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Ultraprotective versus apneic ventilation in V-V ECMO

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Conflicts of interest

Funds and support from Hamilton Medical

Support from Ebenbuild GmbH

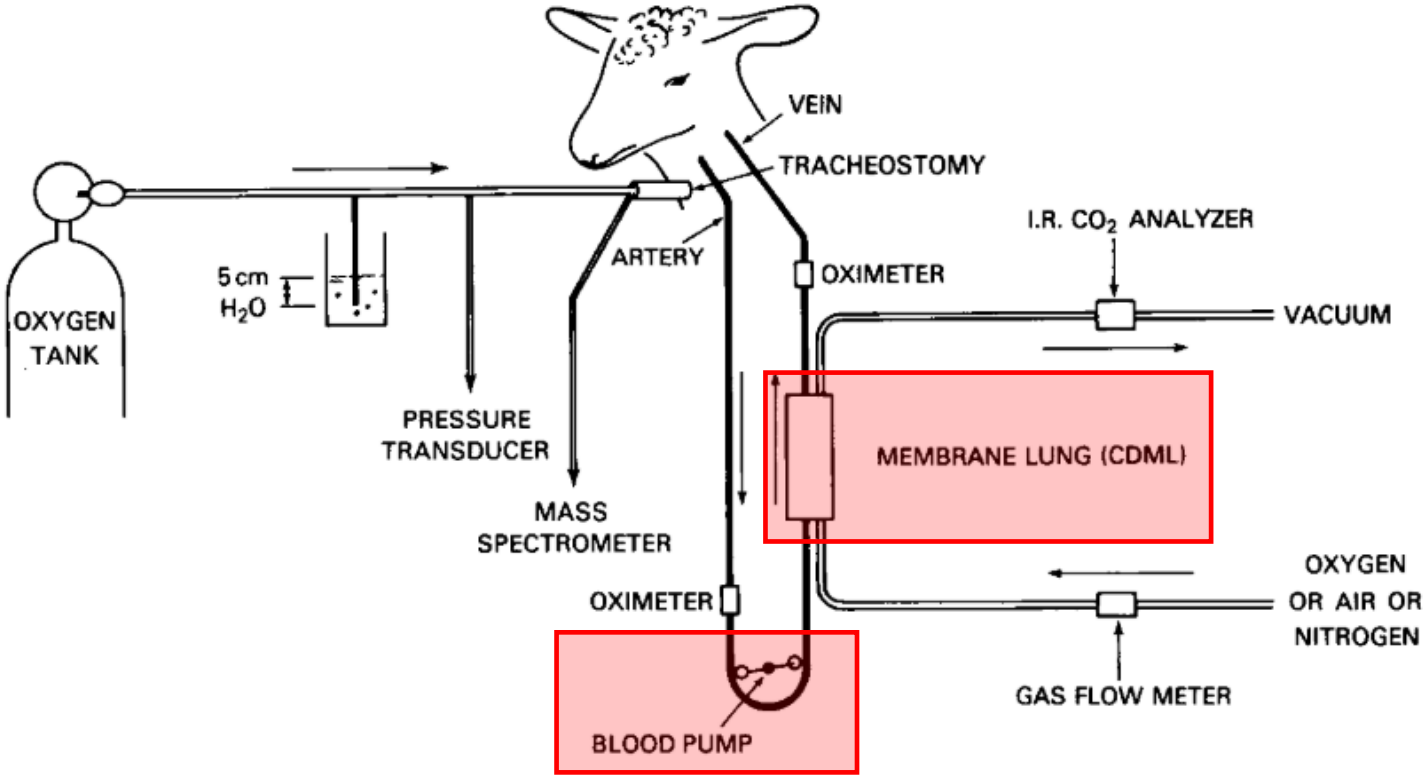
Funds from the Bundesministerium für Bildung und Forschung (BMBF)

Apneic ventilation in ECMO – a 46 year old idea

An alternative to breathing

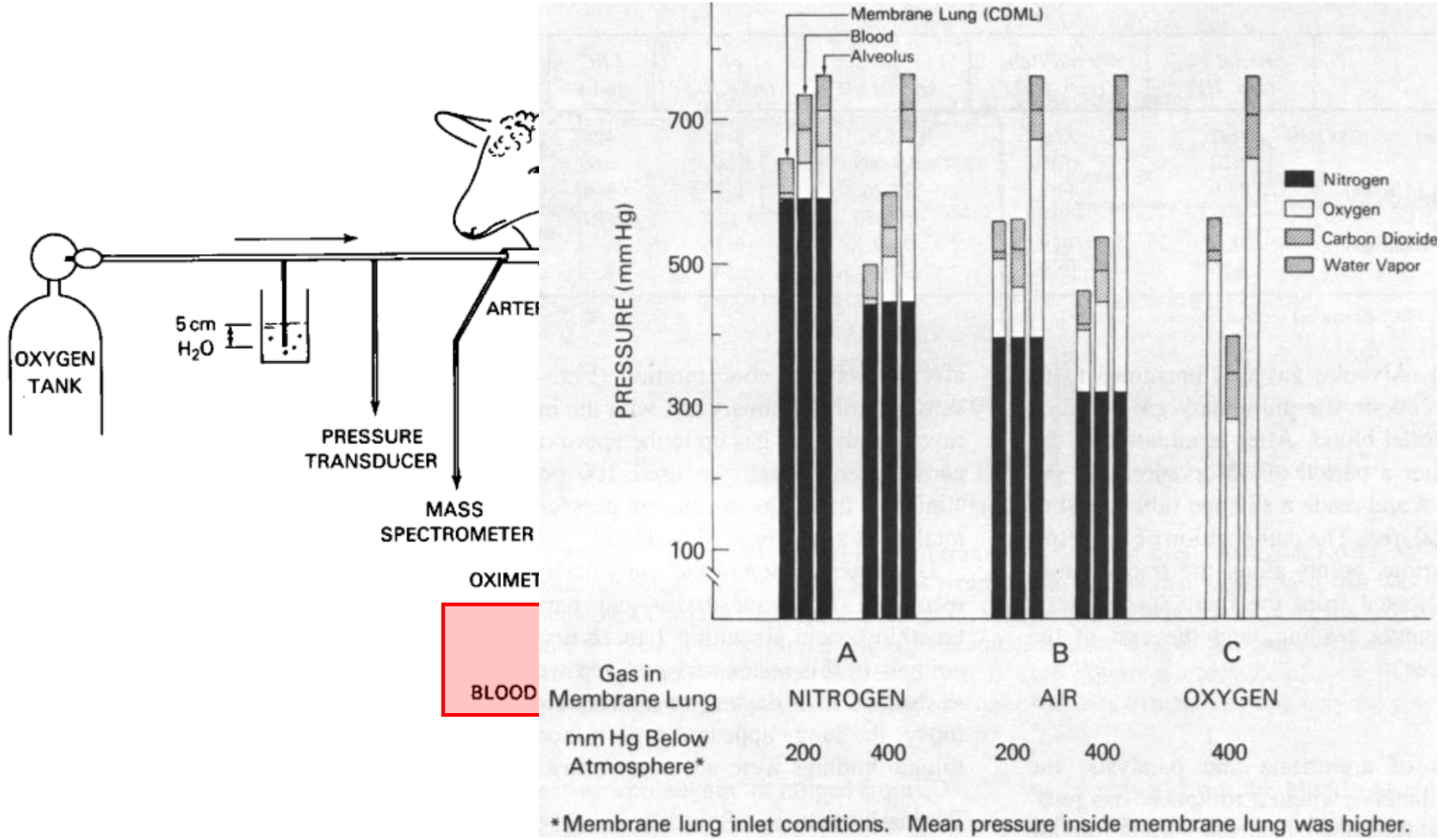
If carbon dioxide is removed b
lung can be used for oxygen tr
''inflated'' with 100 percent o.
membrane lung. This process i
arterial pH, P_{CO_2}, and P_{O_2} all
out in five lambs anesthetized
subclavian artery was pumped
external jugular vein. For oxy
percent oxygen to a pressure o
perfusion had begun or at the
there was no change in acid-b
compliance remained unchang
survived in good health. At equ
pressure of nitrogen in the ven
controlling alveolar oxygen co
the level of the carina.

