Hot Topics in Intensive Care

Ventilatory management of C–ARDS: Lessons from the Pandemic

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Disclosures

Advisor + Research Support/Grants

- Maquet Critical Care
- Timpel Medical

Speaker fees

- Philips
- Air Liquide

“Differential” Characteristics of C-ARDS

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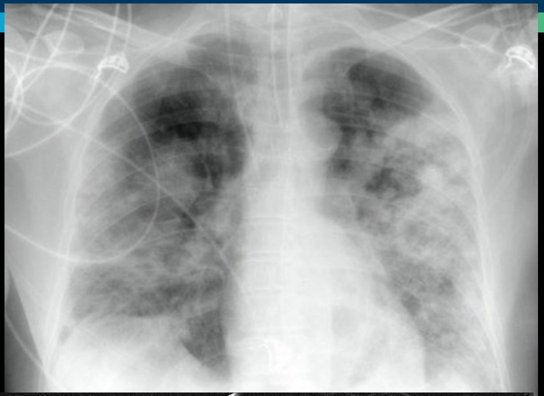
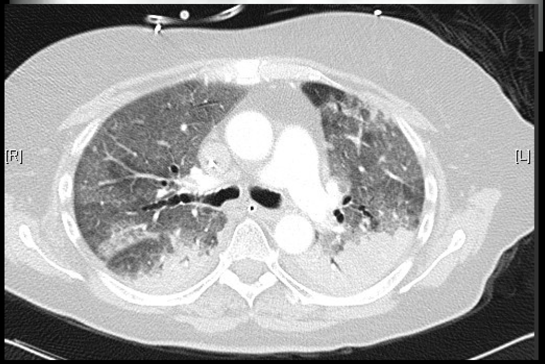
- Diffuse bilateral patchy infiltrates
  Ground glass opacifications
  Sparing of aerated spaces

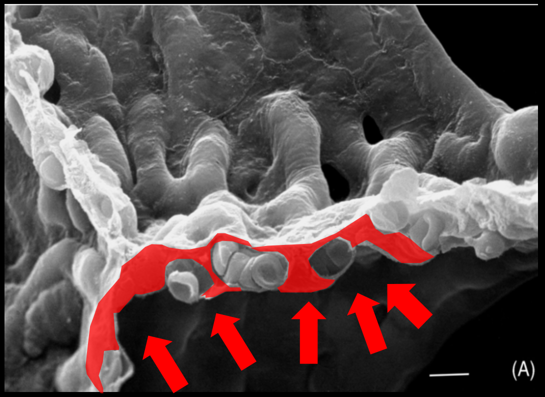
- Initial Hypoxemia out of proportion from the derangement in lung mechanics and radiologic expresión

- Profound derangement in gas exchange
  Increased shunt and later stages Dead space

- Angiocentric Pathophysiolgy
  Involment: endothelium >> endothelium
  Vascular dysfunction (thrombosis
  Perfusion mal-distribution
  Vasodilation- vascular shunt







Integrating the evidence: confronting the COVID-19 elephant

Intensive Care Med (2020) 46:1904–1907

John J. Marini[1*], R. Phillip Dellinger[2] and Daniel Brodie[3]

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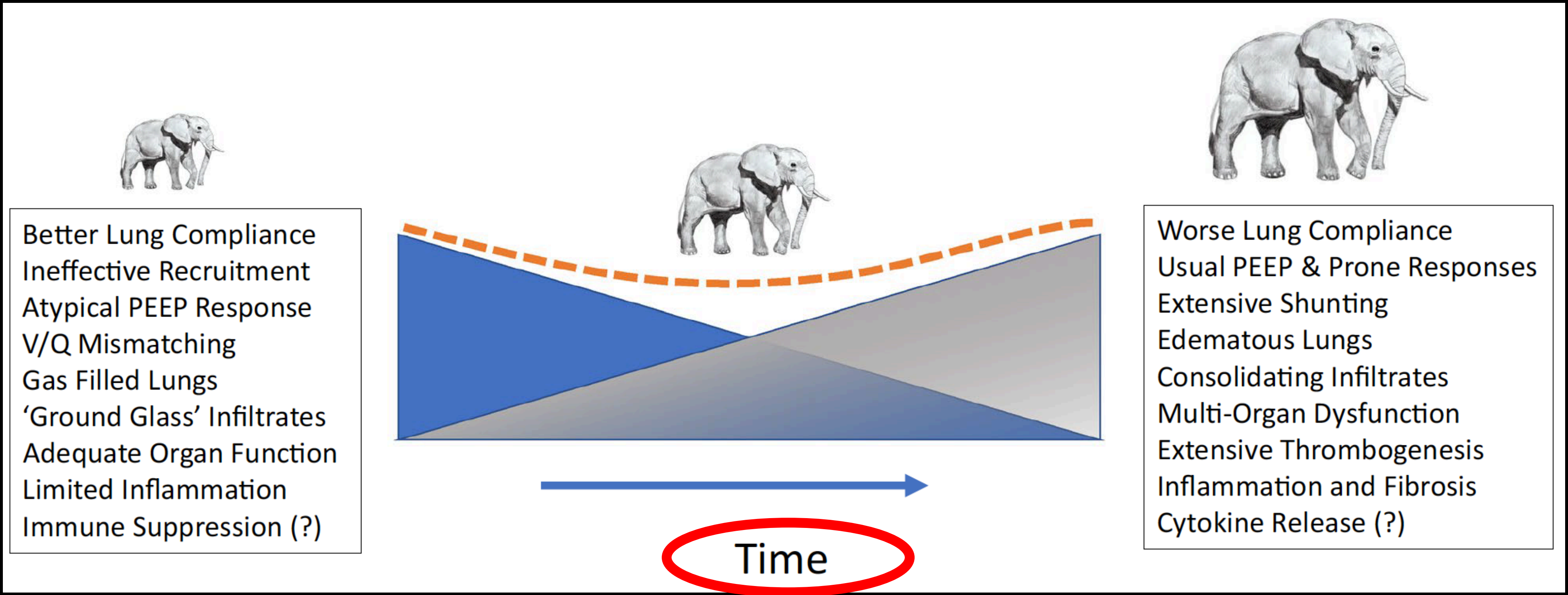


ORIGINAL

Clinical features, ventilatory management, and outcome of ARDS caused by COVID-19 are similar to other causes of ARDS

Carlos Ferrando[1,2*], Fernando Suarez-Sipmann[2,3,4], Ricard Mellado-Artigas[1], María Hernández[5], Alfredo Gea[6], Egoitz Arruti[7], César Aldecoa[8], Graciela Martínez-Pallí[1], Miguel A. Martínez-González[9,10], Arthur S. Slutsky[11,12] and Jesús Villar[2,

Take-home message

COVID-19 patients with ARDS predominantly presented a typical moderate-to-severe ARDS. Ventilatory management, and 28-day outcome did not differ from other causes of ARDS.

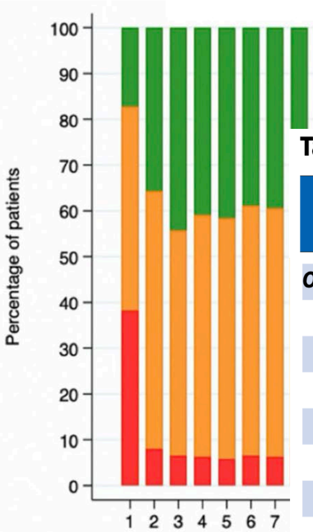
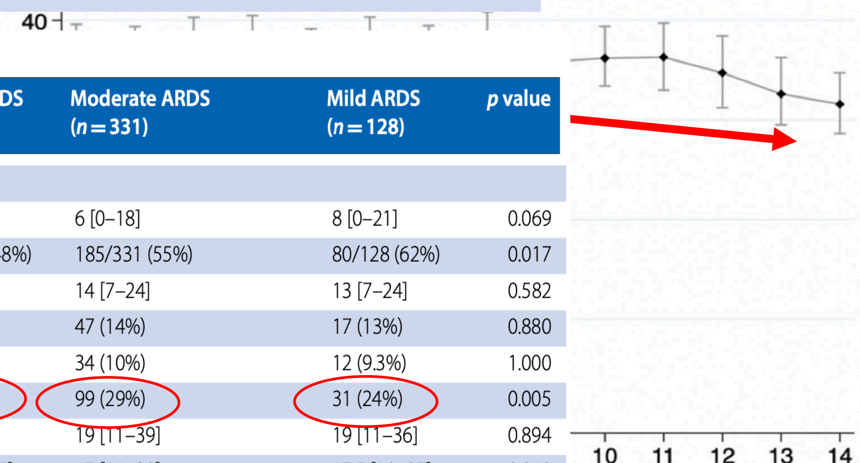


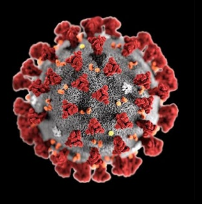
Table 2 Ventilation and outcomes according to ARDS severity

	All (*n* = 742)	Severe ARDS (*n* = 283)	Moderate ARDS (*n* = 331)	Mild ARDS (*n* = 128)	*p* value
Outcomes					
Ventilation-free days	4 [0–18]	0 [0–16]	6 [0–18]	8 [0–21]	0.069
Discharged from ICU	401/742 (54%)	136/283 (48%)	185/331 (55%)	80/128 (62%)	0.017
Length of time on the ventilator	14 [7–24]	14 [8–24]	14 [7–24]	13 [7–24]	0.582
Still in ICU	100 (13%)	36 (12%)	47 (14%)	17 (13%)	0.880
Still under invasive MV	72 (9.7%)	26 (9.1%)	34 (10%)	12 (9.3%)	1.000
28-day mortality	241 (32%)	111 (39%)	99 (29%)	31 (24%)	0.005
ICU length of stay	19 [11–37]	19 [12–35]	19 [11–39]	19 [11–36]	0.894
ICU length of stay of discharge patients	17 [11–28]	17 [12–28.5]	17 [11–30]	17.5 [10–27]	0.940
ICU length of stay of deceased patients	17 [10–25]	17 [11–27]	17 [9–26]	17 [10–21]	0.803

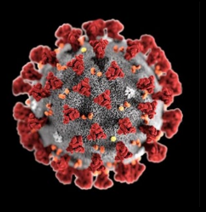
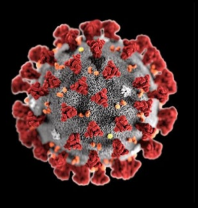
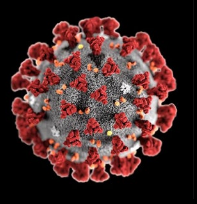
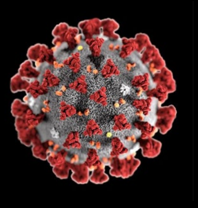
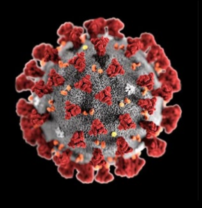


Ferrando C, Suarez-Sipmann F *et al. Intens Care Med* **46**, 2200–2211 (2020).

Lessons (I..) Learned From the Pandemic



- Lung Protection is key
- Reapraisal of the use of Adjuvant interventions: Sinergies!
- PEEP Individualization is Key
- Dangerous transition to spontaneous breathing

Ventilatory Management of C-ARDS

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Lung Protective Ventilation

VT limitation to 4 - 8 mL/kg ideal 6-mL/kg

Pplat limitation ideal ≤ 28 cmH_2O max ≤ 30 cmH_2O

Driving Pressure limitation ≤ 15 cmH_2O

RR minimum necessary to ensure suffcient CO_2 elimination

PEEP individualized to minimize lung collapse and overdistension

Adjuvant measures

Muscle relaxation
Prone positrioning
Recruitment maneuvers
Nitric oxide

And so… the Paella is ready

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But….

