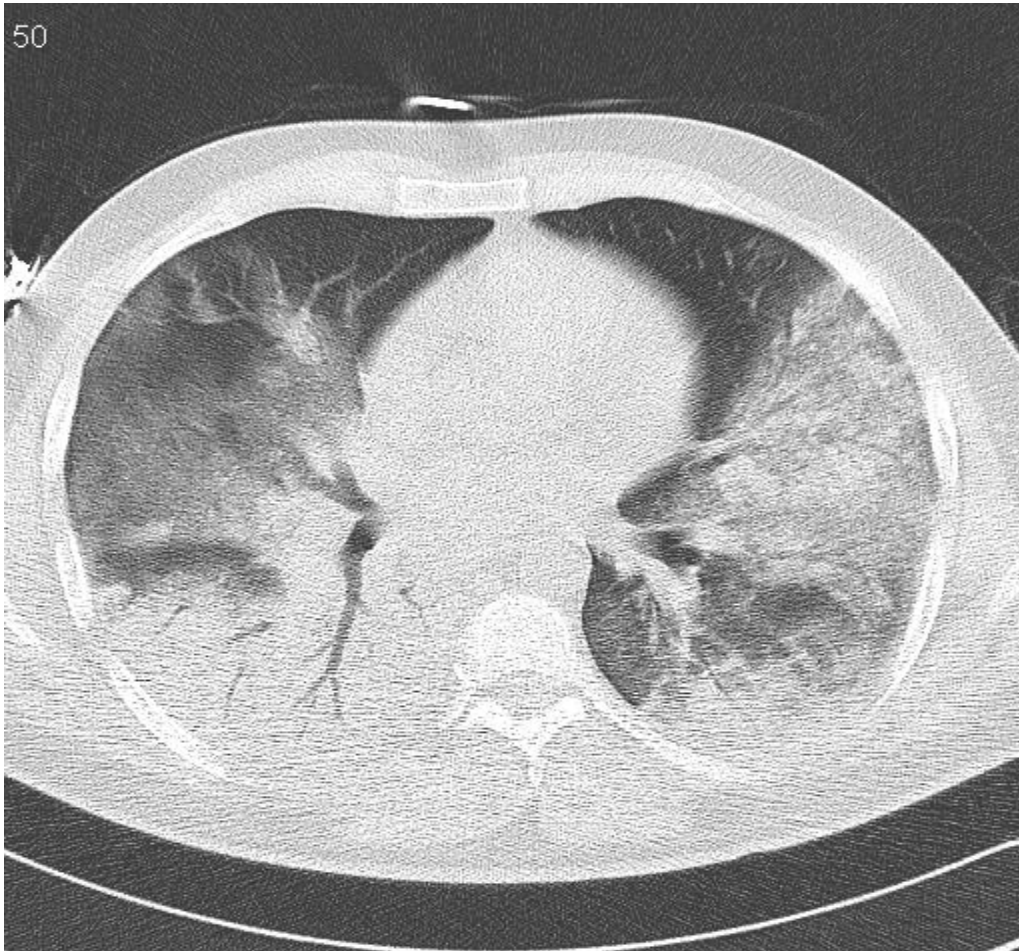
Prono e hiperinflación cíclica

Pacientes con SDRA
Grupo total (n=24)