Theodor Kolobow, M.D.,*
Joseph E. Pierce, D.V.M.,



J Thorac Cardiovasc Surg. 1978 Feb;75(2):261-6

Apneic ventilation in ECMO – a 46 year old idea



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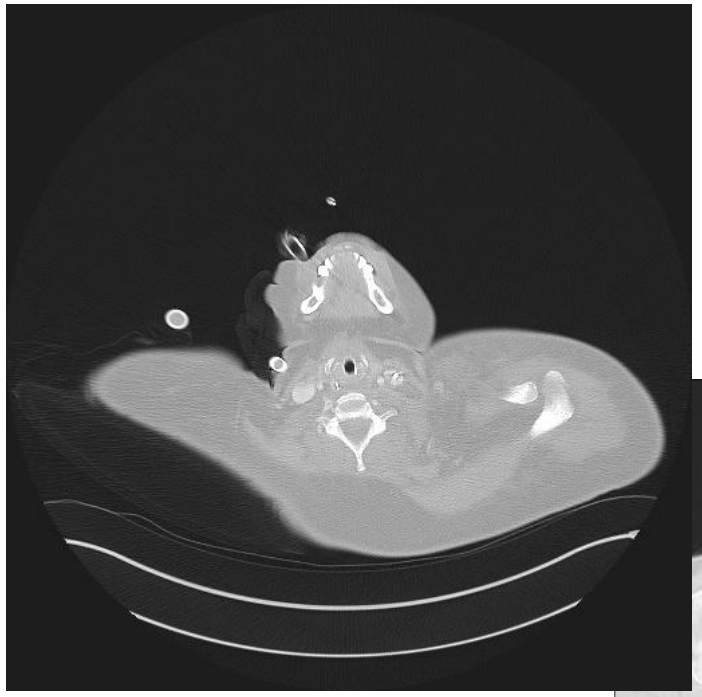
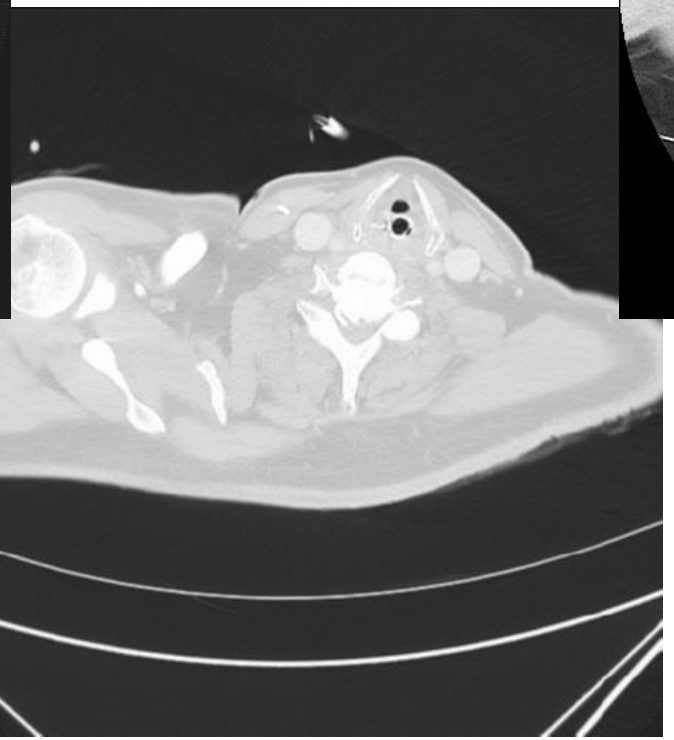
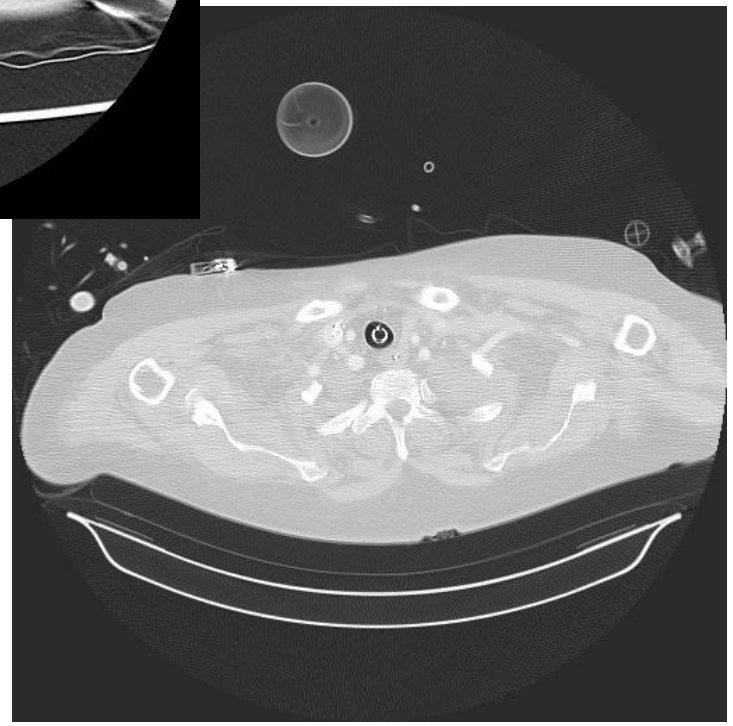
Mechanical ventilation during V-V ECMO

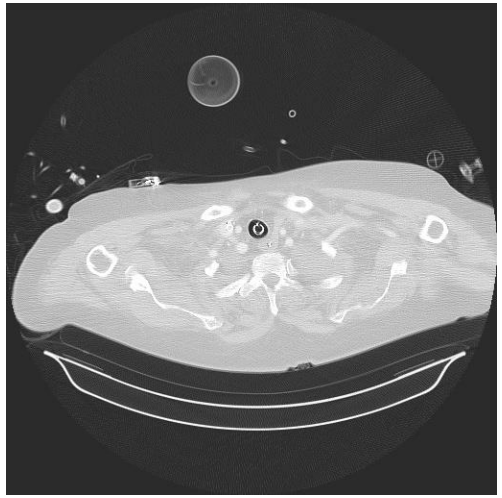






current recommendations

Parameter	Acceptable Range	Recommendation
Inspiratory plateau pressure (P_{plat})	≤30 cm H_2O	<25 cm H_2O
PEEP	10–24 cm H_2O	≥10 cm H_2O
RR	4–30 breaths/min	4–15 breaths/min (set RR) or spontaneous breathing
FiO_2	30–50%	As low as possible to maintain saturations



~ 24 J/min

~ 8 J/min

ASAIO J. 2021 Jun 1;67(6):601-610

Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J
Ann T

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

A. Combes, D. Hajage, G. Capellier, A. Demoule, S. Lavoué, C. Guervilly, D. Da Silva, L. Zafrani, P. Tirot, B. Veber, E. Maury, B. Levy, Y. Cohen, C. Richard, P. Kalfon, L. Bouadma, H. Mehdaoui, G. Beduneau, G. Lebreton, L. Brochard, N.D. Ferguson, E. Fan, A.S. Slutsky, D. Brodie, and A. Mercat, for the EOLIA Trial Group, REVA, and ECMONet*

What acutally happens in the ICU

ORIGINAL ARTICLE

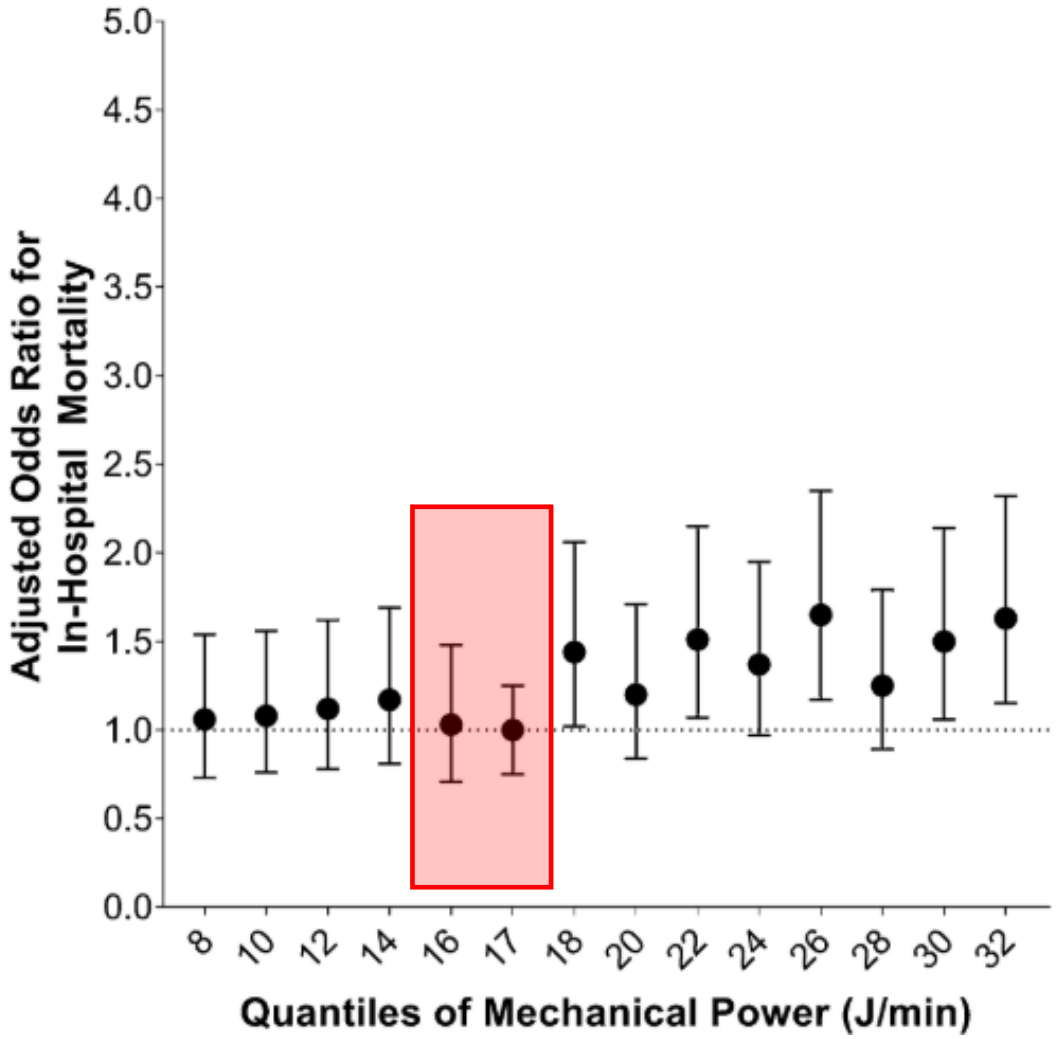
Mechanical Ventilation Management during Extracorporeal Membrane Oxygenation for Acute Respiratory Distress Syndrome