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Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/ijgfs

ELSEVIER

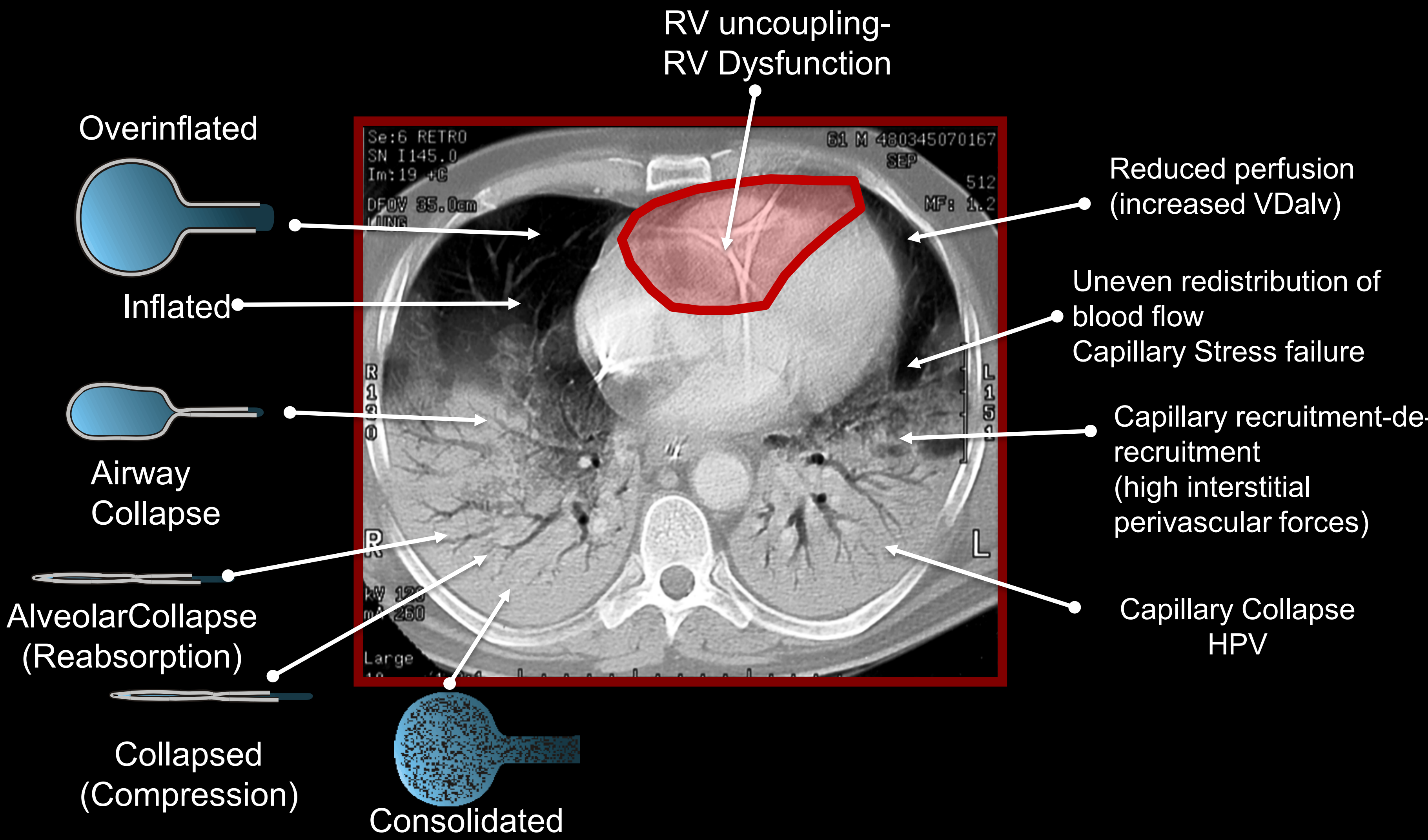
A nightmare glocal discussion. What are the ingredients of Paella Valenciana?

P. Vidal-González [a,*], P. Medrano-Ábalos [b], E.J. Sáez Álvarez [b]

[a] *Anthropology Research Institute, Universidad Católica de Valencia, Spain*
[b] *Nursing School, Universidad Católica de Valencia, Spain, Guillem de Castro, 94, 46003, Valencia, Spain*

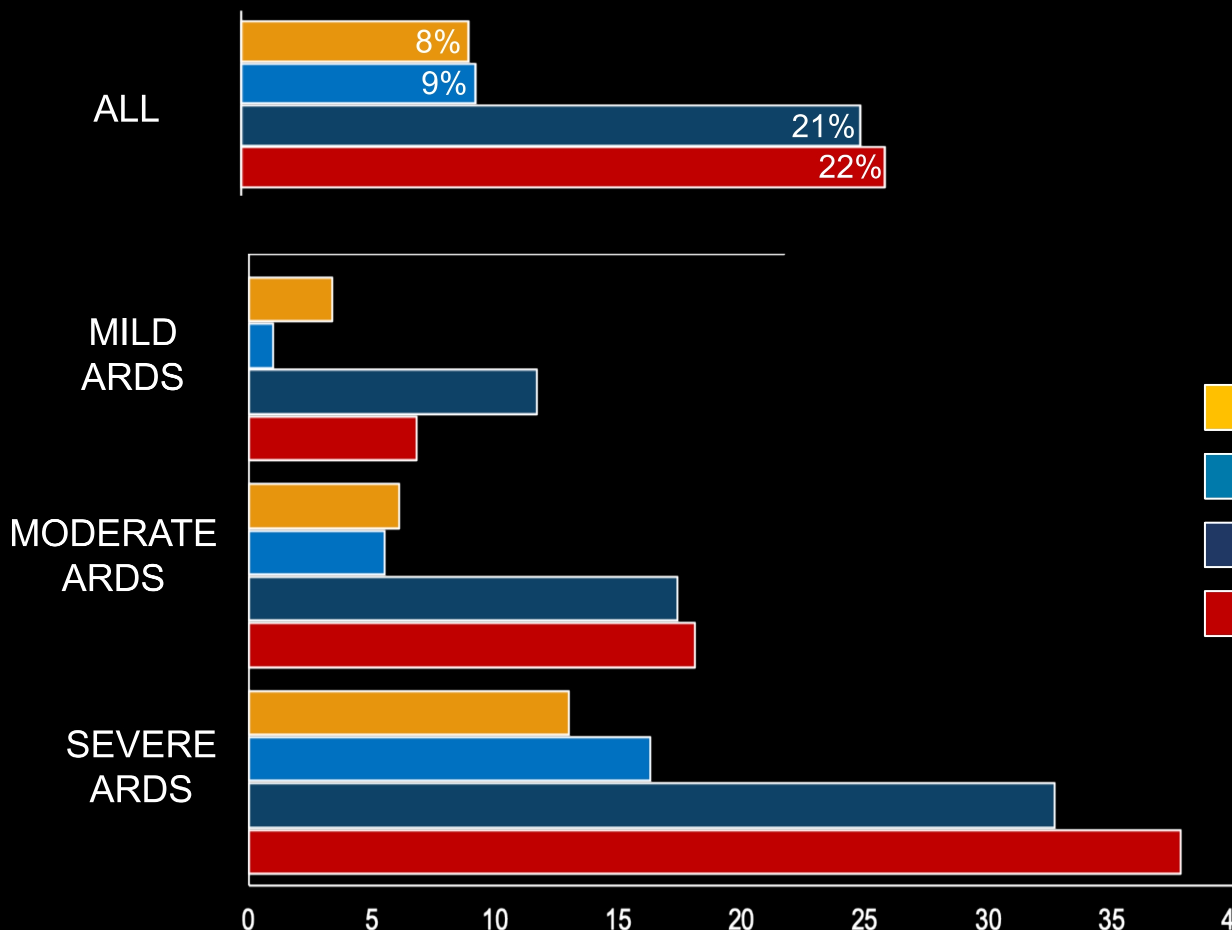
After a quantitative investigation among non-professional chefs from the 266 towns in the province of Valencia, we found that 10 ingredients are repeated with a very high frequency and that we consider to be the basic ingredients. Fifty other ingredients were identified that are used occasionally, as a sign of the diversity and richness of the dish. This study is provided to offer guidelines to focus debate and social discussion on what the ingredients of a "true Paella Valenciana" should be.

The complex heterogeneous ARDS lung



Use of Adjunctive Measures in ARDS

Status Before the Pandemic



LUNG SAFE Study

2377 ARDS patients
459 ICUs
50 countries
5 continents.

Synergies

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The search and use of synergistic effecs is common (and necessary) in clinical medicine

Oncology

- Chemotherapy
  (adyuvant, early consolidation)

Infectious diseases

- Antibiotics
  (ea

….. M

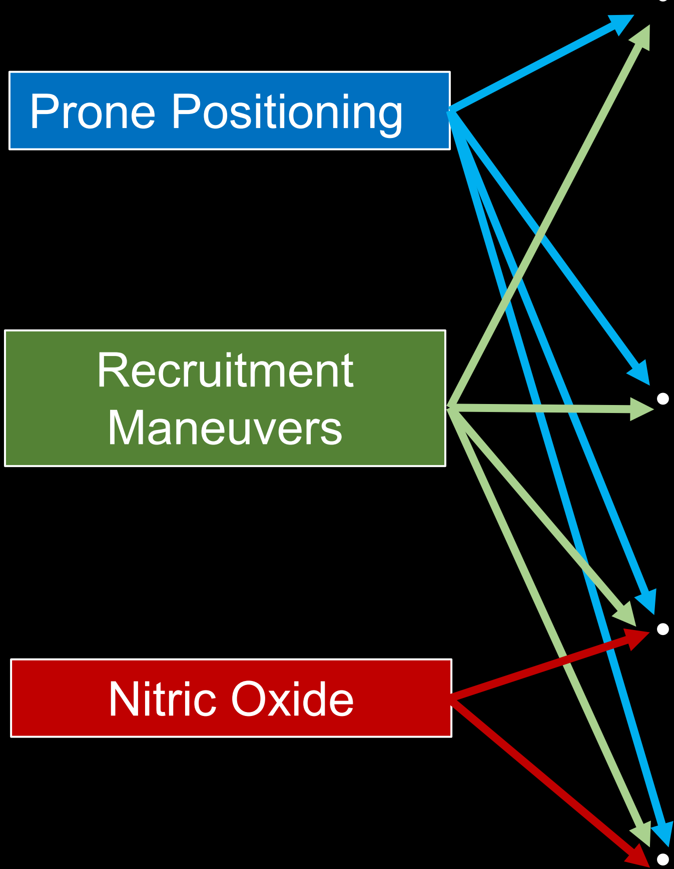
Ventilatory Management of ARDS?

Knowledge of mechanisms of action and predominant pathophysiological aspects of each stage of the in the evolution is critical for applying the correct therapeutic strategies

Adjuvant Measures- Sinergies

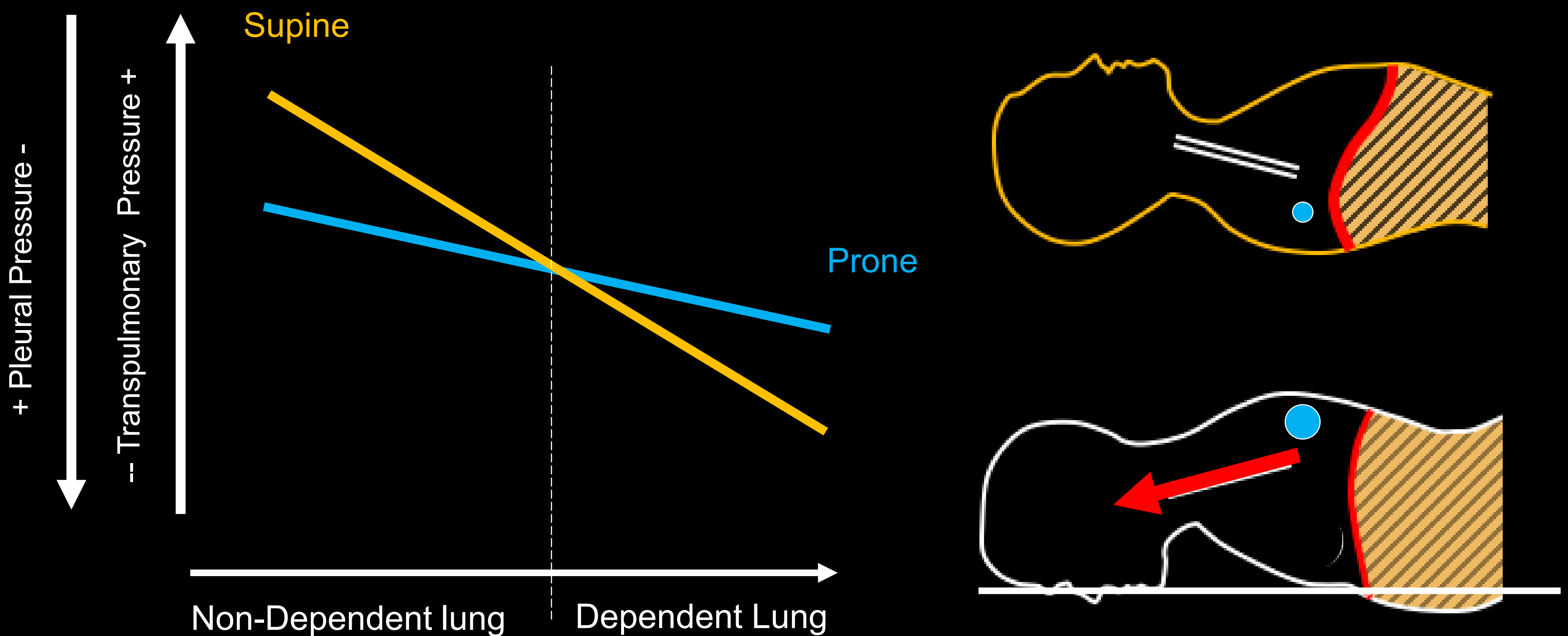
Adjuvant Measures

Objectives



- Homogenize Ventilation
  Minimize collapse and overdistensión
  ↑functional size of the lung
  Improve compliance--- reduce driving pressure
  ↓"strain"
- Reduce cyclic changes in transpulmonary pressure
- ↓ risk of pulmonary vascular dysfunction and RV failure
- Improve gas-Exchange and ↓F_IO_2 needs