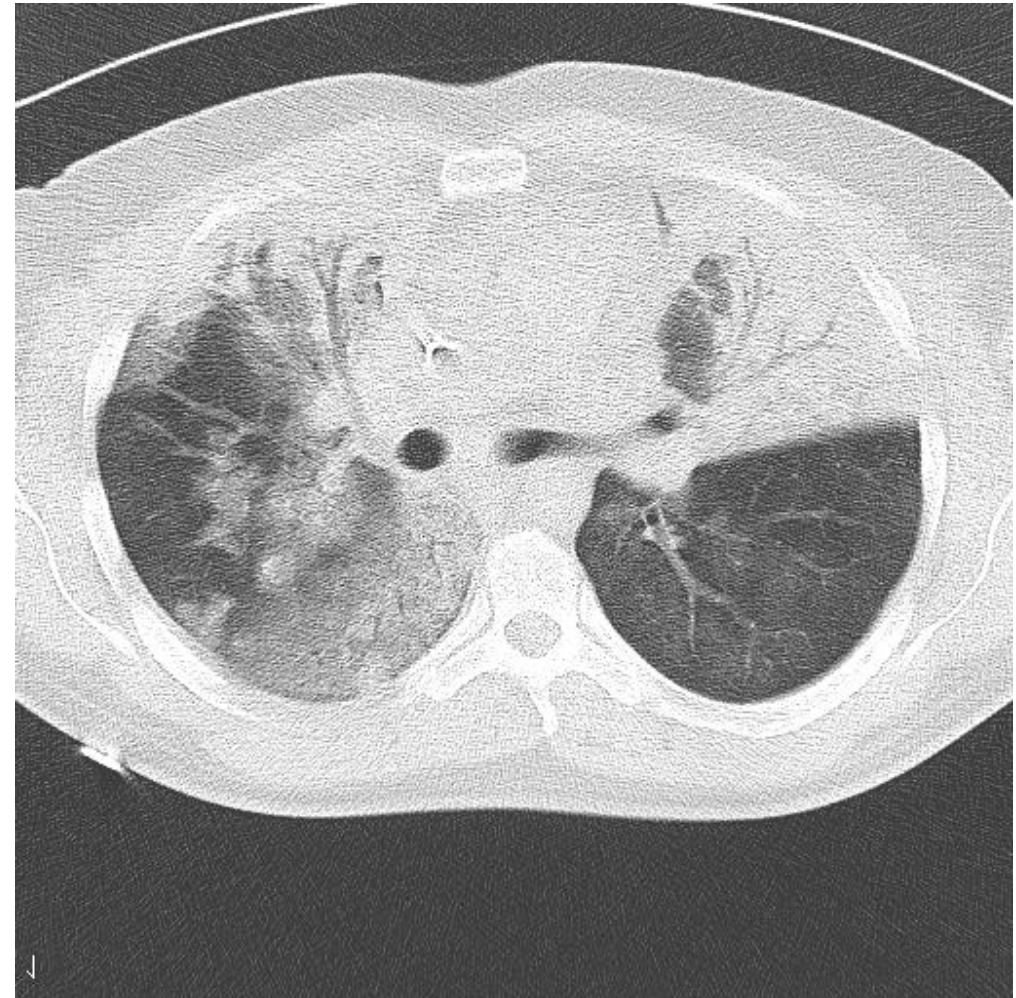


Alto potencial de reclutamiento supino vs prono

PEEP 15 cmH₂O



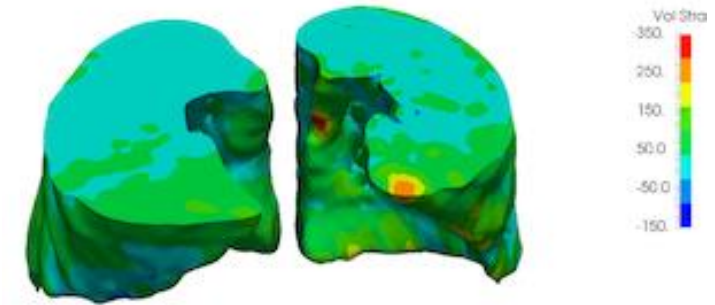
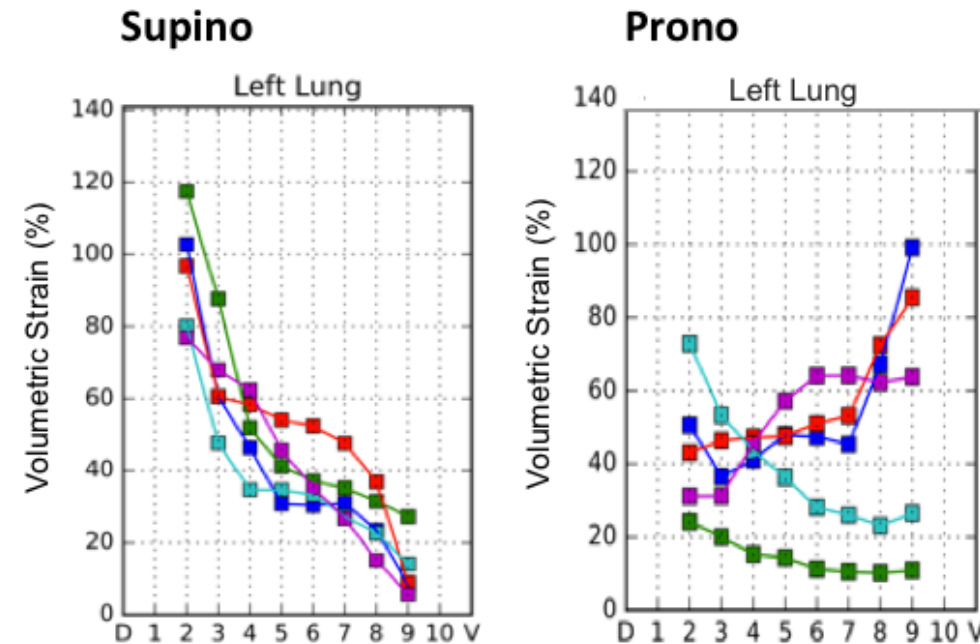
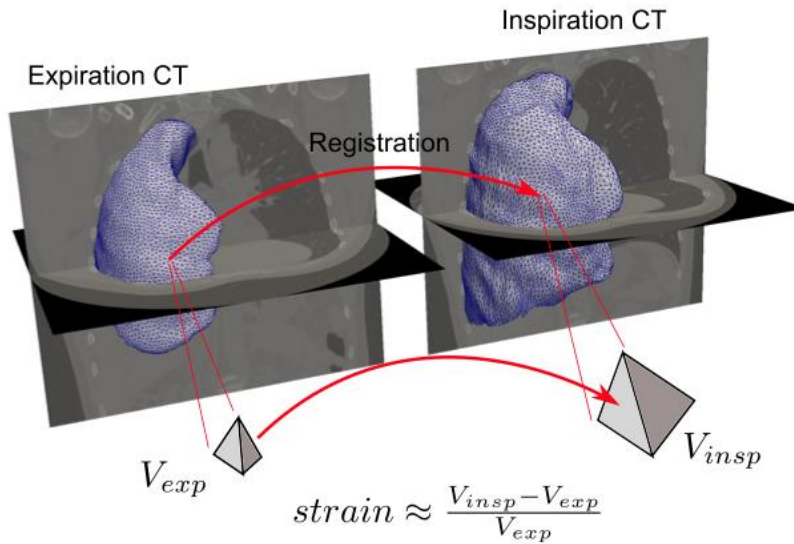
PEEP 15 cmH₂O



Efecto de prono en el *strain* estático regional inducido por el cambio de PEEP 5 a 15 en pacientes con SDRA