An International Multicenter Prospective Cohort

	before ECMO initation	after ECMO initiation
tidal volume [ml/IBW]	6.4 ± 2	3.7 ± 2
respiratory rate [1/min]	26 ± 8	14 ± 6
driving pressure [cm H_2O]	20 ± 7	14 ± 4
mechanical power [J/min]	26 ± 13	7 ± 5

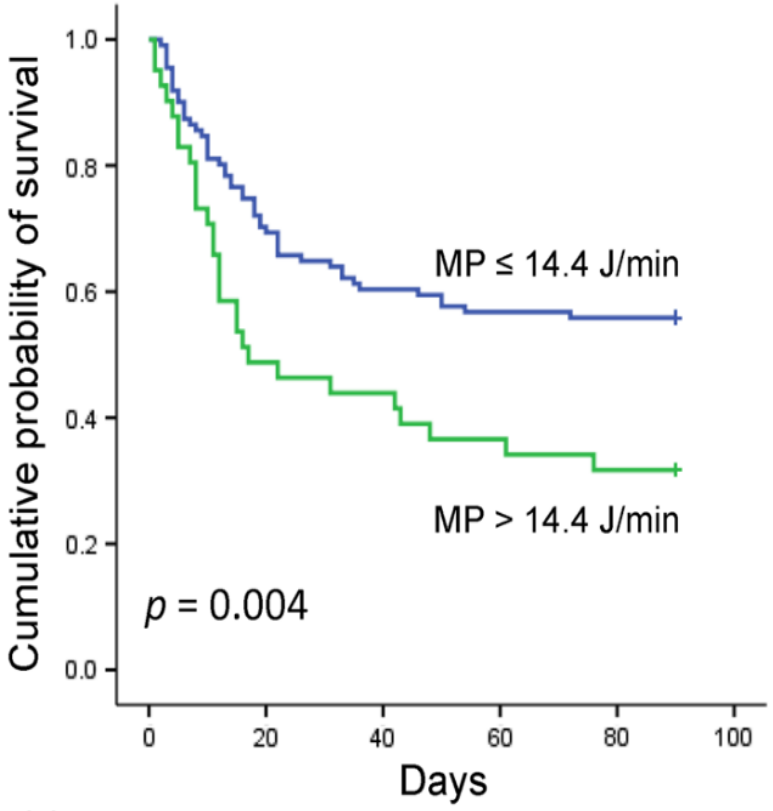
Am J Respir Crit Care Med. 2019 Oct 15;200(8):1002-1012