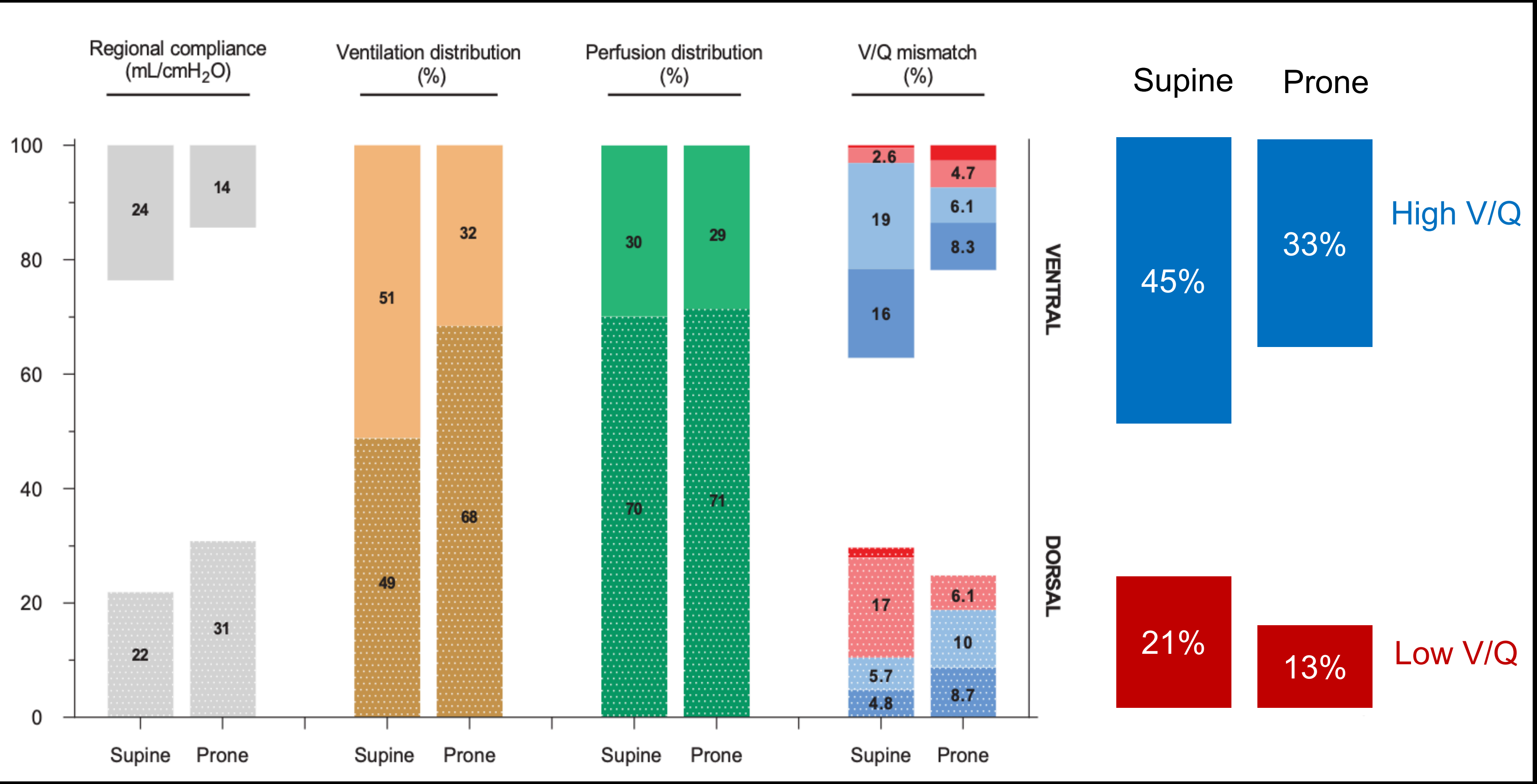
Effects or Prone Positioning



Re-aeration of dorsal lung regions that maintain a greater perfusion

Effects of proning measured by EIT

9 C-ARDS patients



Perier F et al AJRCCM 2020 epub)

Changing the Prone Postioning Paradigm

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Prolongued/Delayed Prone Positioning

- Feasible
- Safe (Low incidence of adverse events)
- Potential clinical – organizational benefits

Prolongued/Delayed Prone sessions

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No	Age	Timeline prone/supine position (hours)	PP > 24h/ PP Total, (%)	MV (days)	Outcome (A/D)
1	61	47 3 47 3 21 98 49	75	23	A
2	59	24 3 48	50	17	A
3	50	39 1 72 1 96 1 96 25 47	100	15	D
4	67	75 3 66 1 120	100	11	D
5	54	48 1 44 50 23	66	27	A
6	53	42 6 43 6 45 2 44	100	41	A
7	72	43 7 42 7 44	100	33	A
8	73	51 20 23 290 47 4 45	75	42	A
9	62	42	100	24	A
10	75	44 218 46 3 44 27 23	75	27	D
11	57	43 120 49 2 44	100	31	A
12	72	72 23 27	100	29	A
13	53	48	100	18	A
14	77	35 3 22	50	30	A
15	45	20 2 48 2 44 5 44 5 43	80	26	A
16	61	45 3 45 24 46 4 47 2 47	100	19	A
17	39	47 4 24 7 39 3 47	75	11	A

Prone Supine

Days 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Mean duration of Prone sessions 48h

Concha P, et al. Med Intensiva. 2022;46:161-163.

Lung Recruitment and individualized PEEP

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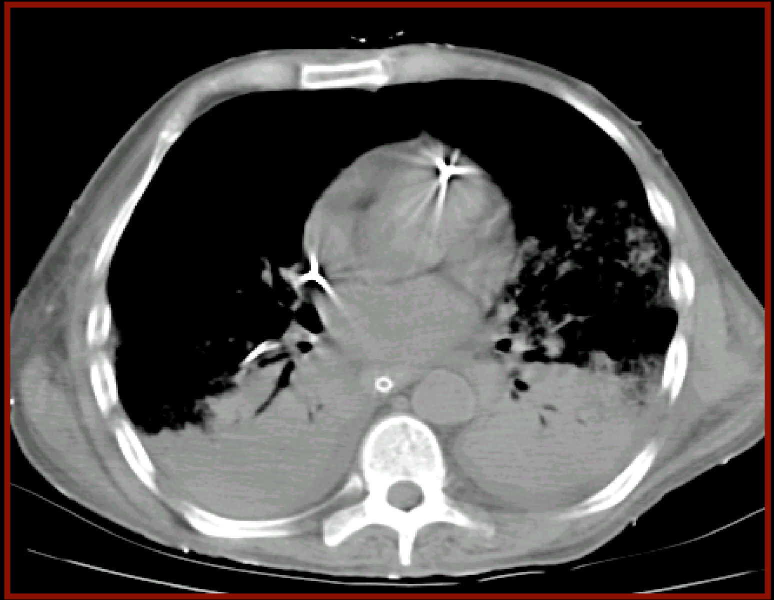
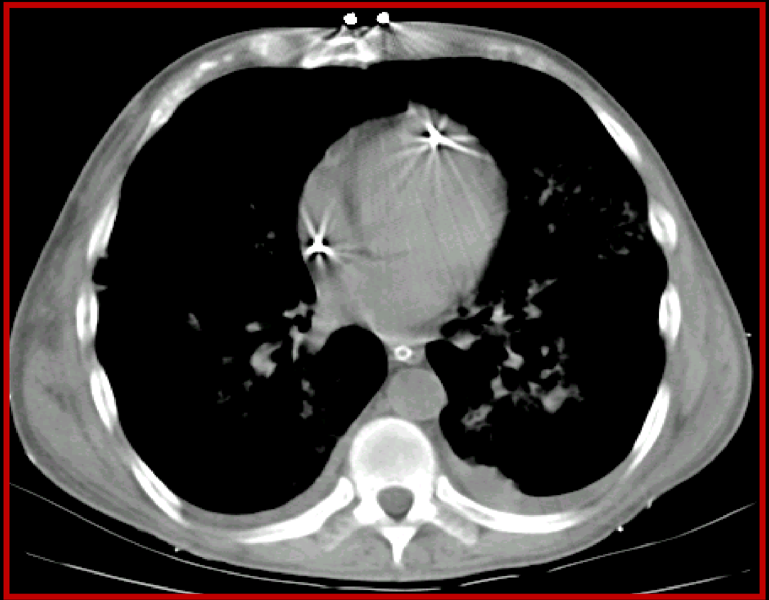
When lung collapse is an important pathophysiological component…

Baseline



Post-Recruitment + PEEP



Less heterogenity

Increased functional size

Increased compliance

Lager EELV

Autmated Open Lung Procedure

Recruitment Phase

Cycling Pressure Controlled Ventilation
Incremental PEEP steps with fixed ΔP

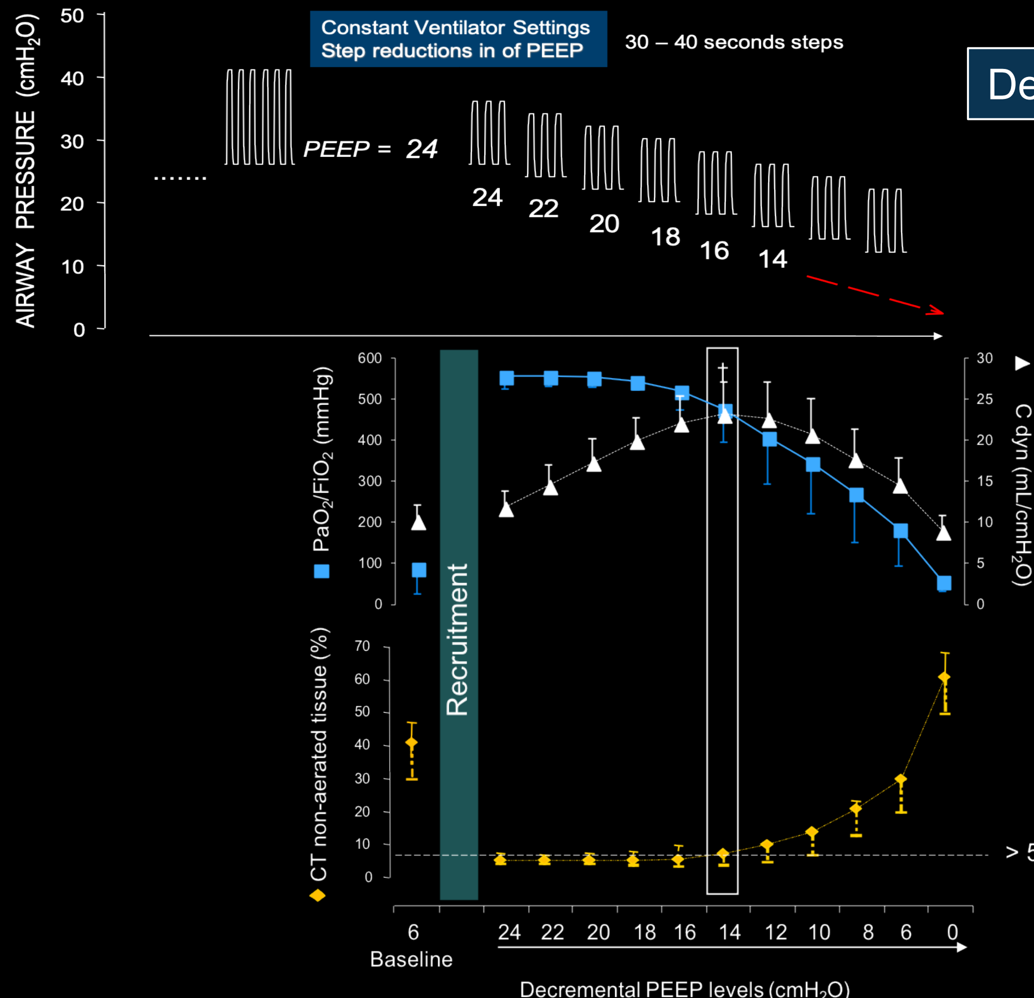
PEEP titration

- Volume Controlled Ventilation
- 2 cmH_2O PEEP steps
- Automatic detection of optimal PEEP
- Based on maximal Cdyn