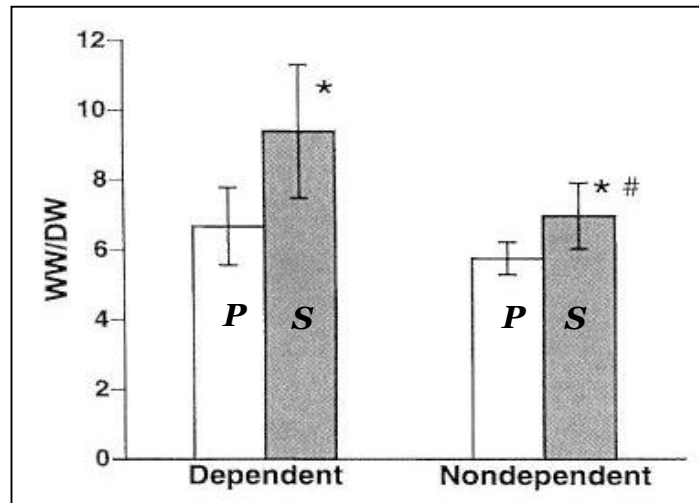
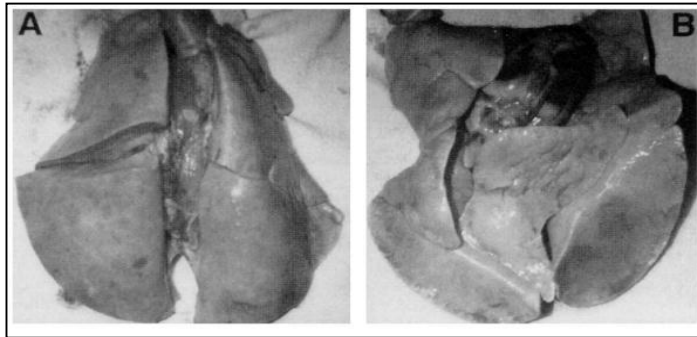
Strain estático global $44 \pm 20\%$ en supino versus $41 \pm 12\%$ en prono $p = ns$

Gradiente de *strain* entre región dorsal y ventral fue menor en prono ($33 \pm 23\%$ versus $48 \pm 20\%$, $p=0,049$)

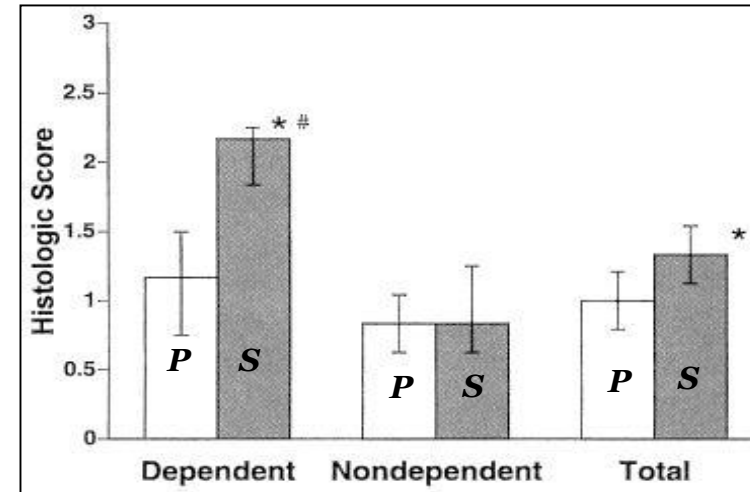
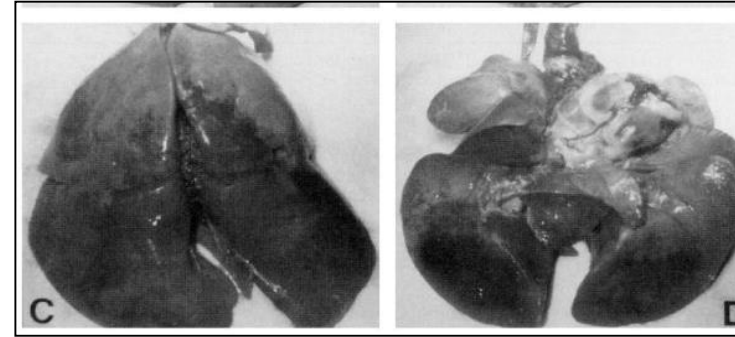