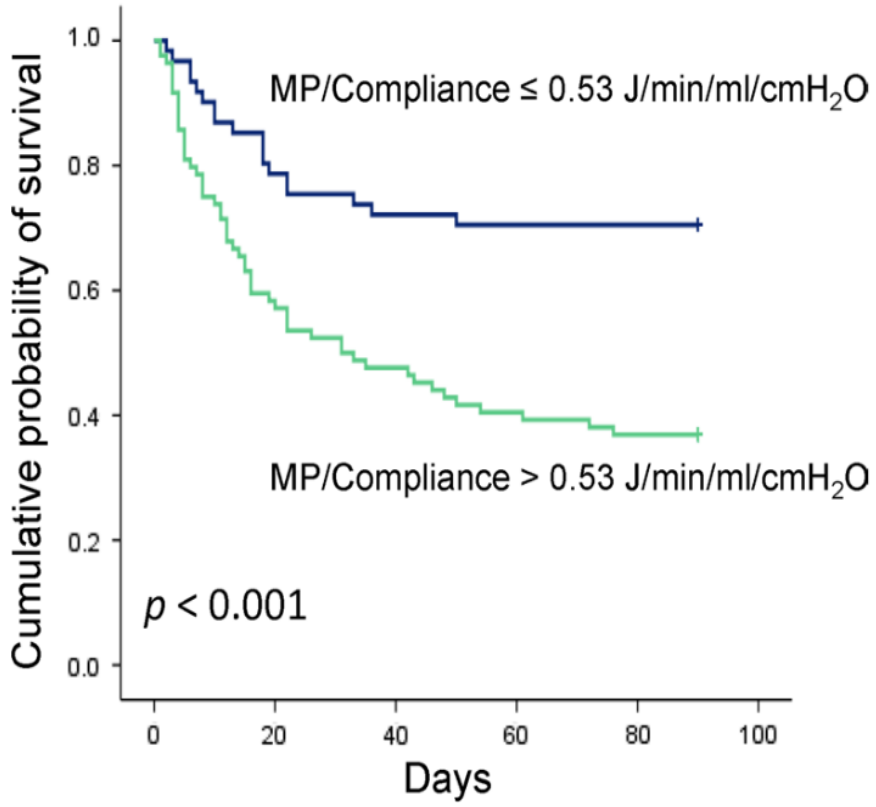
What acutally happens in the ICU



Intensive Care Med. 2018 Nov;44(11):1914-1922

What acutally happens in the ICU

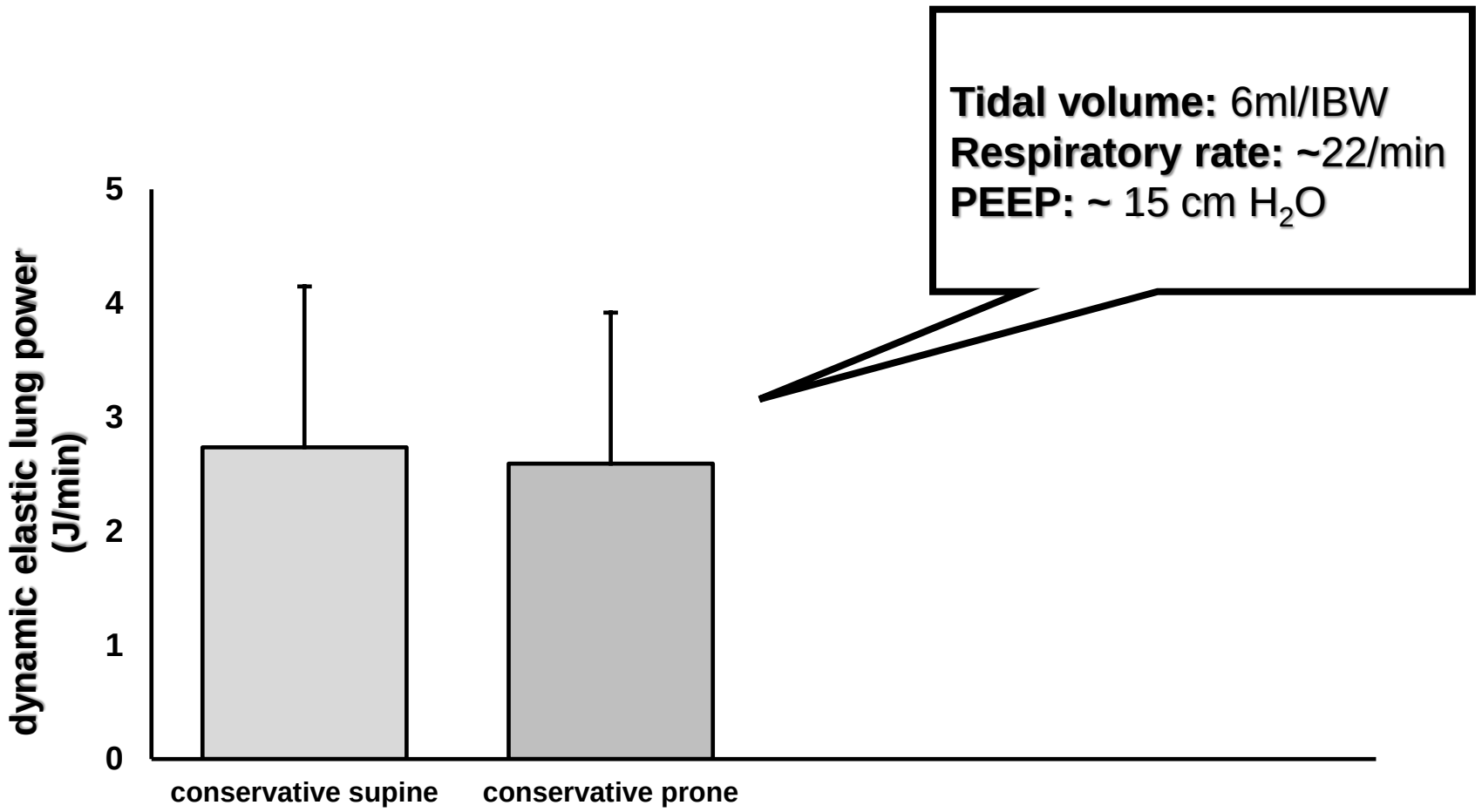




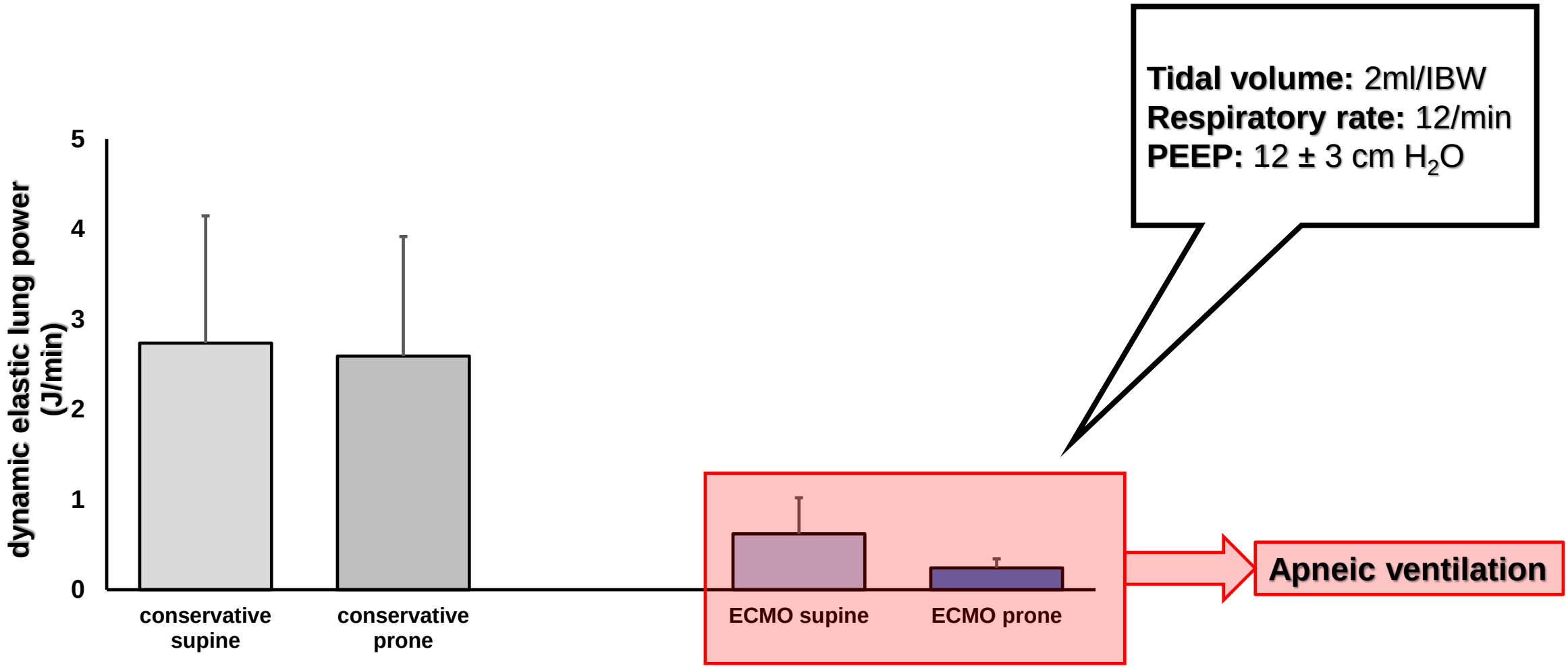
Crit Care. 2021 Jan 6;25(1):13

Maybe we should use apneic ventilation in V-V ECMO patients to reduce MP even further?

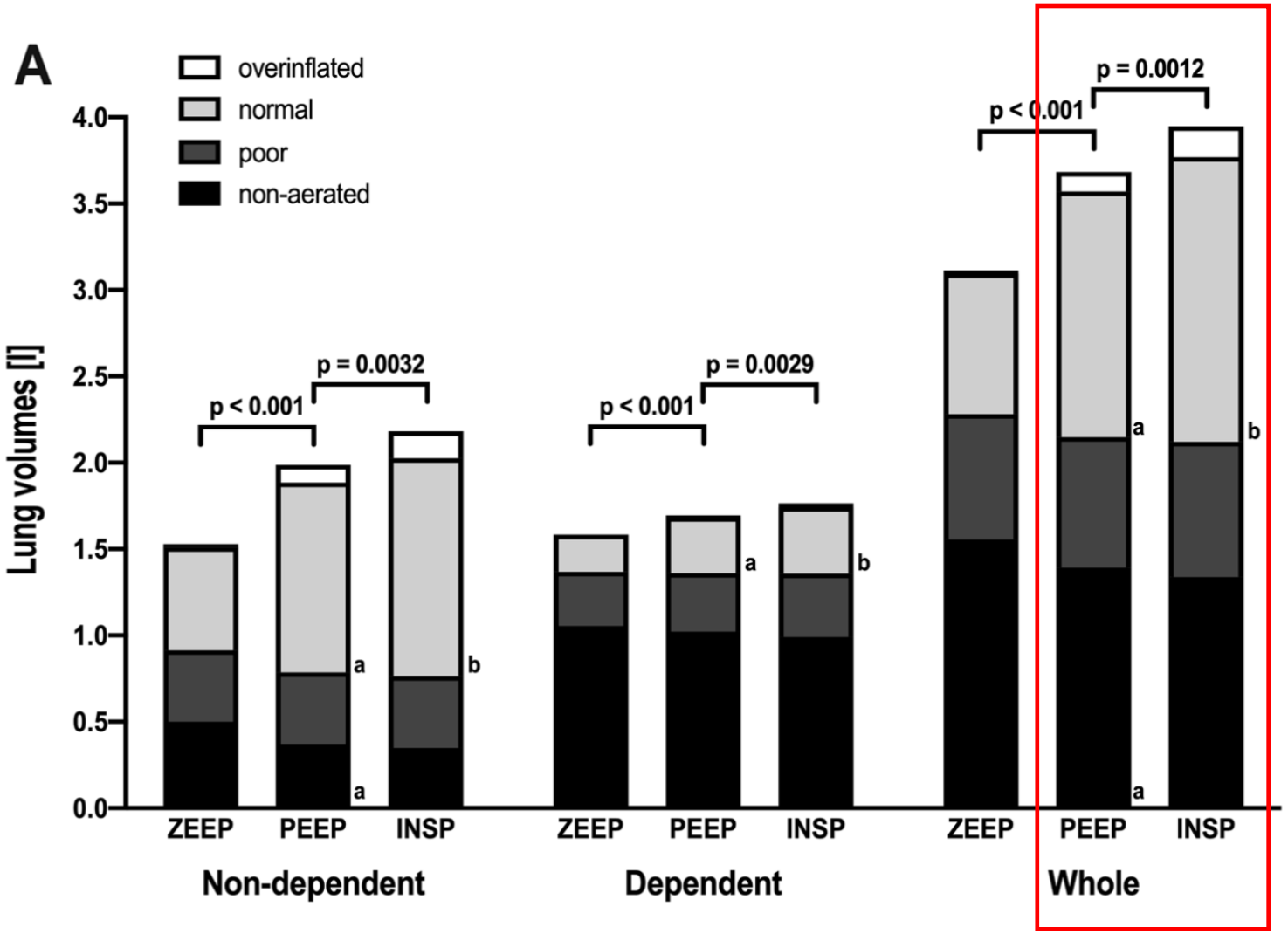
ultraprotective or apneic ventilation during V-V ECMO – what to expect?



ultraprotective or apneic ventilation during V-V ECMO – what to expect?