Individualized PEEP

PEEP that minimizes lung colapse and overdistension

Decremental PEEP titration



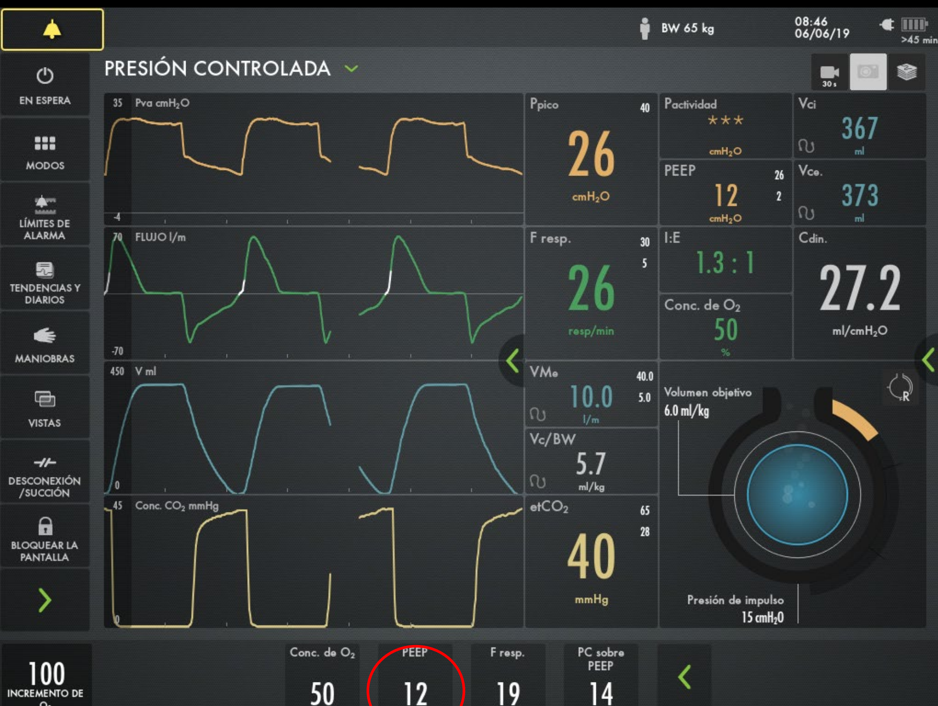
Suarez Sipmann et al Crit Care Med 2007; 35:214–221

Automatic PEEP detection

Automatic PEEP detection at 10 cmH_2O

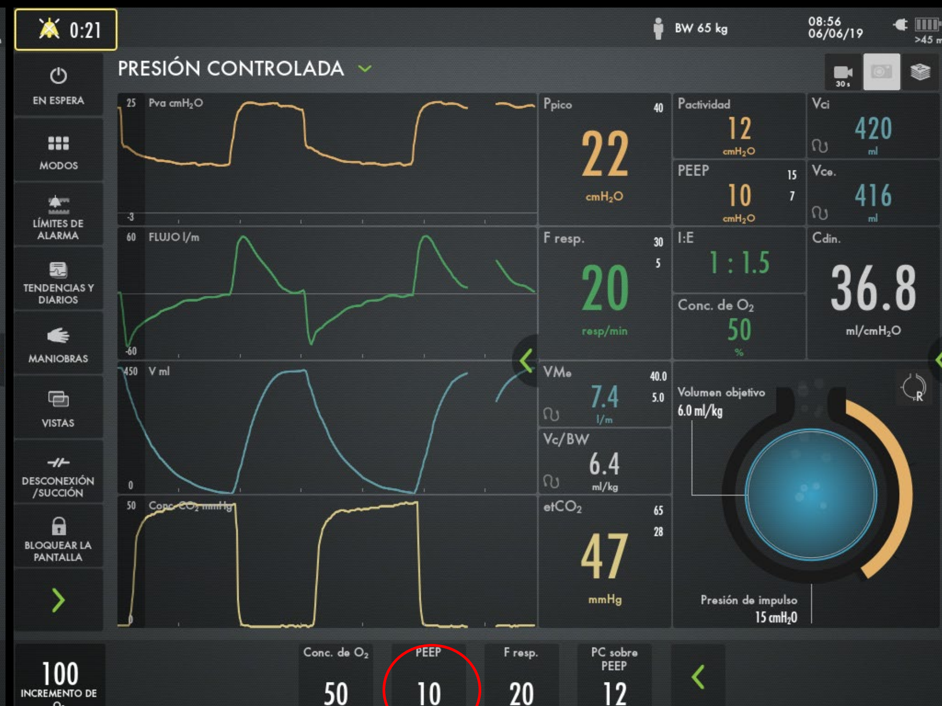
PaO_2/FIO_2 161 mmHg
$PaCO_2$ 49 mmHg
Cdyn 37 mL/cmH_2O

Before



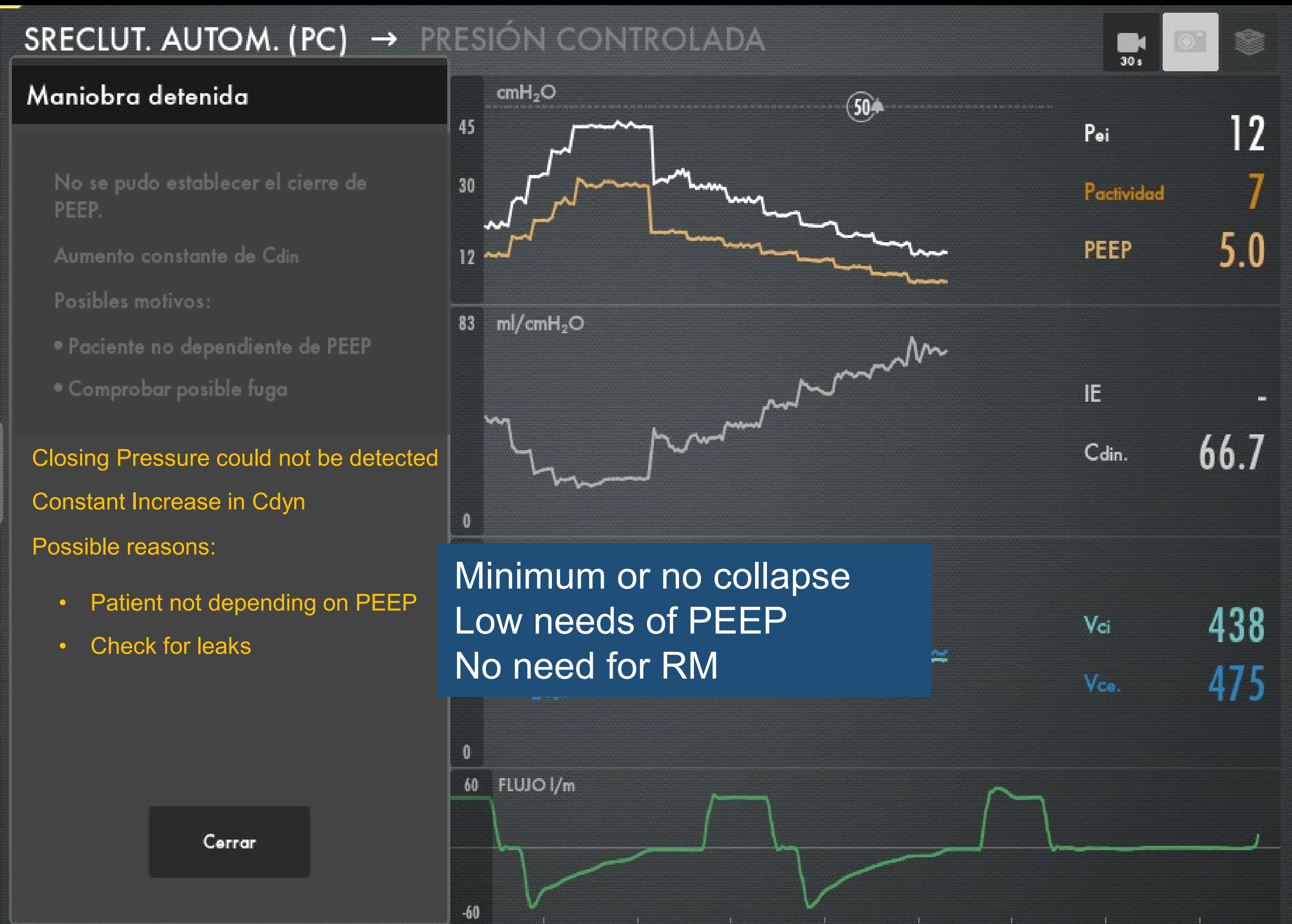
PaO_2/FIO_2 136 mmHg
$PaCO_2$ 47 mmHg
Cdyn 33 mL/cmH_2O

After…….. (10 min later)