Efecto de prono en modelo de VILI

Prono

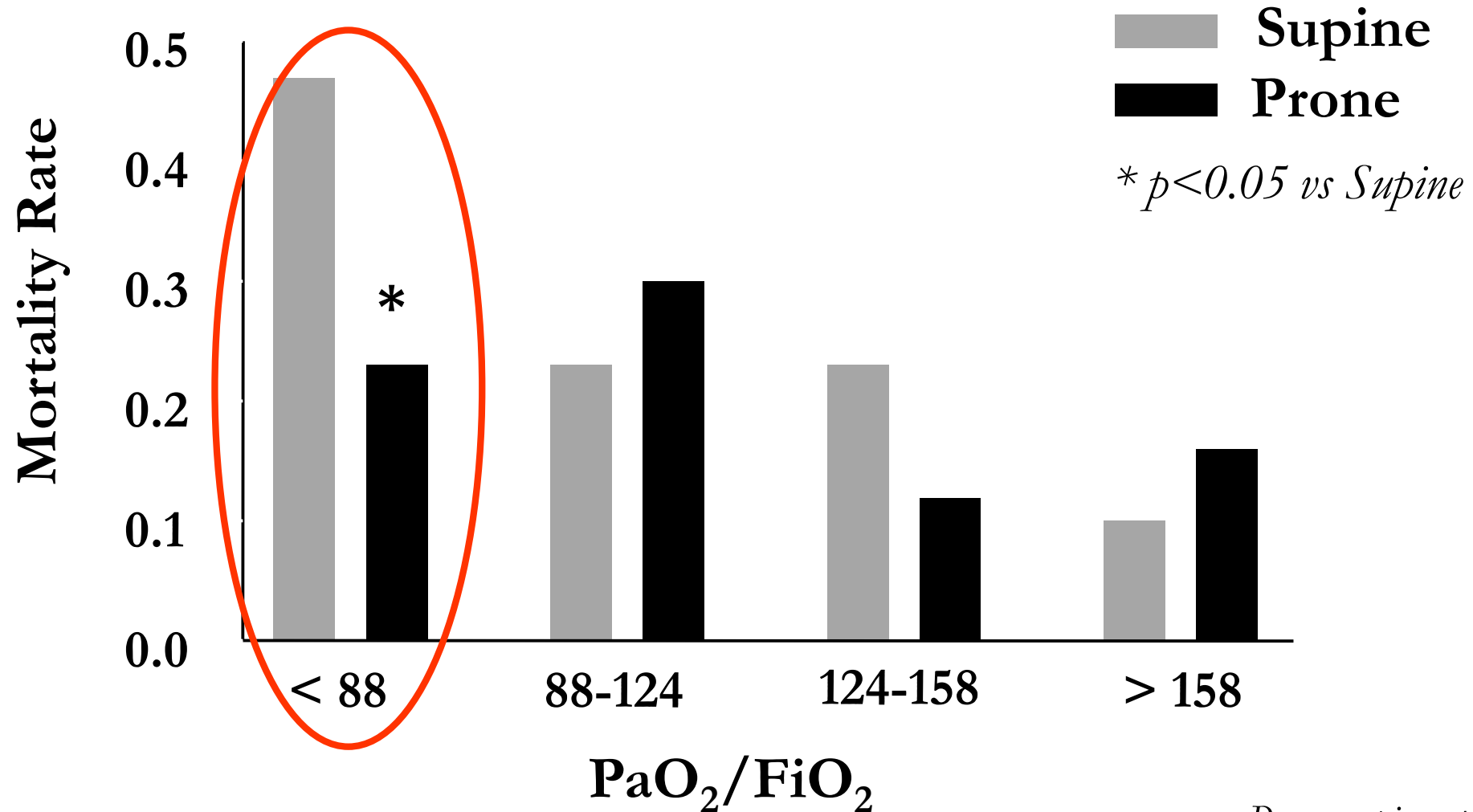


Supino



Evidencia clínica a favor del rol
protector del pronóstico

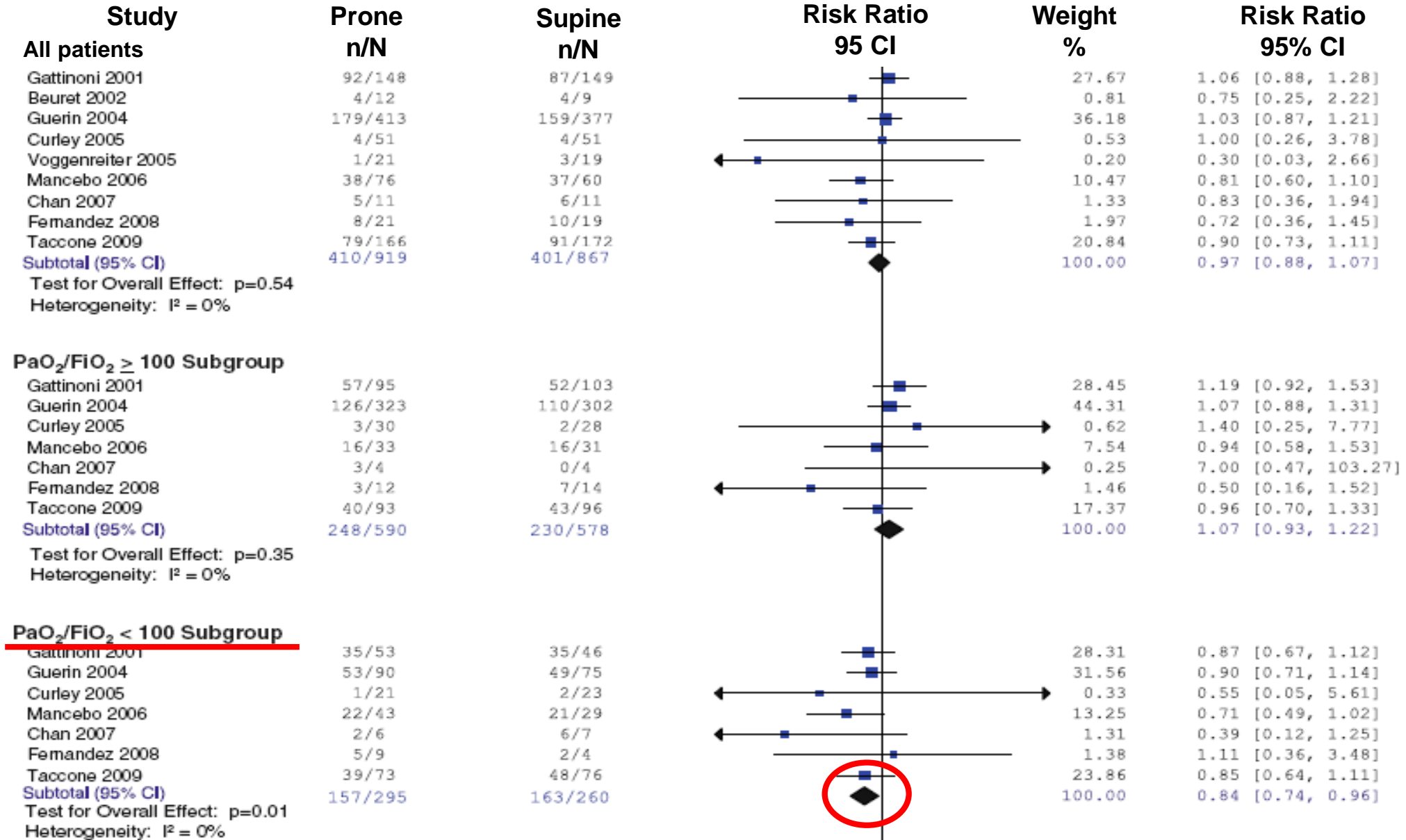
Efecto de la ventilación en prono según nivel de hipoxemia