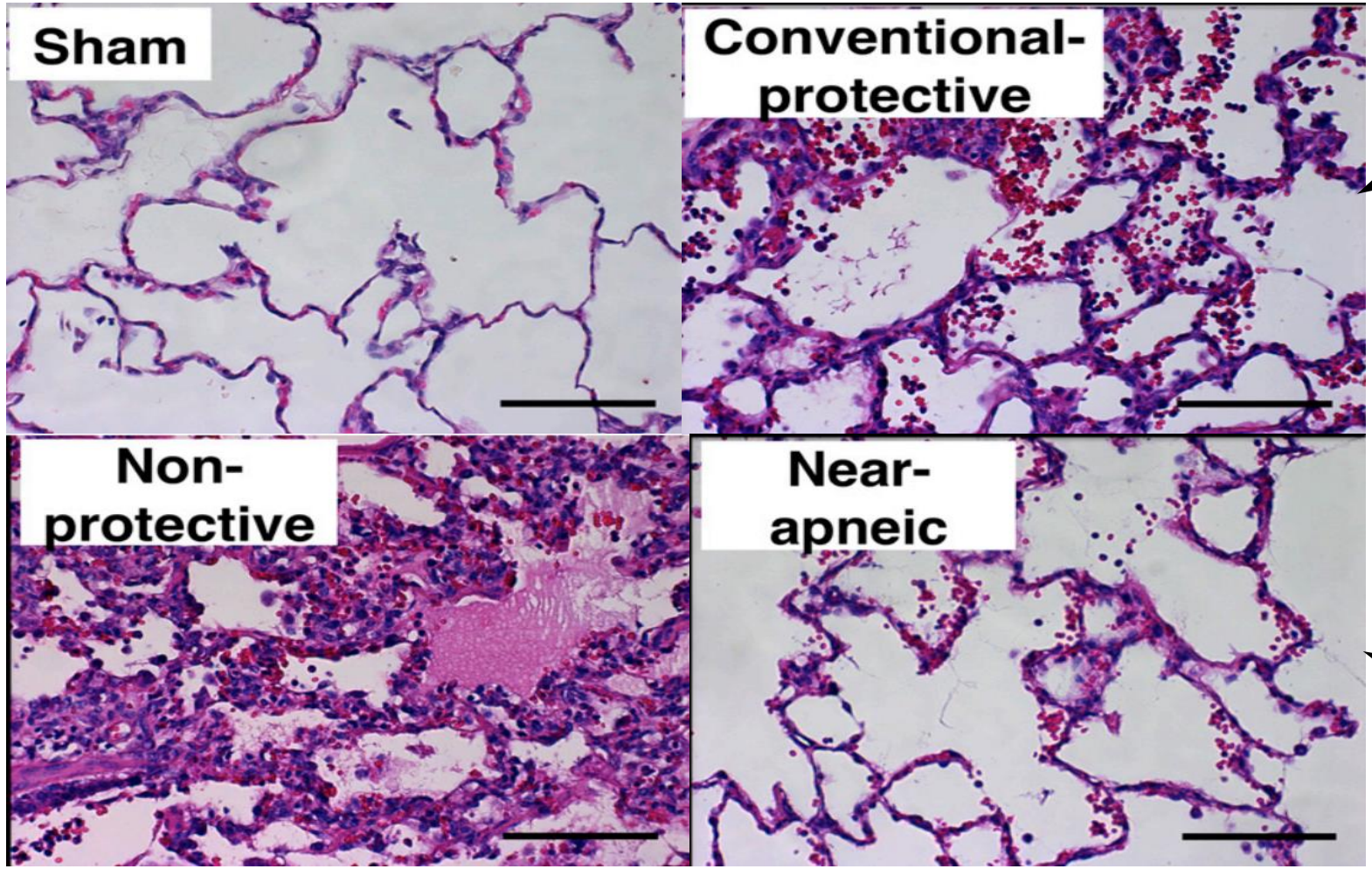
Physiological effects of ultraprotective and apneic ventilation during V-V ECMO



Tidal volume: 3ml/IBW
Respiratory rate: 12/min
PEEP: 15.4 ± 4.8 cm H_2O
MP: ~ 13 J/min

J Intensive Care. 2022 Mar 7;10(1):12

Physiological effects of ultraprotective and apneic ventilation during V-V ECMO

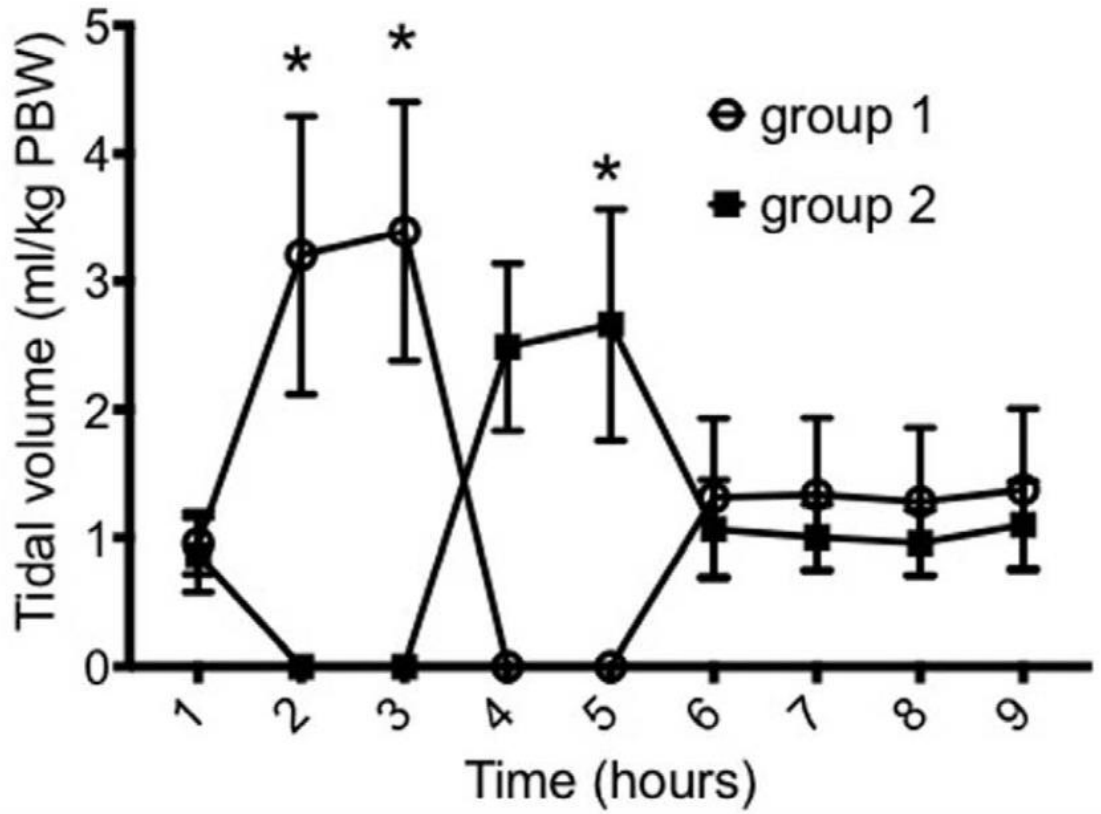


Driving pressure: ~15 cm H_2O
Respiratory rate: 20/min
PEEP: 10 cm H_2O
MP: ~ 6 J/min

Driving pressure: 10 cm H_2O
Respiratory rate: 5/min
PEEP: 10 cm H_2O
MP: ~ 0.4 J/min

Am J Respir Crit Care Med. 2019 Mar 1;199(5):603-612

Physiological effects of ultraprotective and apneic ventilation during V-V ECMO



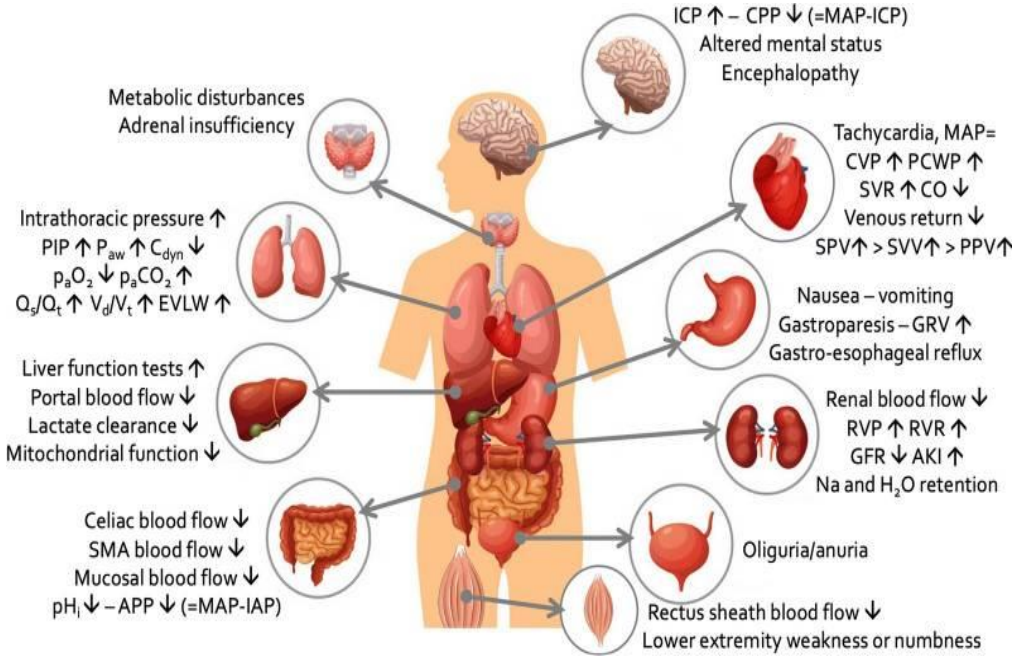
Biomarker	Ratio of Means		p
	Estimate	95% CI	
Interleukin-6	1.22	1.15–1.30	0.0000
Soluble receptor for advanced glycation end products	1.06	1.03–1.08	0.0001
Interleukin-1 receptor antagonist	1.10	1.05–1.14	0.0001
Interleukin-10	1.07	1.03–1.12	0.0024
Tumor necrosis factor alpha	1.08	1.04–1.13	0.0002