PaO_2/FIO_2 161 mmHg
$PaCO_2$ 49 mmHg
Cdyn 37 mL/cmH_2O

Assessment of recruitability



COVID-ARDS PEEP tritration examples

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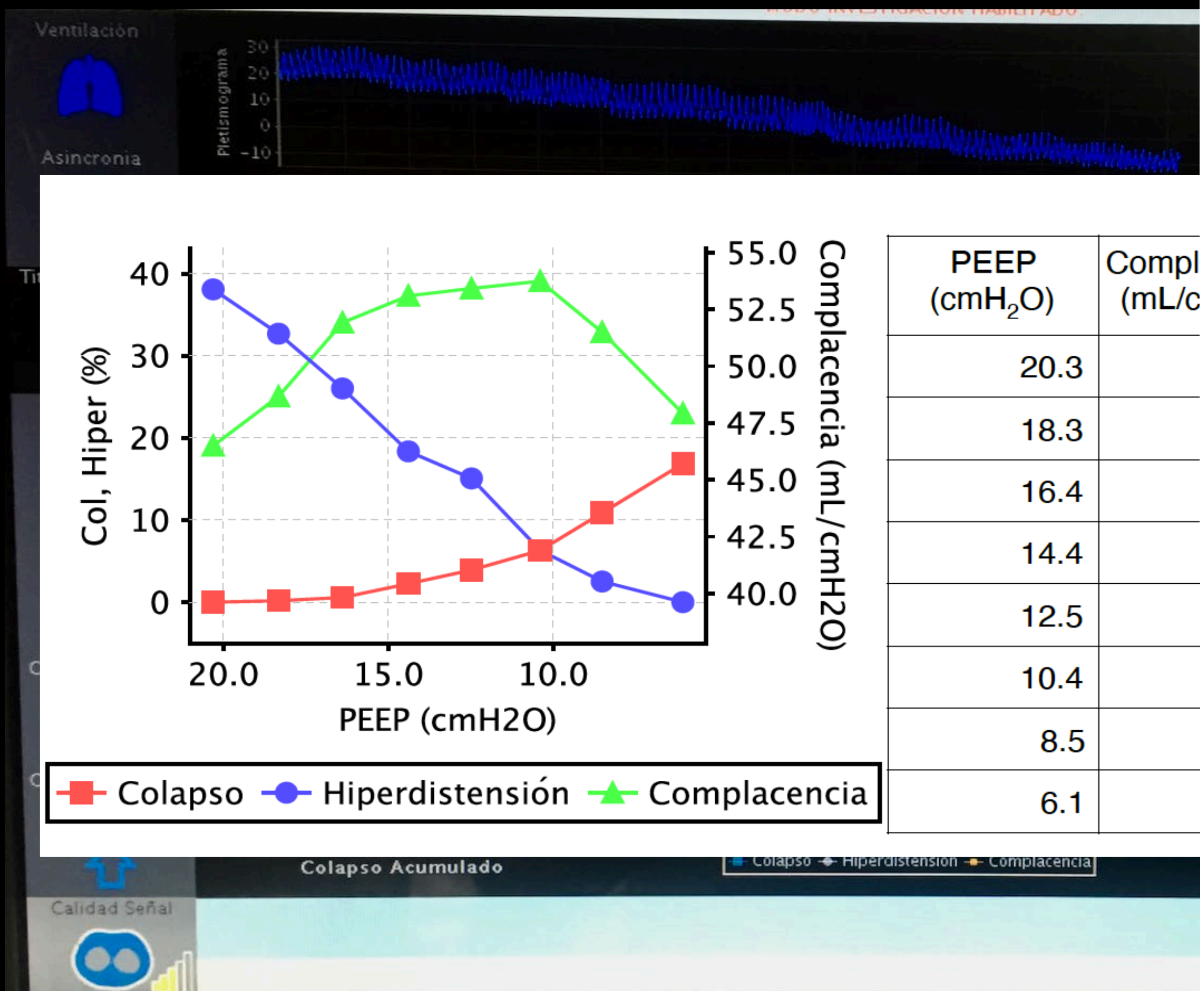
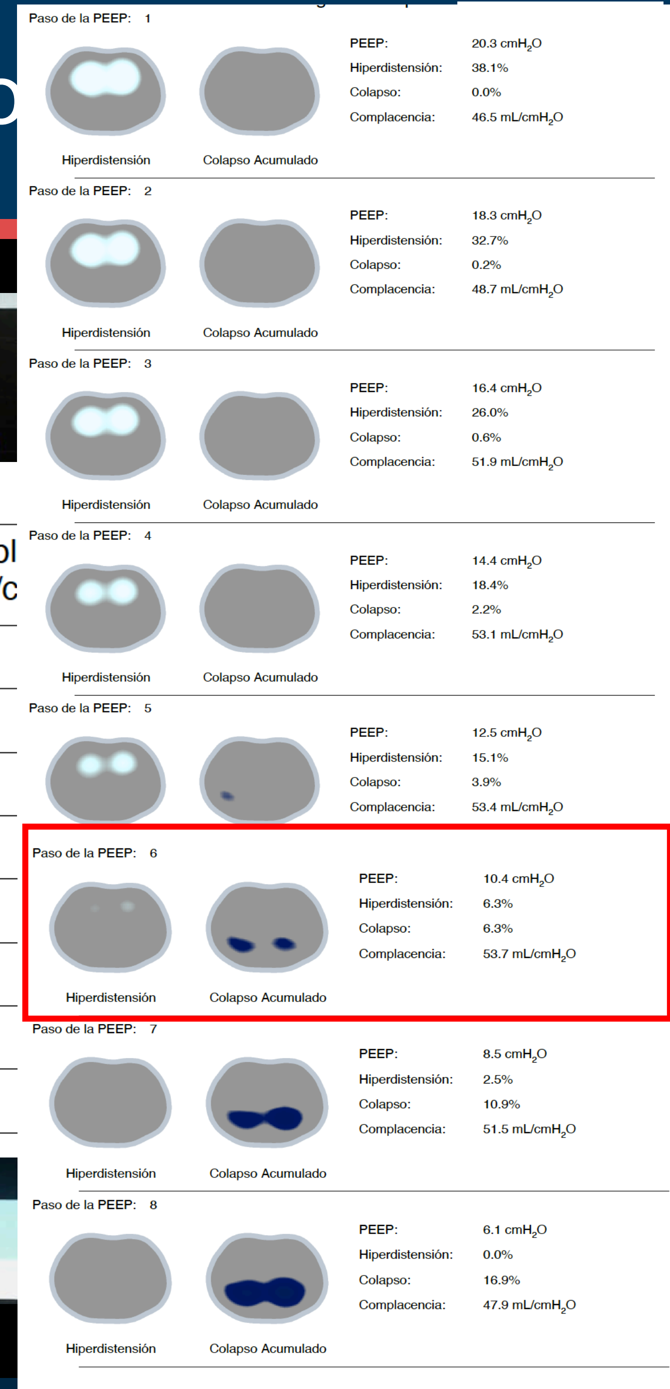
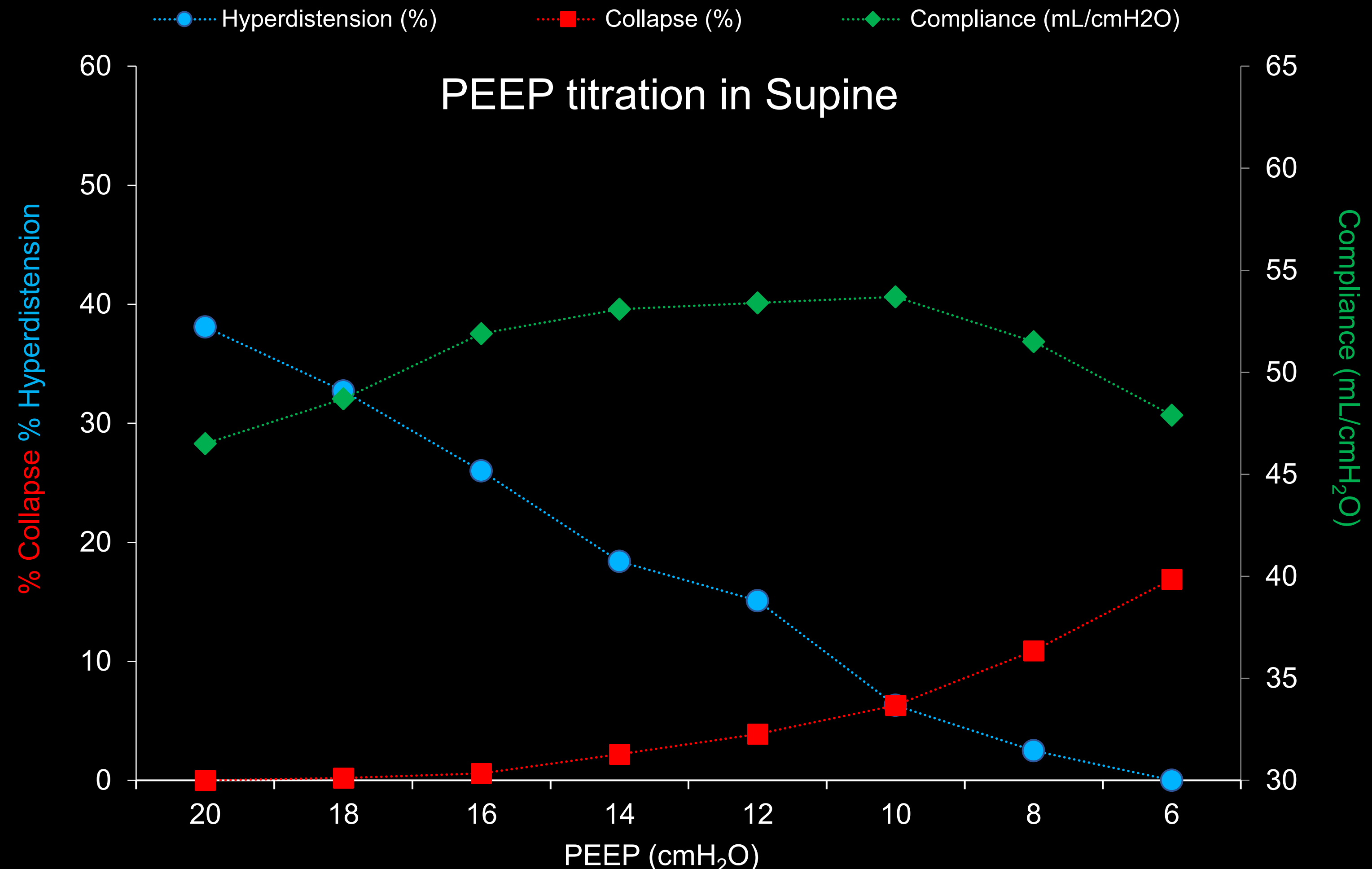
Decremental PEEP titratio