Prone-supine study

Mortalidad

ojo



Sud S, et al. Intensive Care Med. 2010 Feb 4. [Epub ahead of print]

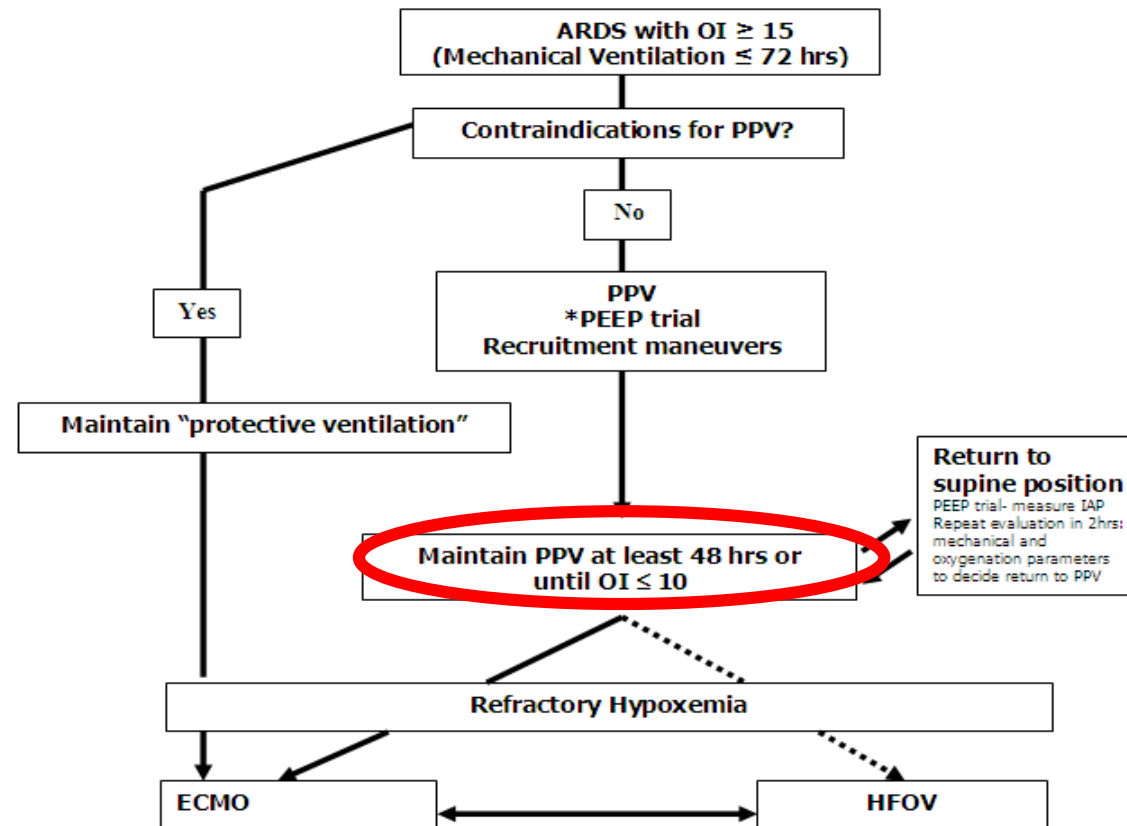
Adverse Events

	Trials (patients, events)	Treatment effect		Heterogeneity I^2 (%)
		Risk ratio [95% CI]	p -Value	
Ventilator-associated pneumonia	7 (1,066, 242)	0.81 [0.67, 1.00]	0.05	0
Pressure ulcers	6 (1,279, 620)	1.29 [1.16, 1.44]	<0.00001	0
Endotracheal tube obstruction	7 (1,351, 184)	1.58 [1.24, 2.01]	<0.001	0
Unplanned extubation or endotracheal tube dislodgement ^a	10 (1,813, 155)	1.07 [0.69, 1.65]	0.77	25
Unplanned removal of central or arterial lines	8 (886, 59)	1.49 [0.42, 5.27]	0.54	67
Thoracostomy tube dislodgement	8 (886, 17)	3.14 [1.02, 9.69]	0.05	0
Pneumothorax	7 (1,167, 67)	0.75 [0.47, 1.20]	0.23	0
Cardiac arrests	7 (1,031, 164)	0.96 [0.73, 1.26]	0.77	Not applicable ^b

Extended prone position ventilation in severe acute respiratory distress syndrome: A pilot feasibility study

Carlos M. Romero^{a,*}, Rodrigo A. Cornejo^a, L. Ricardo Gálvez^a,
Osvaldo P. Llanos^a, Eduardo A. Tobar^a, M. Angélica Berasaín^b,
Daniel H. Arellano^c, Jorge F. Larrondo^d, José S. Castro^a

J Crit Care. 2009 Mar;24(1):81-8. Epub 2008 May 14.