Crit Care Med. 2020 Dec;48(12):1771-1778

Apneic ventilation in V-V ECMO … things to consider

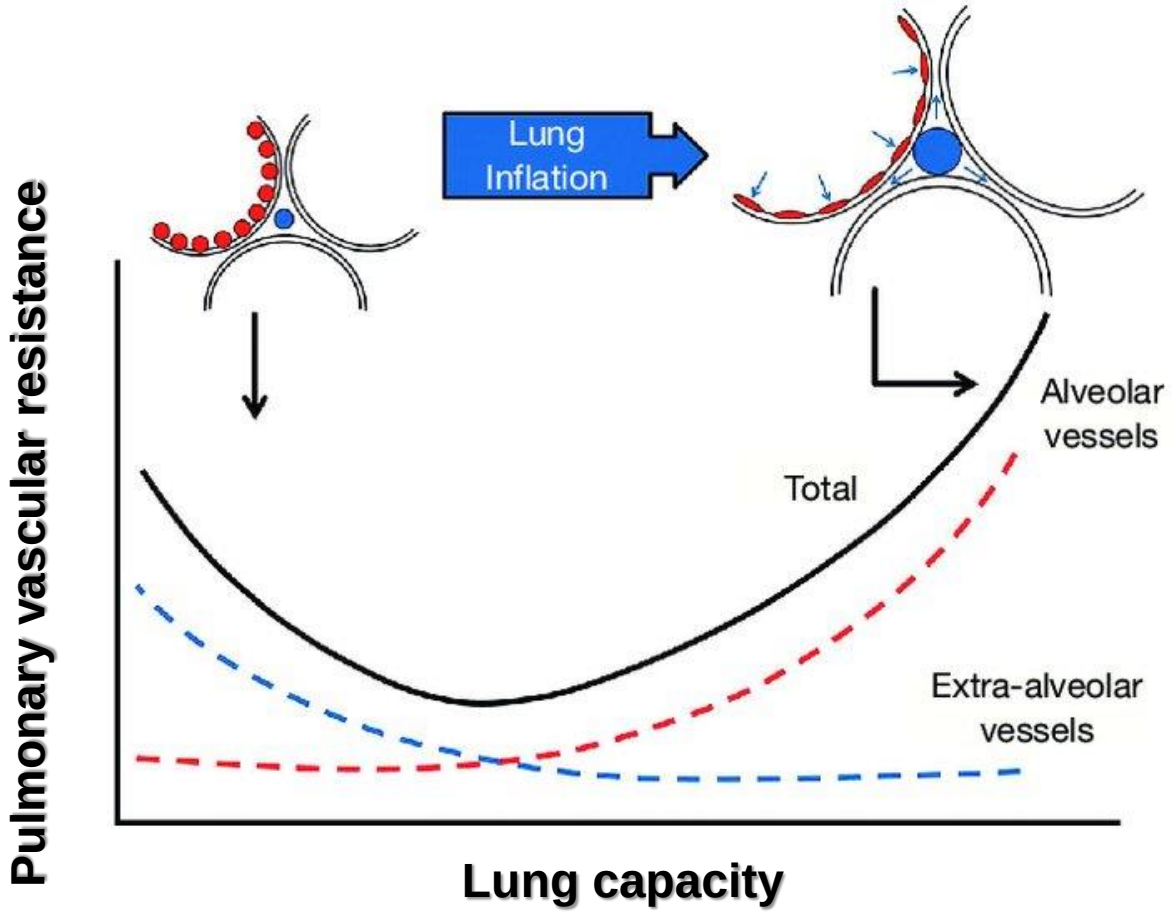
what about the other organs?
let´s speculate…

- Liver and kidney → venous congestion?
- Lymphatic system → reduction of pulmonary edma?
- Heart



Ann Intensive Care. 2019 Apr 25;9(1):52

a (theoretical?) caveat – heart-lung interaction



Ann Transl Med. 2018 Sep;6(18):353

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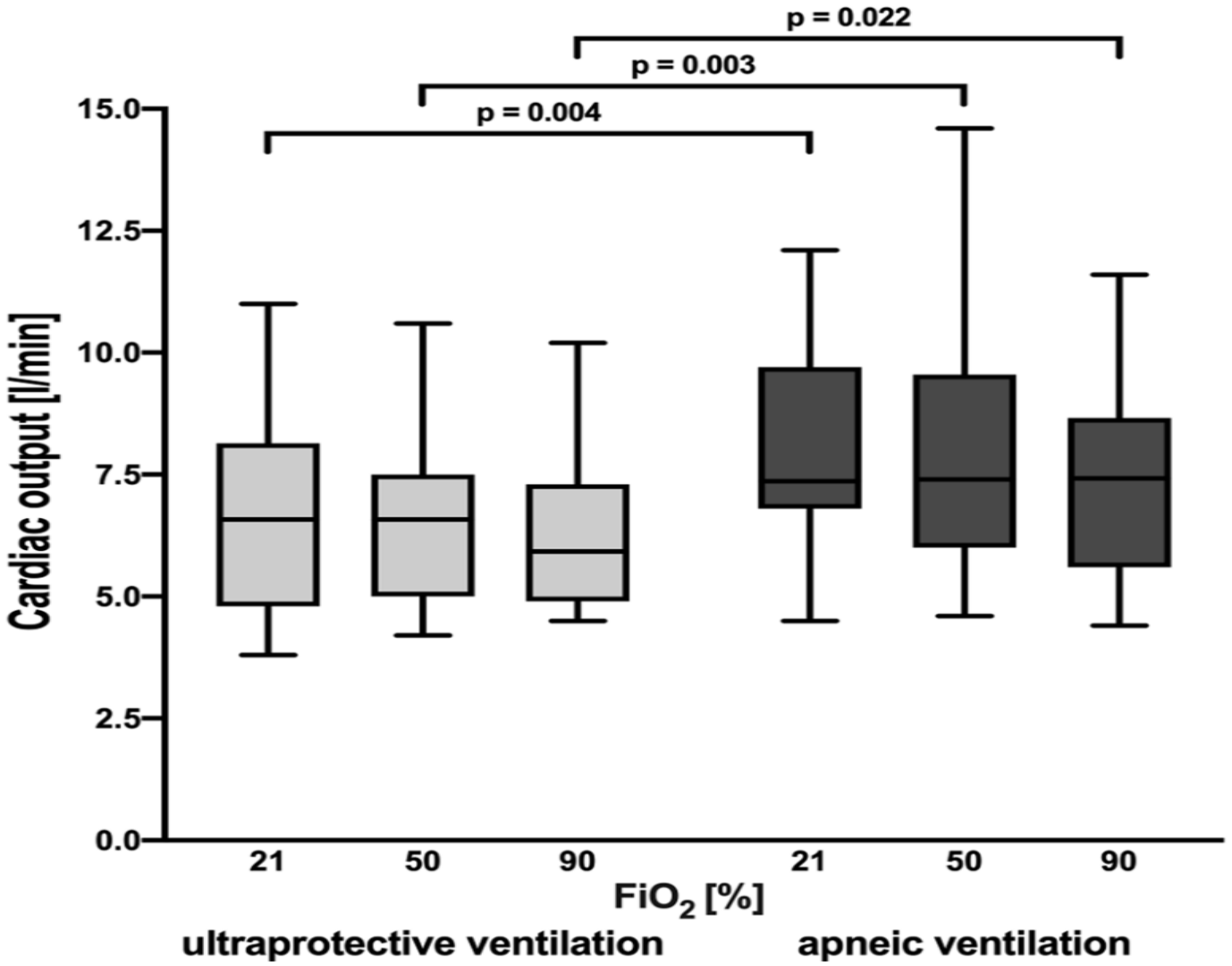