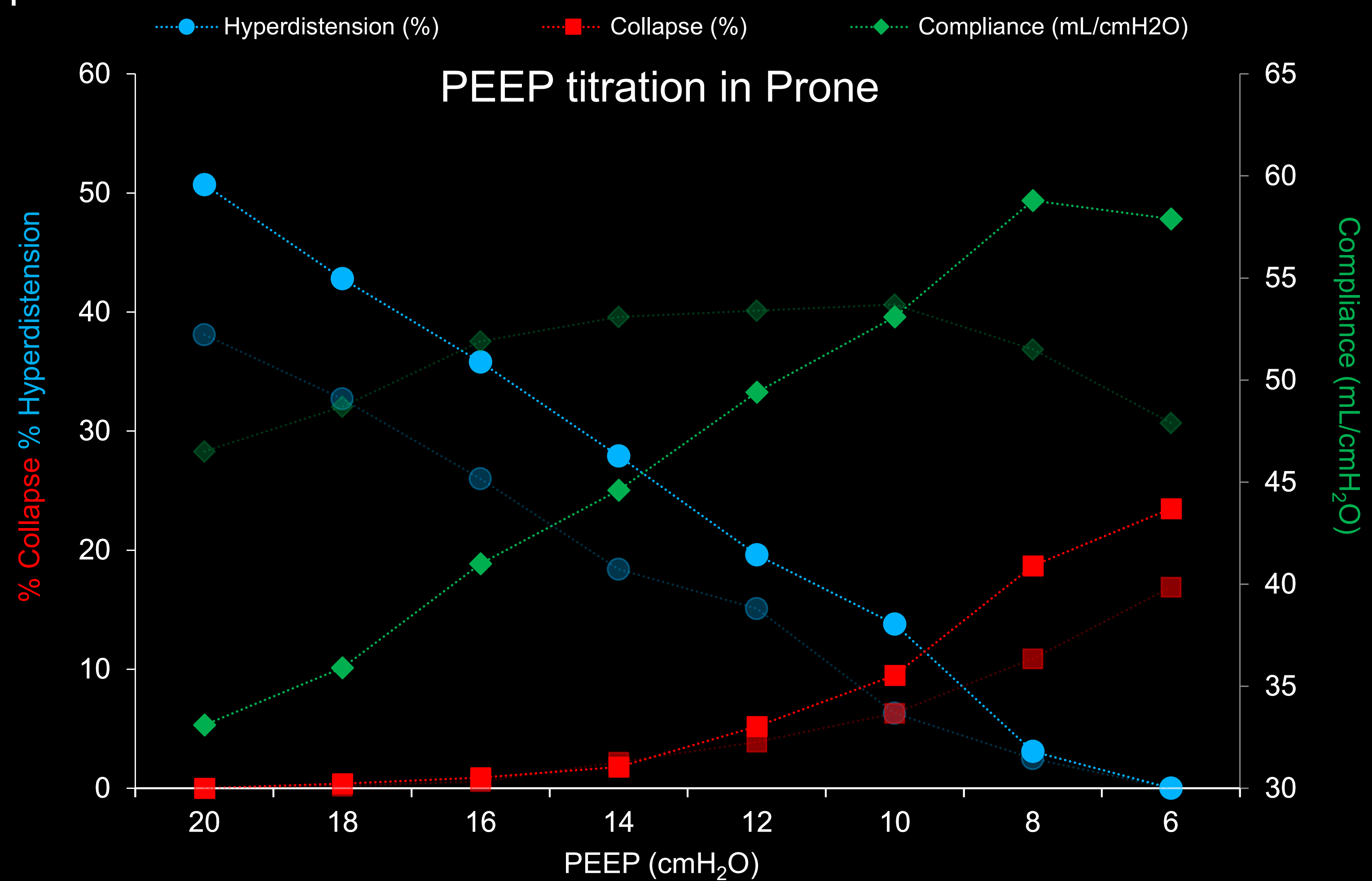
Individualizing the PEEP level

C-ARDS patient



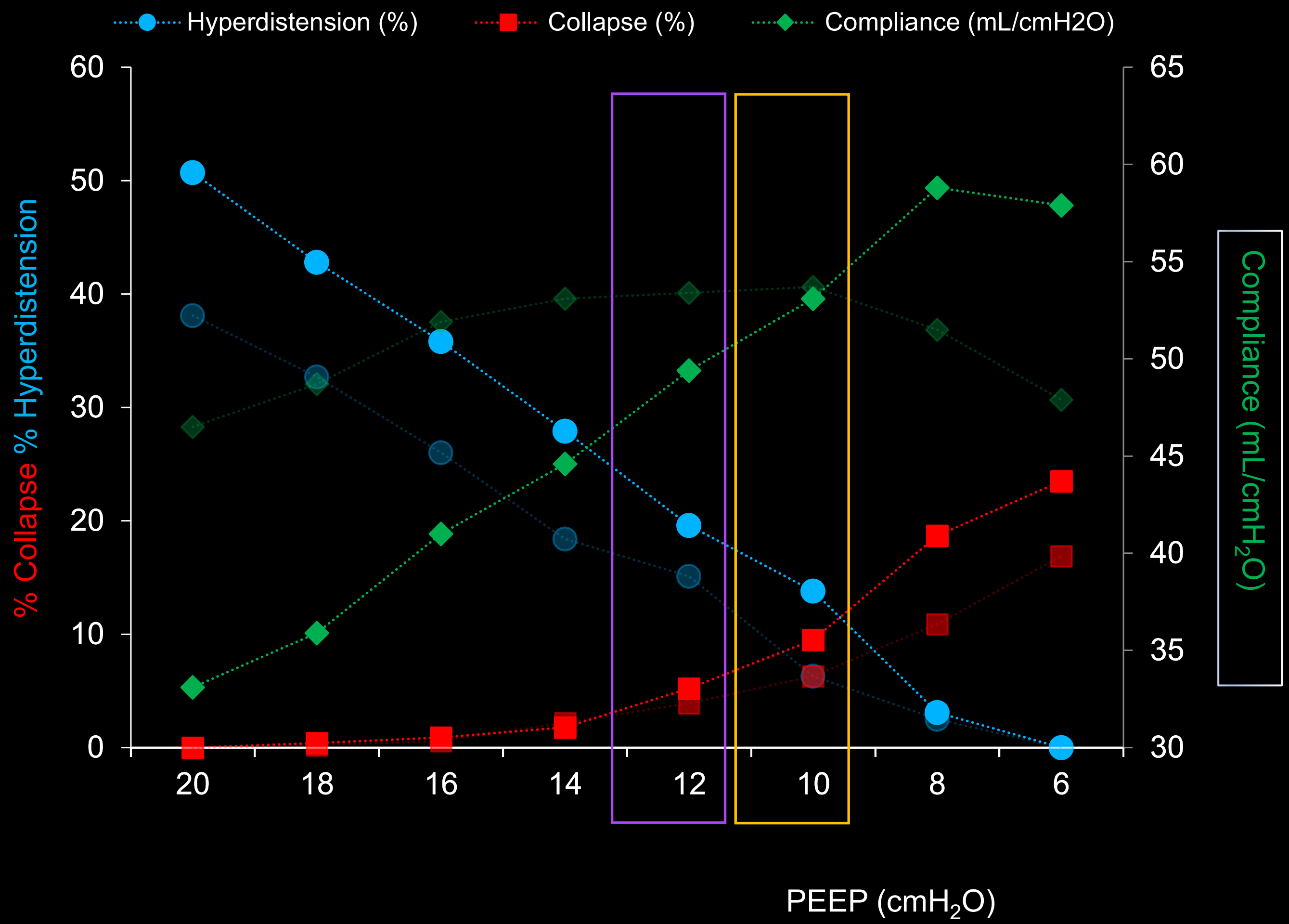
Individualizing the PEEP level

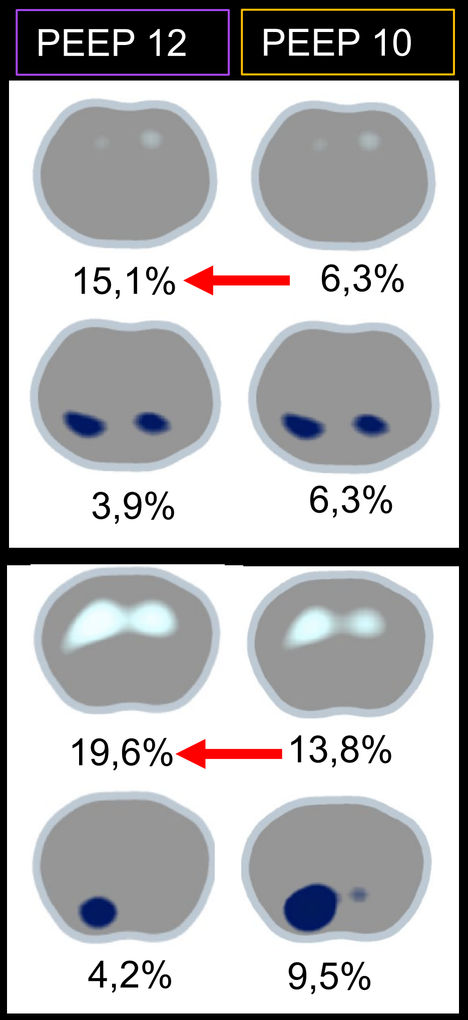
C-ARDS patient



Careful when selecting your PEEP!

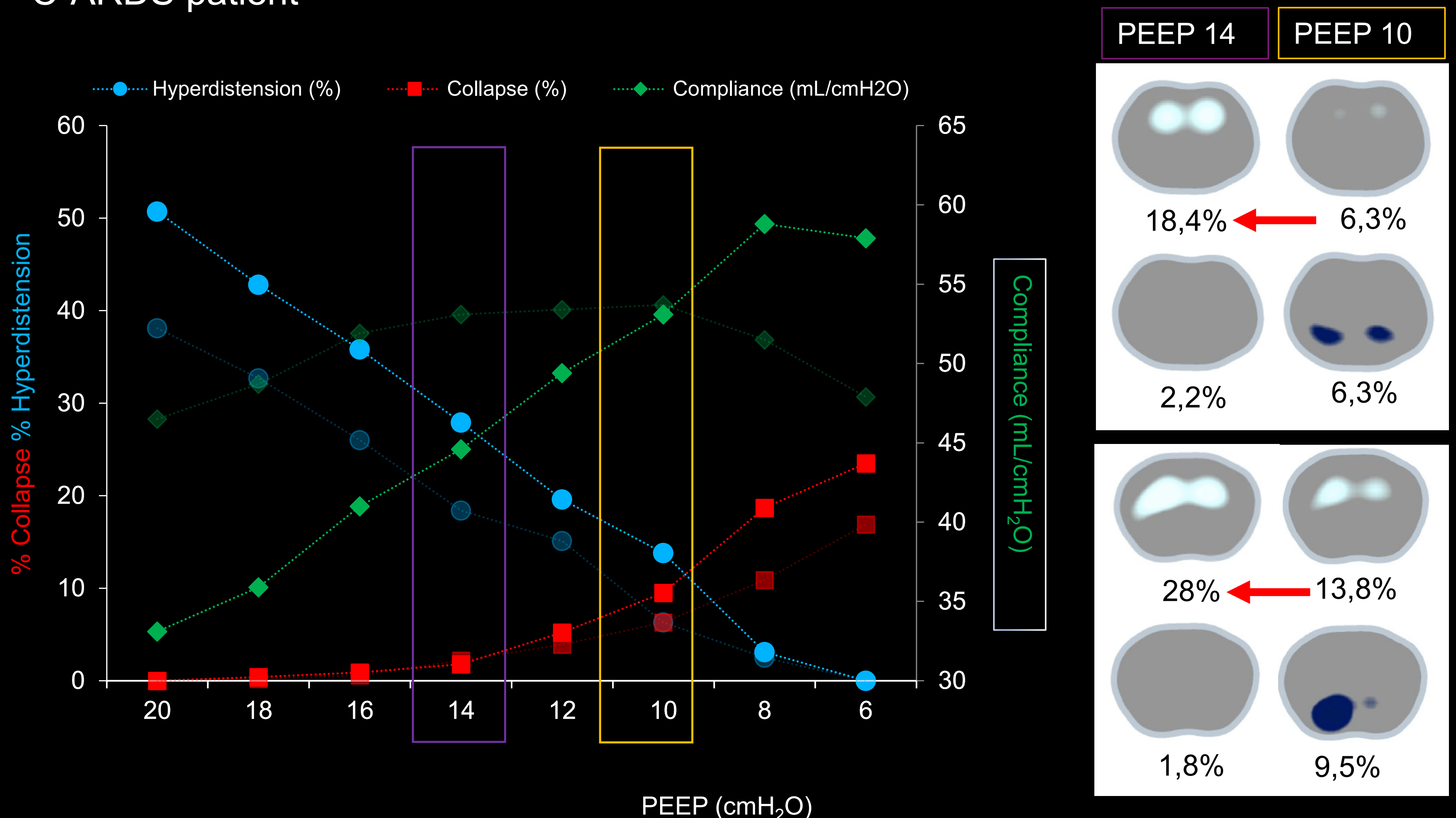
C-ARDS patient





Careful when selecting your PEEP!

C-ARDS patient

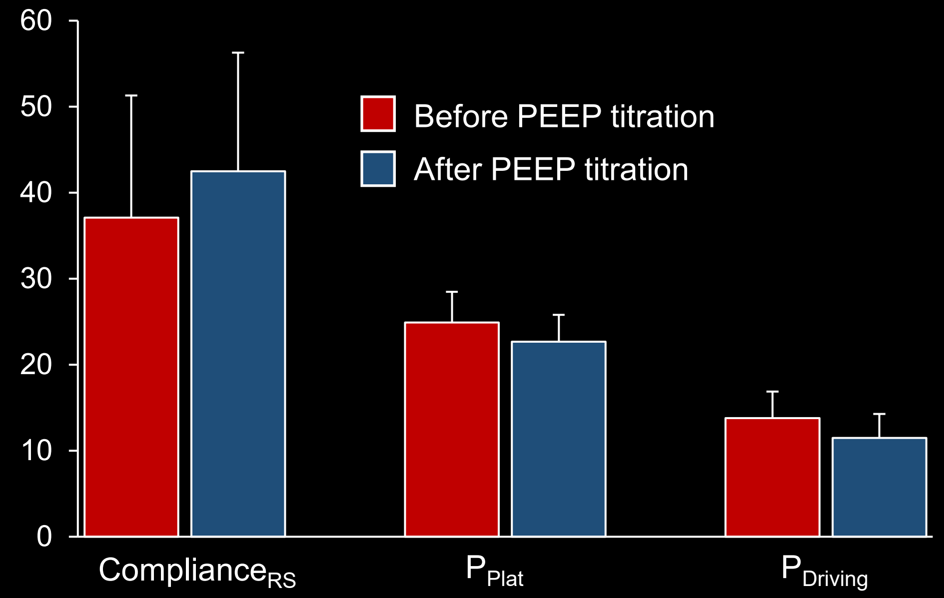


90 Fully recored Decremental PEEP titrations (60 in supine 30 in prone)

$PEEP_{Clin}$ 11.3 ± 3.6
$PEEP_{Cdyn}$ 10.5 ± 3.1

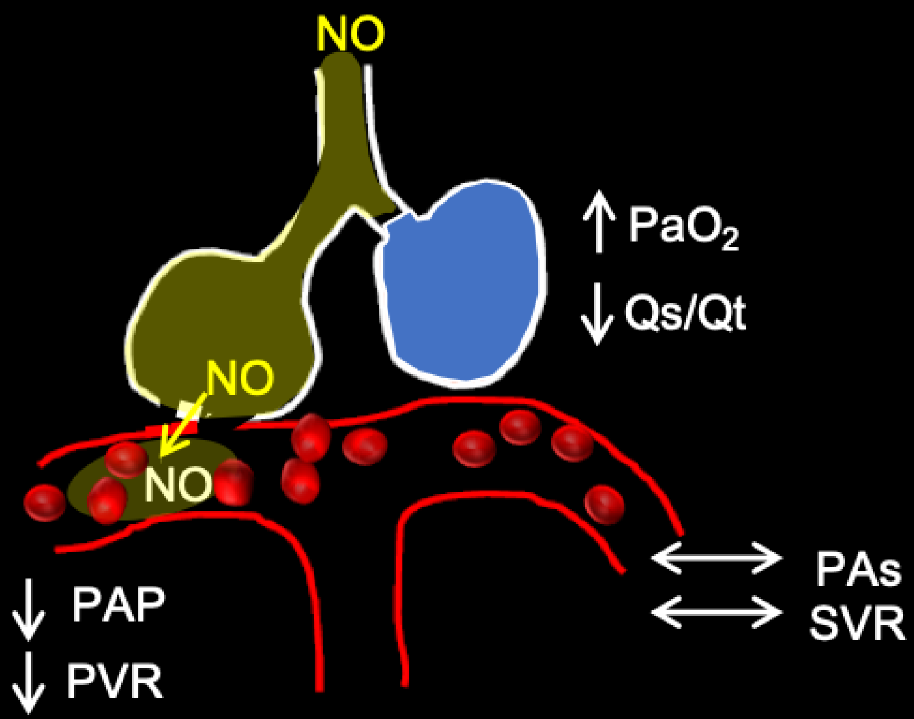
$PEEP_{Cdyn}$ < $PEEP_{CLIN}$ 62% (2.6 ± 2 cmH_2O)
$PEEP_{Cdyn}$ > $PEEP_{CLIN}$ 28% (3.1 ± 1.7 cmH_2O)
$PEEP_{Cdyn}$ = $PEEP_{CLIN}$ 10%