Systematic approach for severe respiratory failure due to novel A (H1N1) influenza

R. CORNEJO ¹, E. TOBAR ¹, G. DÍAZ ¹, C. ROMERO ¹, O. LLANOS ¹, L. R. GÁLVEZ ¹,
A. ZAMORANO ¹, L. FÁBREGA ¹, W. NEIRA ¹, D. ARELLANO ¹, C. REPETTO ¹, D. AEDO ¹,
I. CARLOS DÍAZ ², R. GONZÁLEZ ³

Minerva Anesthesiol. 2011 May; 77(5): 510-21.

ARTÍCULOS ORIGINALES

Efectos de la ventilación en posición prono
extendida en SDRA secundario
a influenza A(H1N1)

Revista Chilena de Medicina Intensiva 2011 vol 26 (1): 17-26



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Prone Positioning in Severe Acute Respiratory Distress Syndrome

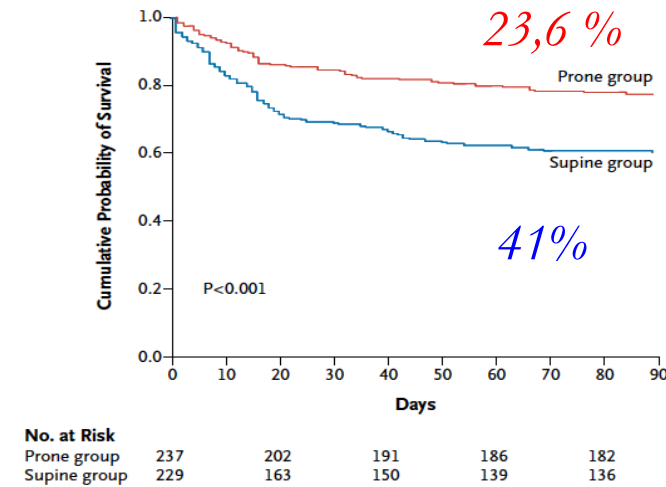
Pacientes incluidos: 466 (229 supino – 237 prono)

$\text{PaO}_2/\text{FiO}_2 < 150 \text{ mmHg}$

$\text{FiO}_2 \geq 60 \%$

$\text{PEEP} \geq 5 \text{ cmH}_2\text{O}$

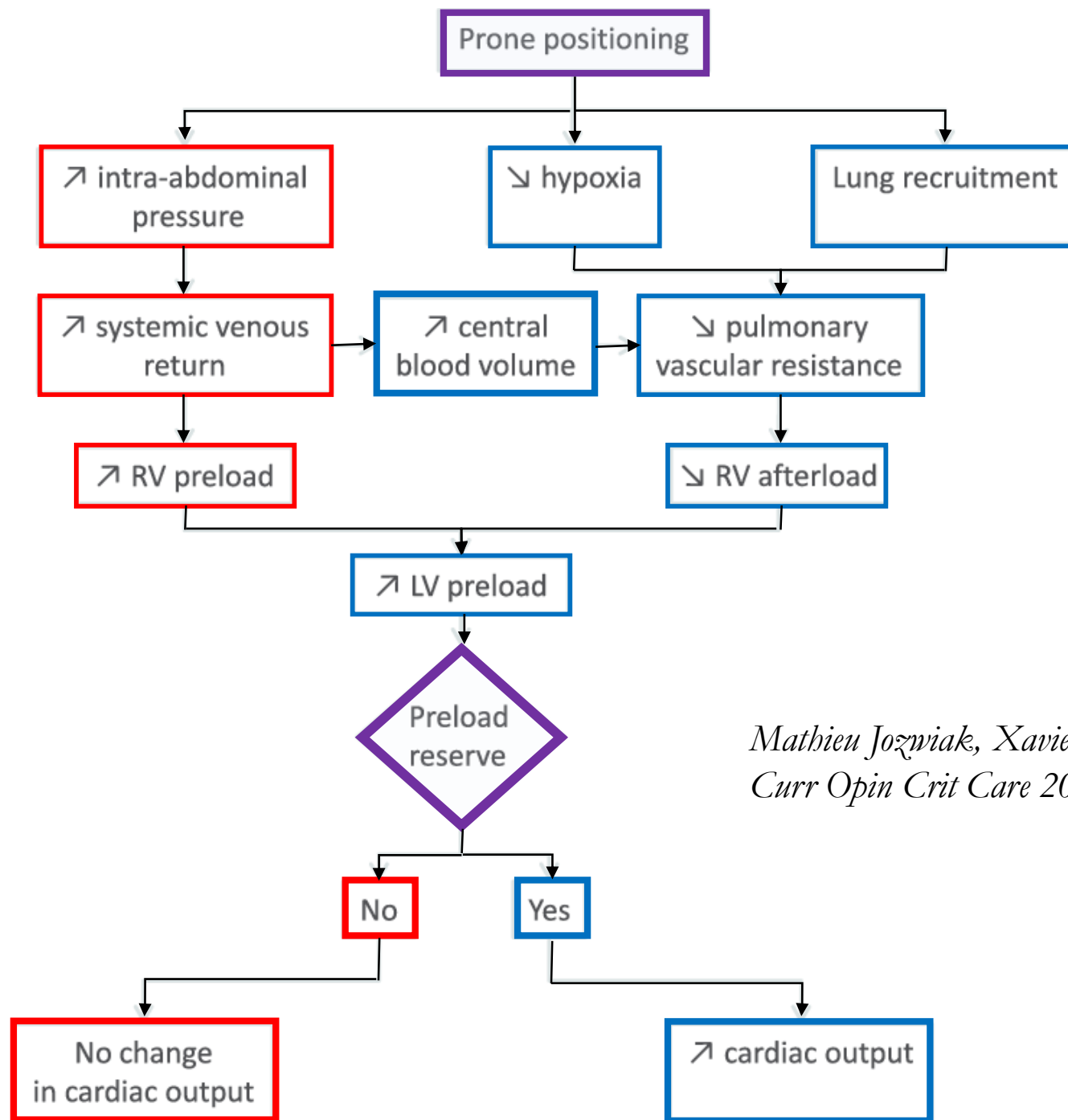
Posición prono por al menos 16 horas/día