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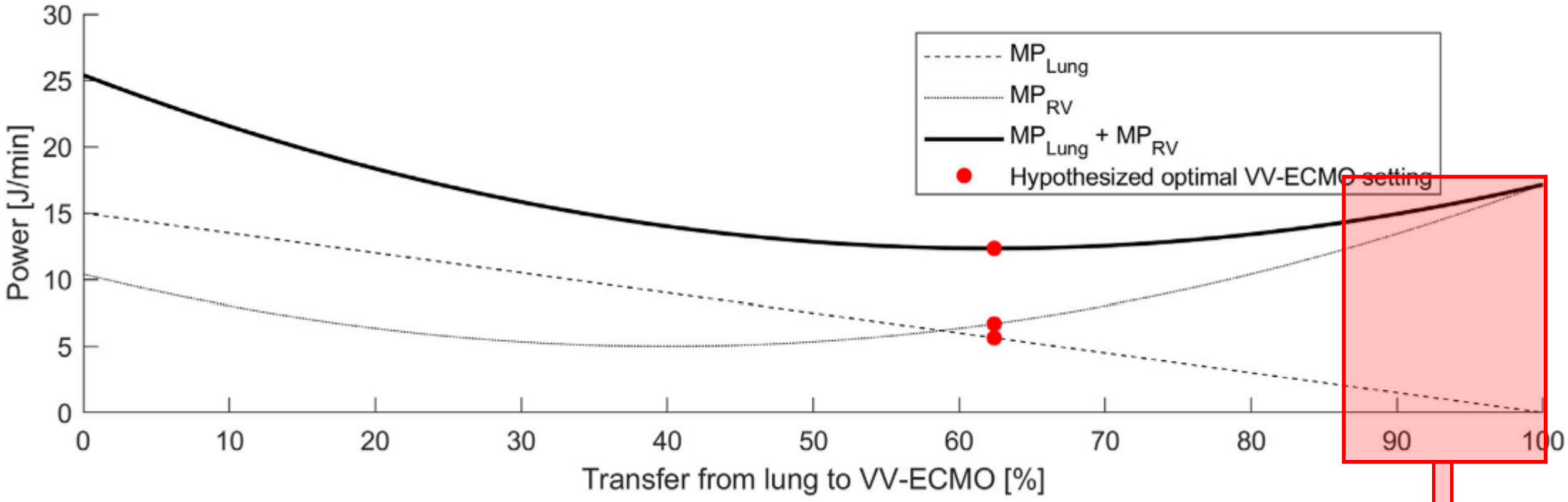

Apneic ventilation

Front Physiol. 2023 Sep 12:14:1231016

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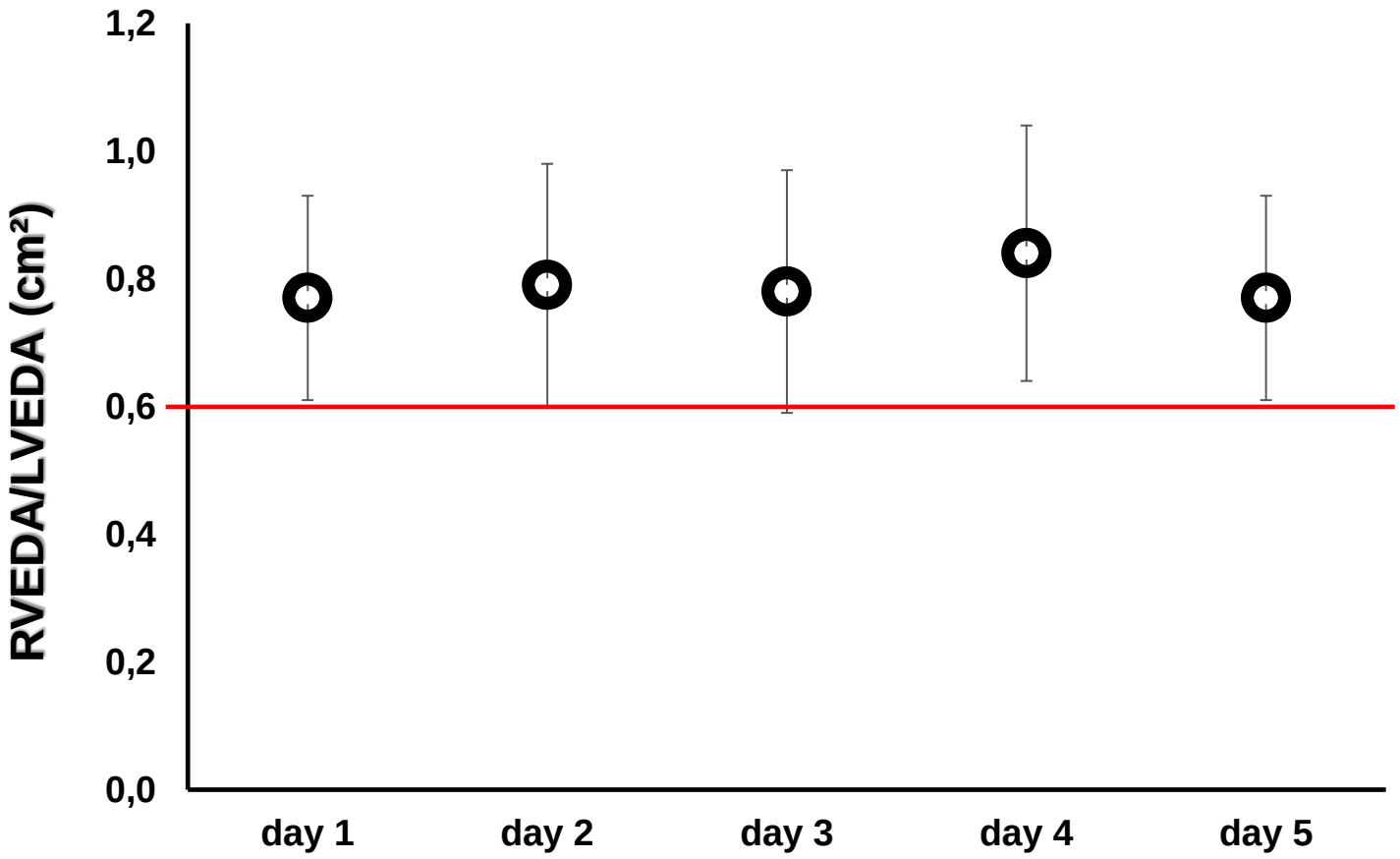

Tidal volume: 2ml/IBW
Respiratory rate: 12/min
PEEP: 12 ± 3 cm H_2O
MP: 4 ± 1 J/min

Apneic ventilation in V-V ECMO … wrap up

The short term physiological effects of apneic ventilation seem not to be harmful and maybe even beneficial for the lung

However:

- **in which patients?**
- **when and how to start the ventilator again?**
- **when to promote spontaneous breathing?**
- **What about the long term effects on other organs?**

→ Not that different to a „conservative“ V-V ECMO run

Thank you for your attention!

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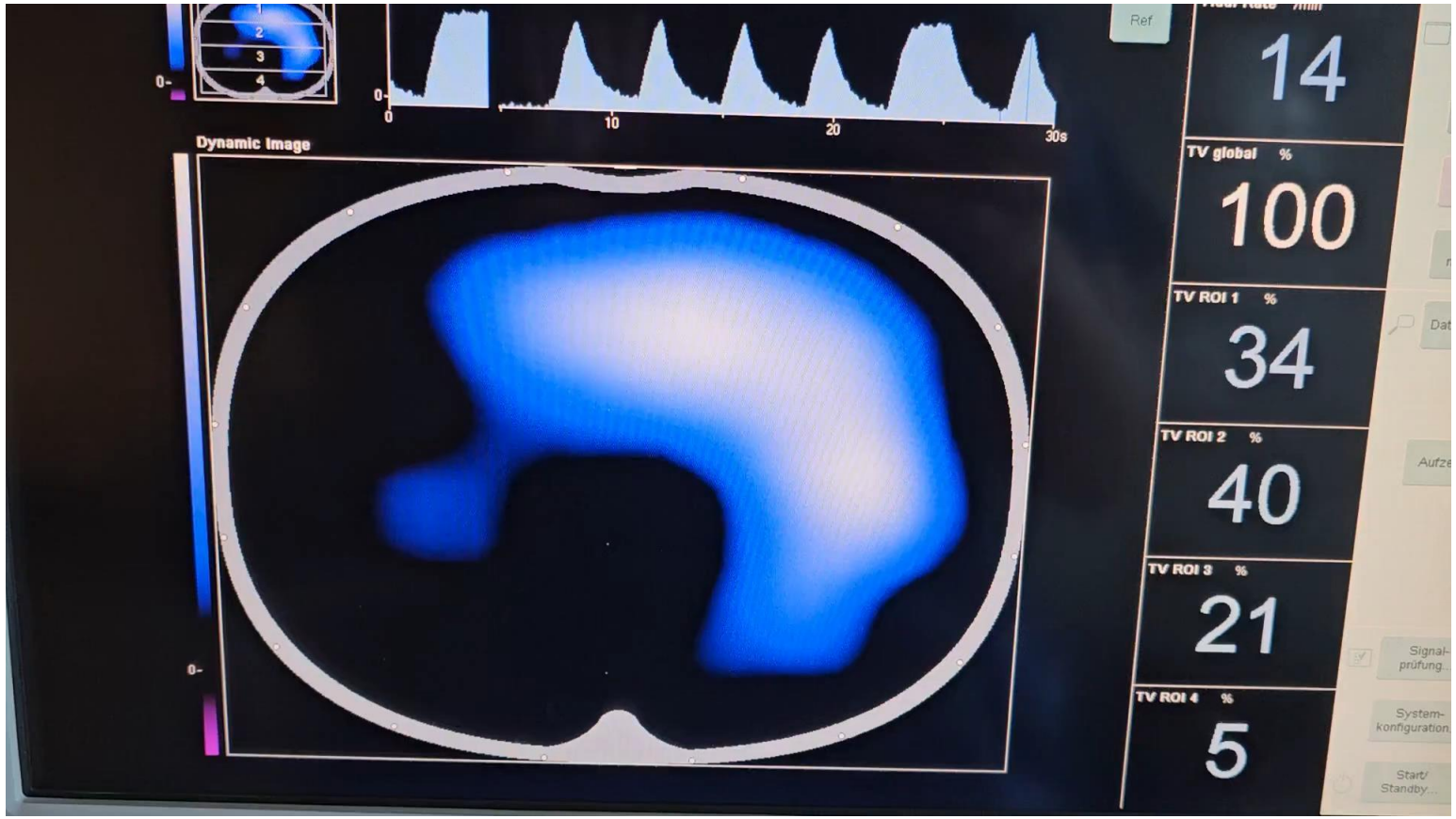