Overall improvement in lung mechanics



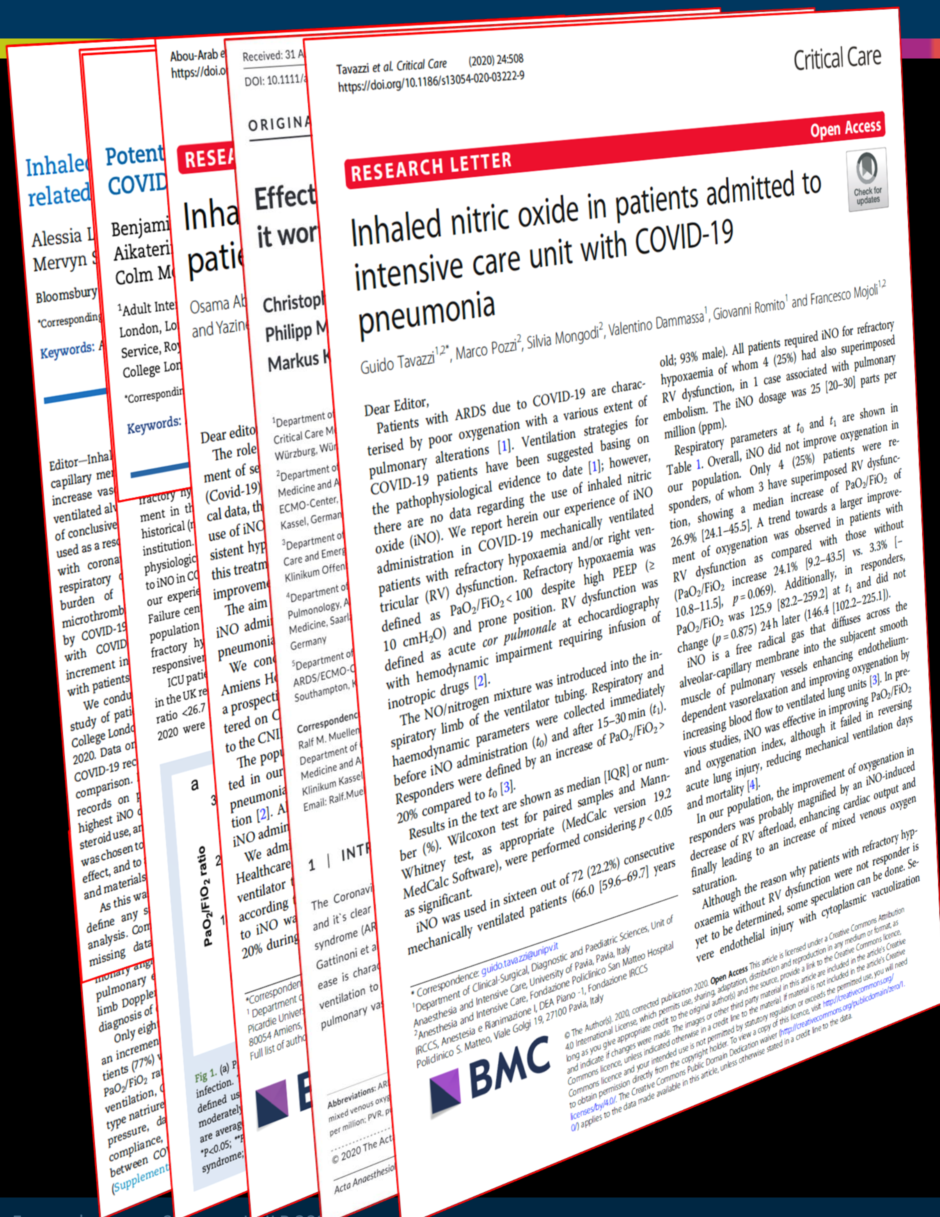
Sanchez Giralt et al. ICMex 2020 Conf-Abs

Physiological effects of iNO



- Selective Pulmonary Vasodilator
- Improved VQ
  Blood Flow redistribution to better aerated regions
  Dosis ≤10 ppm
- Improved Pulmonary Hemodynamics
  ↓PVR and PAP
  Dosis ≥15-20 ppm

Nitric Oxide in C-ARDS



iNO improves oxygenation in a majority of C-ARDS patients

Causes for lack of response are not known

There may be benefits beyond oxygenation (not thoroughly studied)

RESEARCH LETTER Open Access

Inhaled nitric oxide in patients admitted to intensive care unit with COVID-19 pneumonia

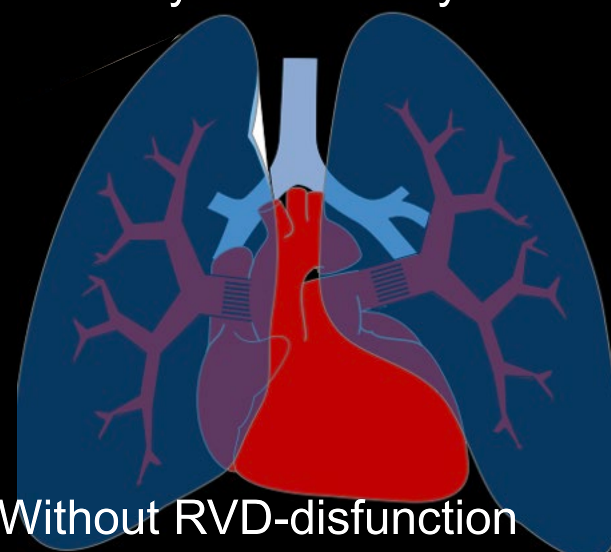
Tavazzi *et al. Critical Care* (2020) 24:508
https://doi.org/10.1186/s13054-020-03222-9

Guido Tavazzi[1,2*], Marco Pozzi[2], Silvia Mongodi[2], Valentino Dammassa[1], Giovanni Romito[1] and Francesco Mojoli[1,2]

Conclusion

Overall, iNO did not improve oxygenation in COVID-19 patients with refractory hypoxaemia, when administered as a rescue treatment after prone position. A subgroup of patients with RV dysfunction was better iNO responders probably due to the haemodynamic improvement associated with RV unloading.

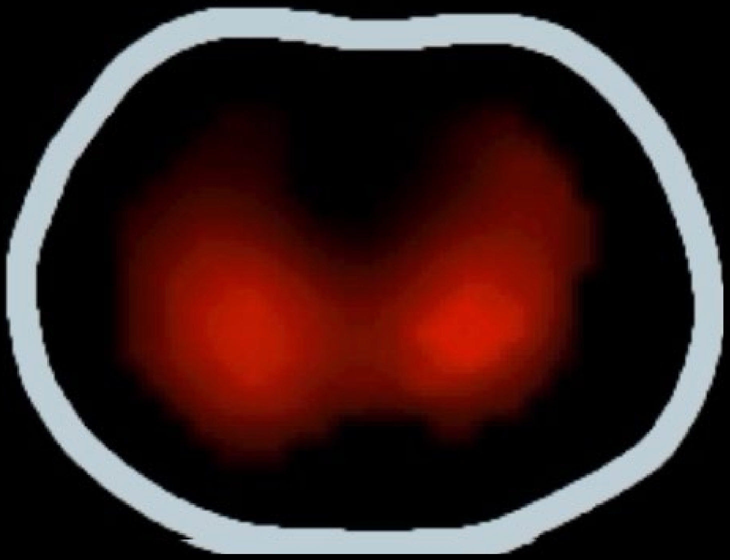
Pulmonary Vascular Dysfunction



iNO 20 - 30 ppm	With RV disfunction	Without RVD-disfunction
PaO_2/FIO_2 improvement	24.1% [9.2–43.5]	3.3% [-10.8 –11.5]

p = 0.069

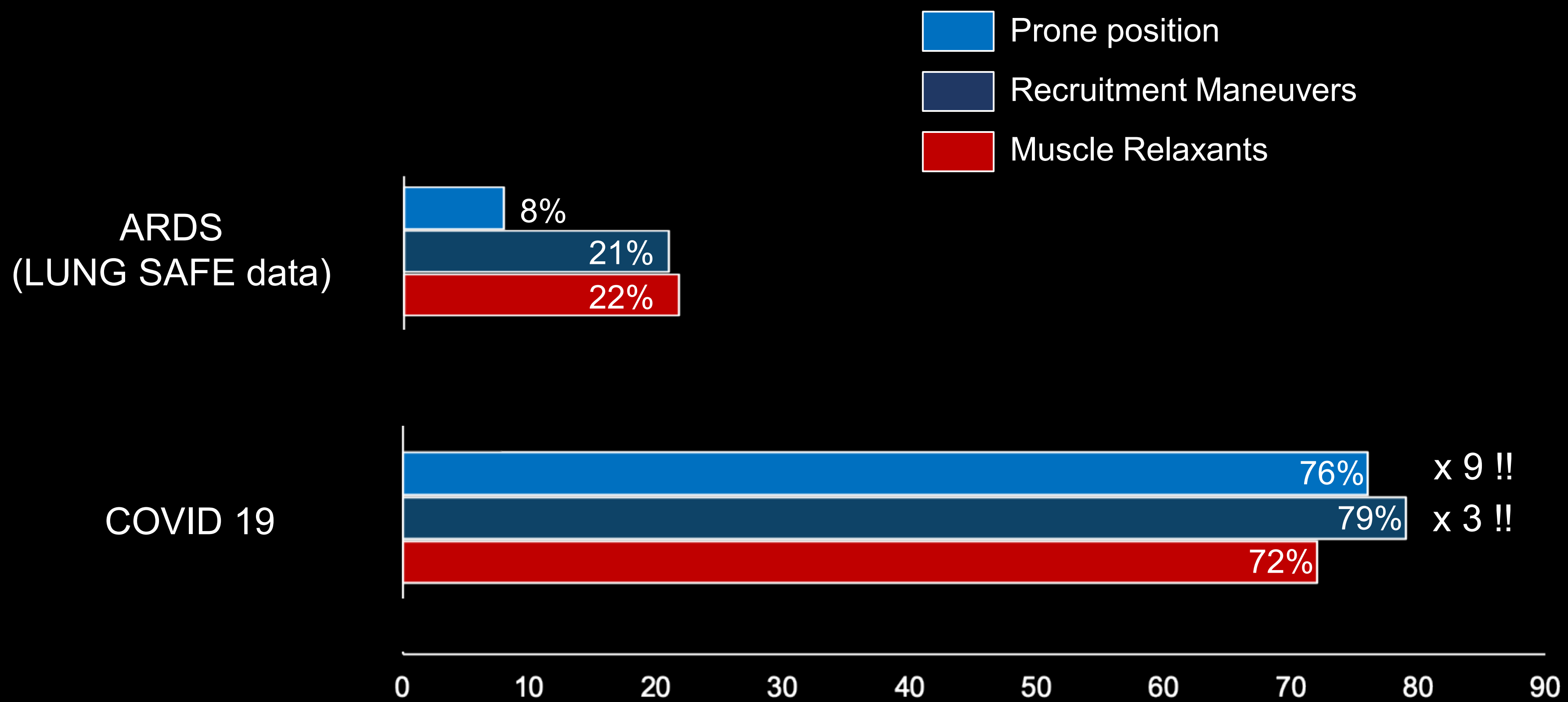
- Variable response   N= 8
- Shift of perfusion measured by EIT
- Dorsal shift --- decrease in oxygenation and efficiency
- Ventral shift – Increase in oxygenation PaO2/FiO2 by 30± 28%
- Decrease in $PaCO_2$ by 2.3%
- Best response evident between 5 and 15 ppm of iNO