Guerin, et al. Proseva Group. N Engl J Med 2013

Contraindicaciones

- Hipertensión endocrana
- Hipertensión Intraabdominal
- Lesiones inestables de la médula espinal
- Cirugía abdominal o torácica reciente
- Tórax abierto o tórax volante
- Incapacidad para tolerar la posición de decúbito prono (por ej., fractura pélvica, fractura de hueso largo inestable).



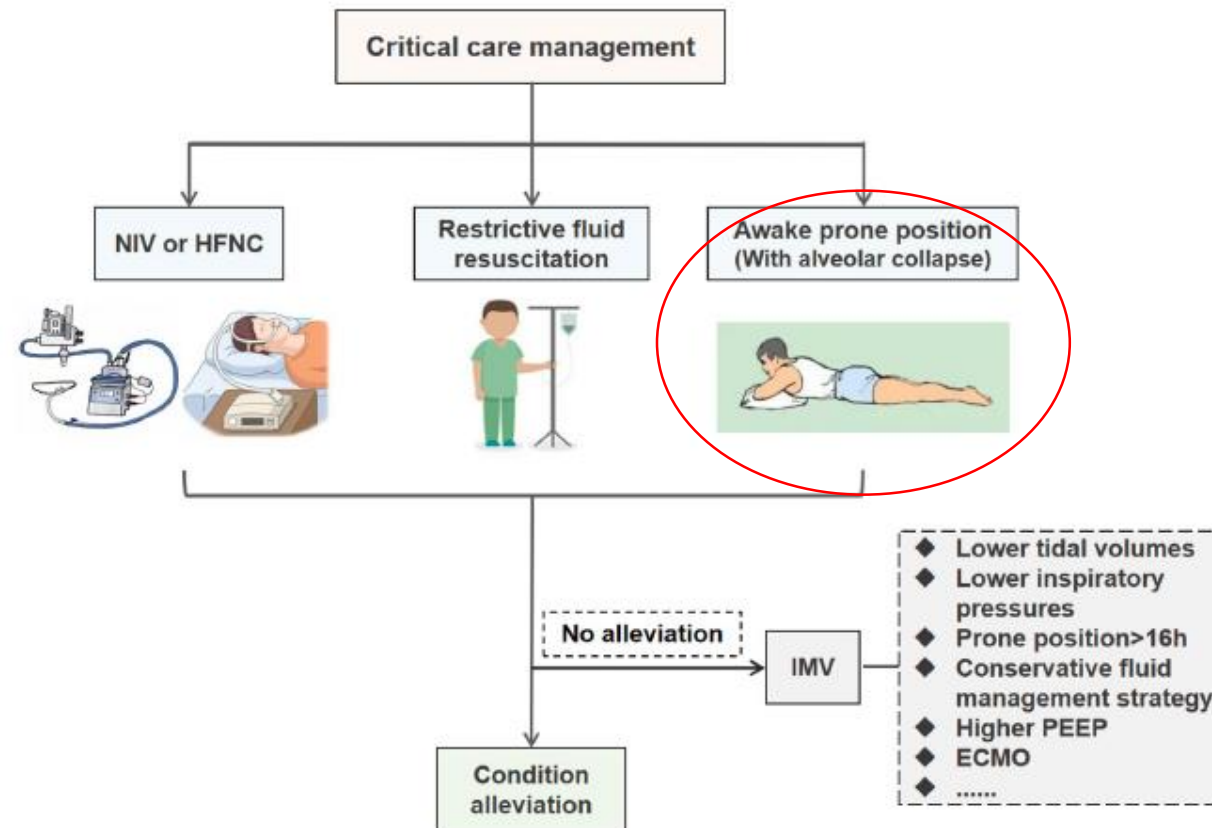
*Mathieu Jozwiak, Xavier Monneta and Jean-Louis Teboul
Curr Opin Crit Care 2016, 22: 239–245*

LETTER TO THE EDITOR

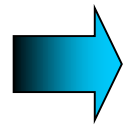
Open Access



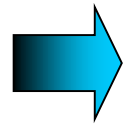
Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province



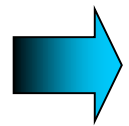
El intercambio gaseoso mejora en prono si:



Se produce una reducción del tejido no aireado con el cambio a posición prono (reclutamiento)

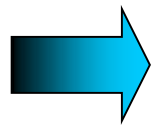


La distribución de la ventilación es más homogénea

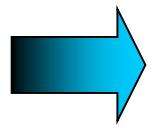


Mejora la ventilación de las zonas bien perfundidas, disminuyendo el shunt

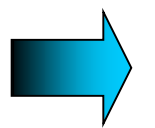
En comparación con el supino, el riesgo de VILI en prono se reduciría porque:



Se produce una distribución más homogénea de la presión transpulmonar y reduce el gradiente de *stress* y de *strain*.