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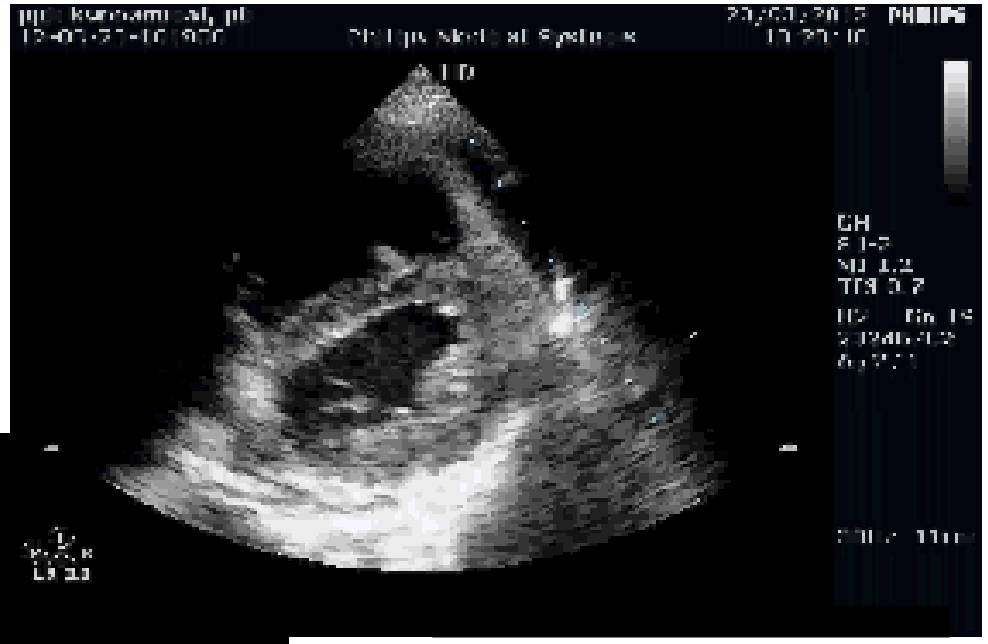

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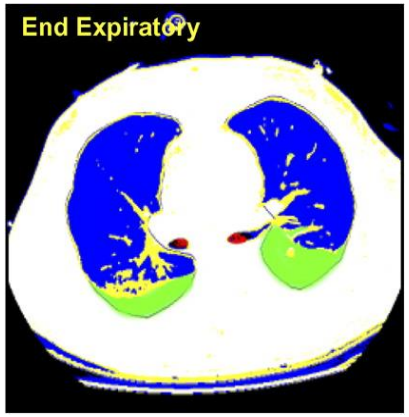

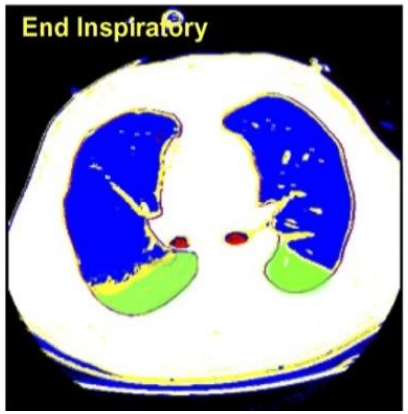

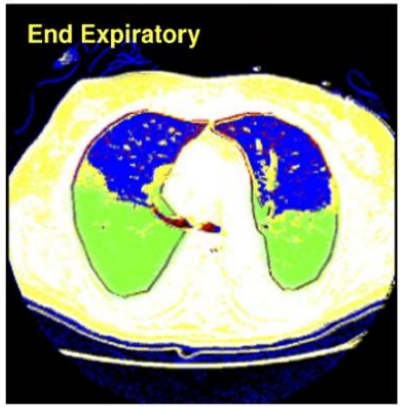

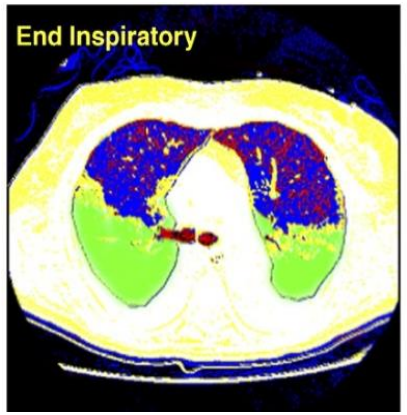

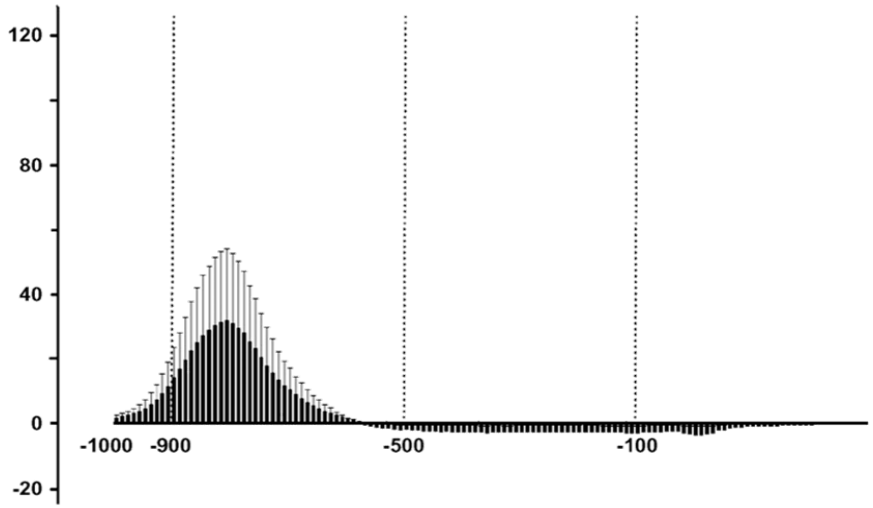

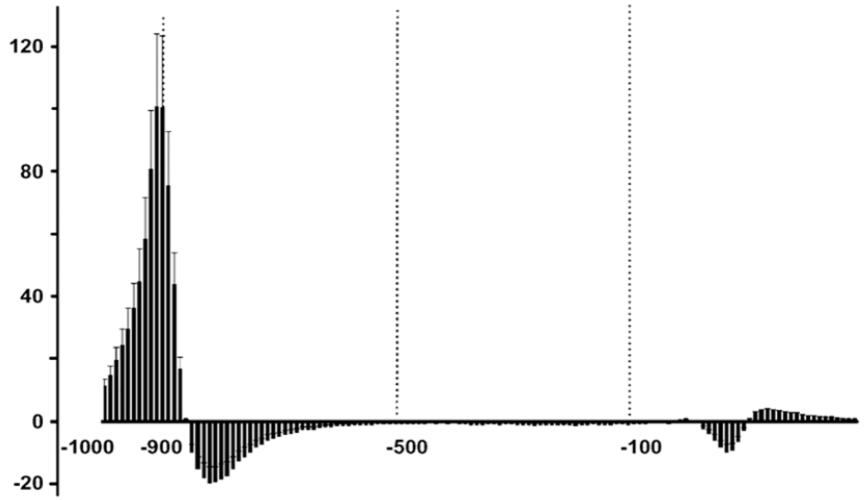

Am J Respir Crit Care Med. 2007 Jan 15;175(2):160-6