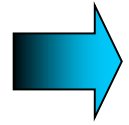


Se produce mayor reclutamiento sin generar mayor sobredistensión a igual nivel de PEEP



Prono afecta favorablemente los fenómenos cíclicos (R/D y TH) además de generar una VM más homogénea

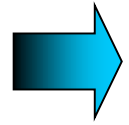
Desde una perspectiva clínica



La VPP es un procedimiento factible, relativamente seguro y de bajo costo



Cuando se lleva a cabo por un equipo entrenado es relativamente fácil de realizar

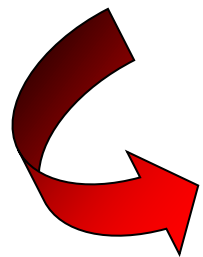


Las complicaciones en general son menores y rápidamente reversibles

Aumenta la incidencia de úlceras por presión y la obstrucción del TOT (no su desplazamiento) y parece reducir la incidencia de NAVM

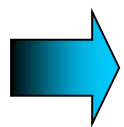


Por ahora la VPP sólo estaría indicada en pacientes con SDRA grave ($\text{PaFi} < 150$), en quienes podría mejorar sobrevida



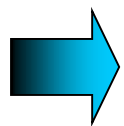
¿Cómo definimos la VPP ?

Según la experiencia acumulada



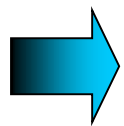
A quienes ?

SDRA con $PaO_2/FiO_2 < 150$ mmHg



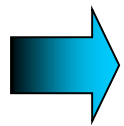
Timing – Cuándo ?

SDRA fase precoz



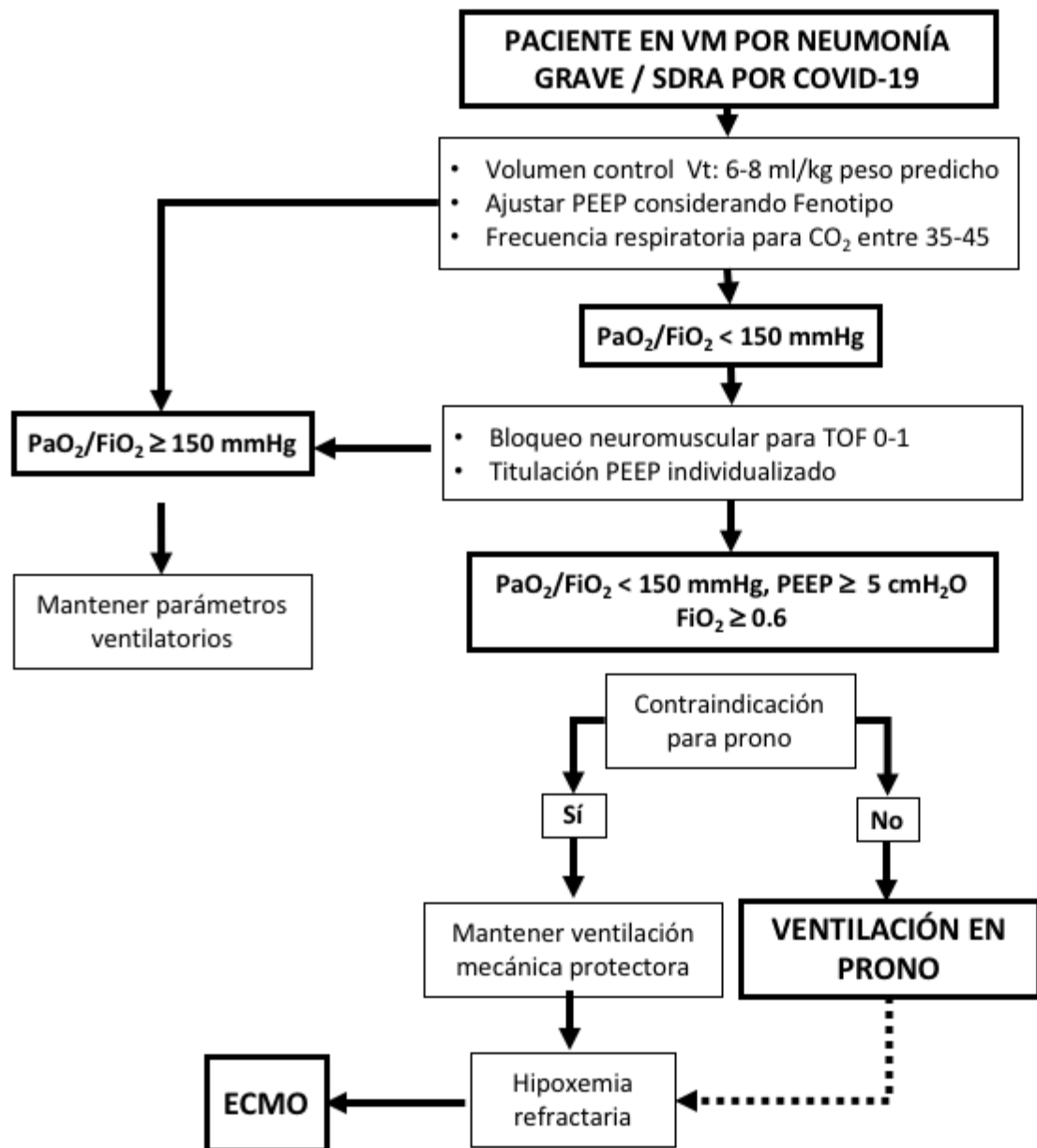
Dosis – Por cuánto ?

Al menos 72 hrs y hasta $PaO_2/FiO_2 \geq 200$ mmHg



Capacitación del personal involucrado Continua

Incluída en un Algoritmo de manejo



Objetivos:

- Presión meseta < 28 cmH₂O
- Driving pressure < 14 cmH₂O

Objetivos:

- Mantener 72 horas
- Hasta PaO₂/FiO₂ ≥ 200 mmHg