iNO 20 ppm
Baseline

Sanchez Giralt et al. ICMex 2020 Conf-Abs

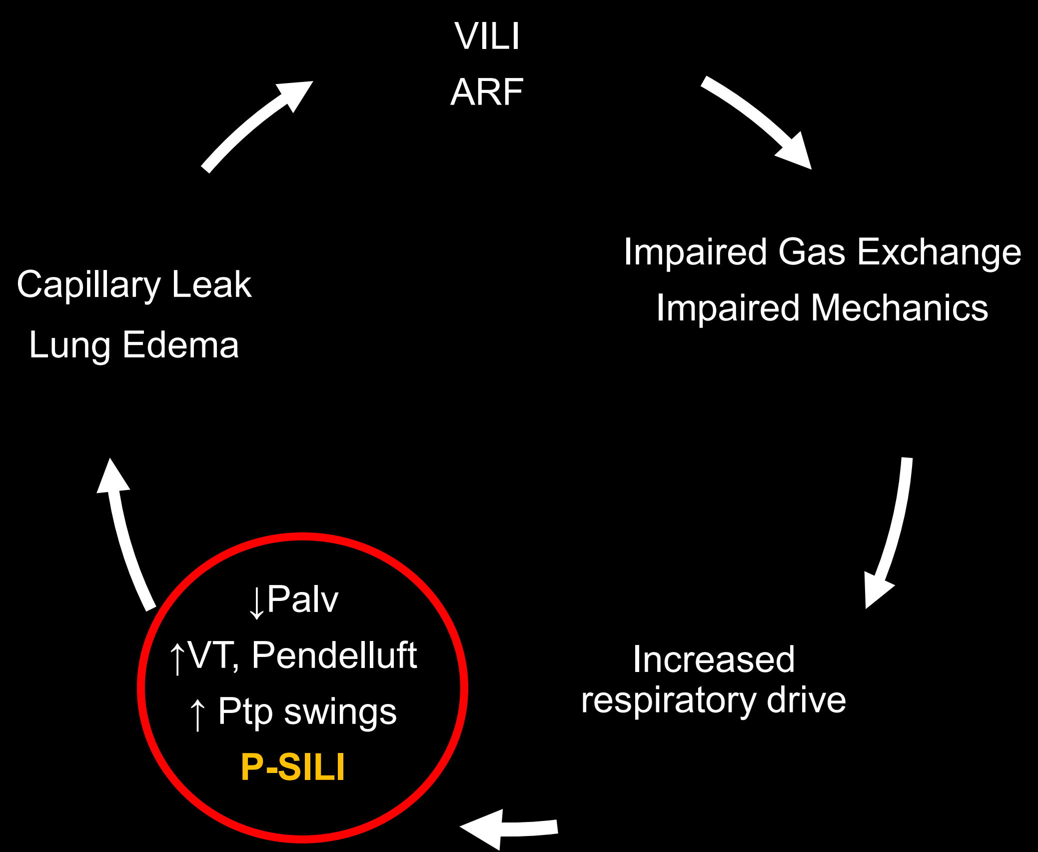
Adjunctive measures during C-ARDS



Ferrando C, Suarez-Sipmann F *et al. Intens Care Med* **46**, 2200–2211 (2020).

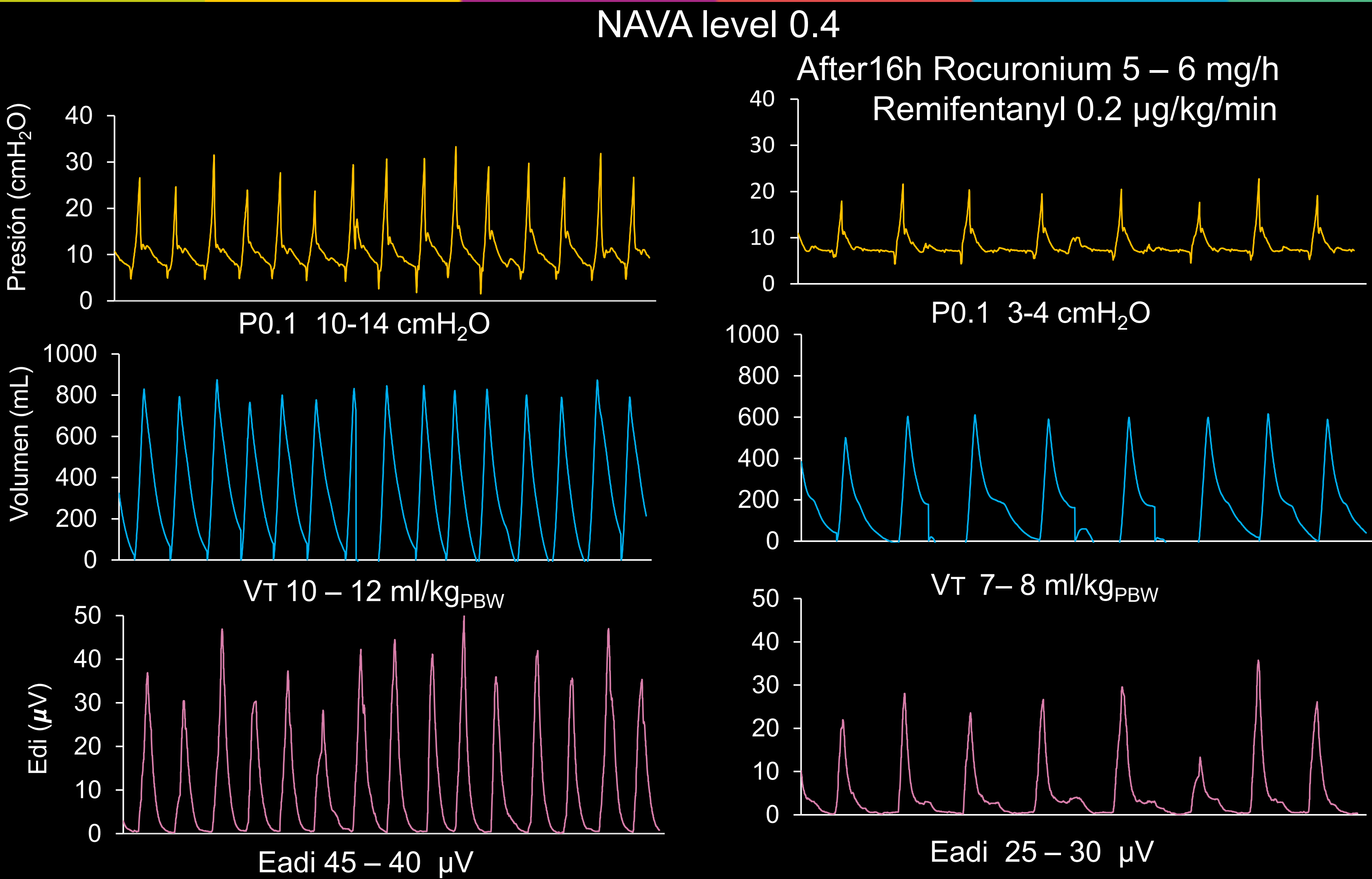
The transition to spontaneous breathing

P-SILI Patient Self Inflicted Lung Injury



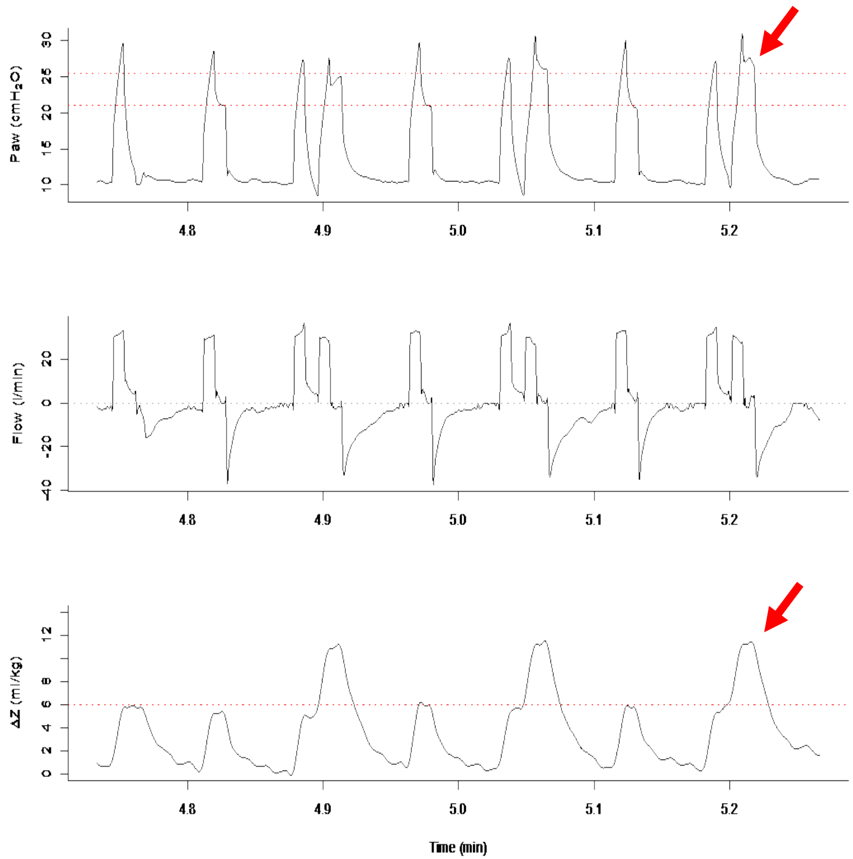
Modiified from Brochard et al AJRRCM 2017;195, 438–442

High respiratory drive



Double Triggering and breath stacking

Patient ventilated with set V_T = 6 mL/kg –
Sacked breaths : V_T = 12 mL/kg and P_{PLAT} = 28 cmH_2O



Do you recognize this…?

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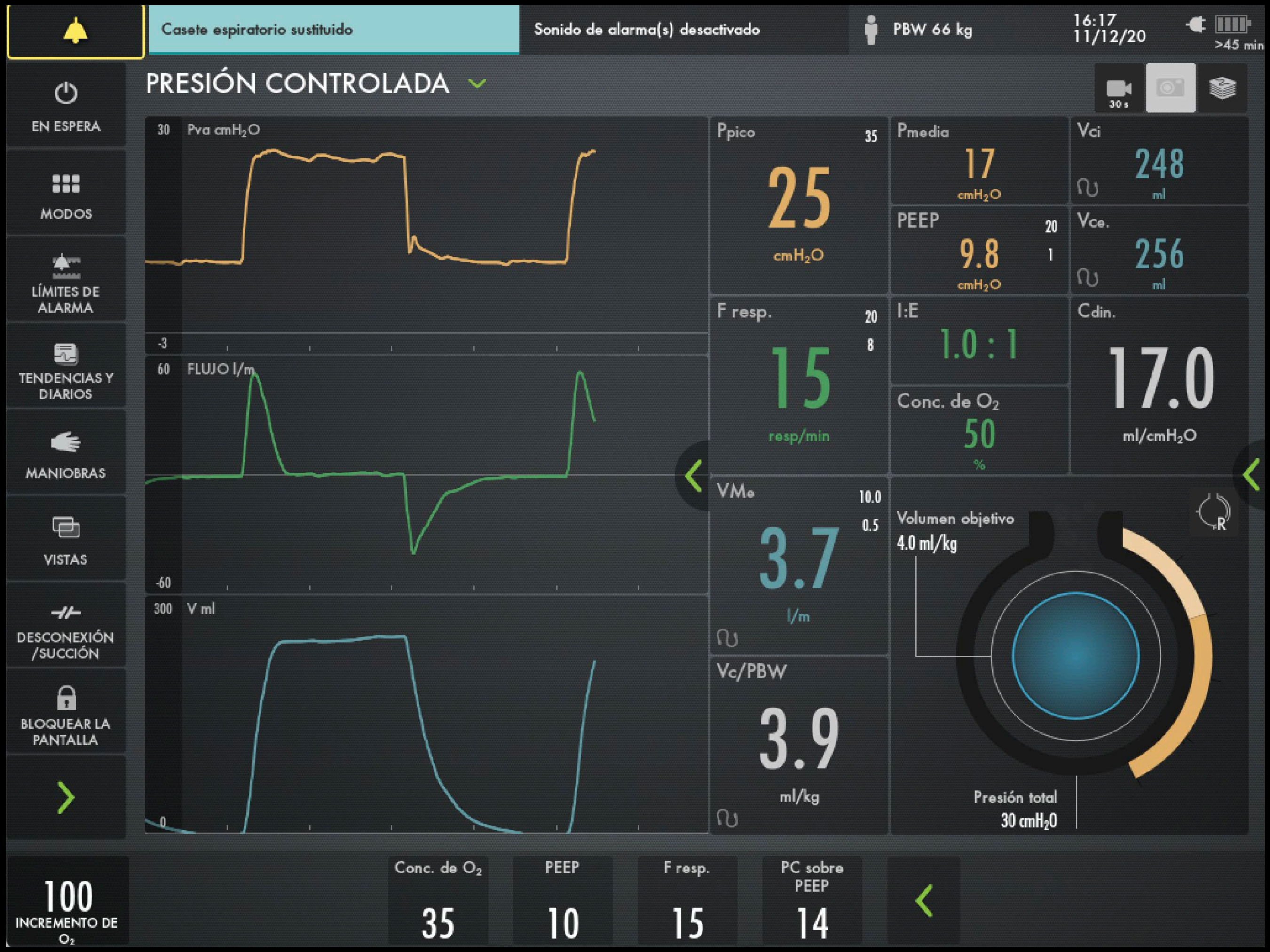
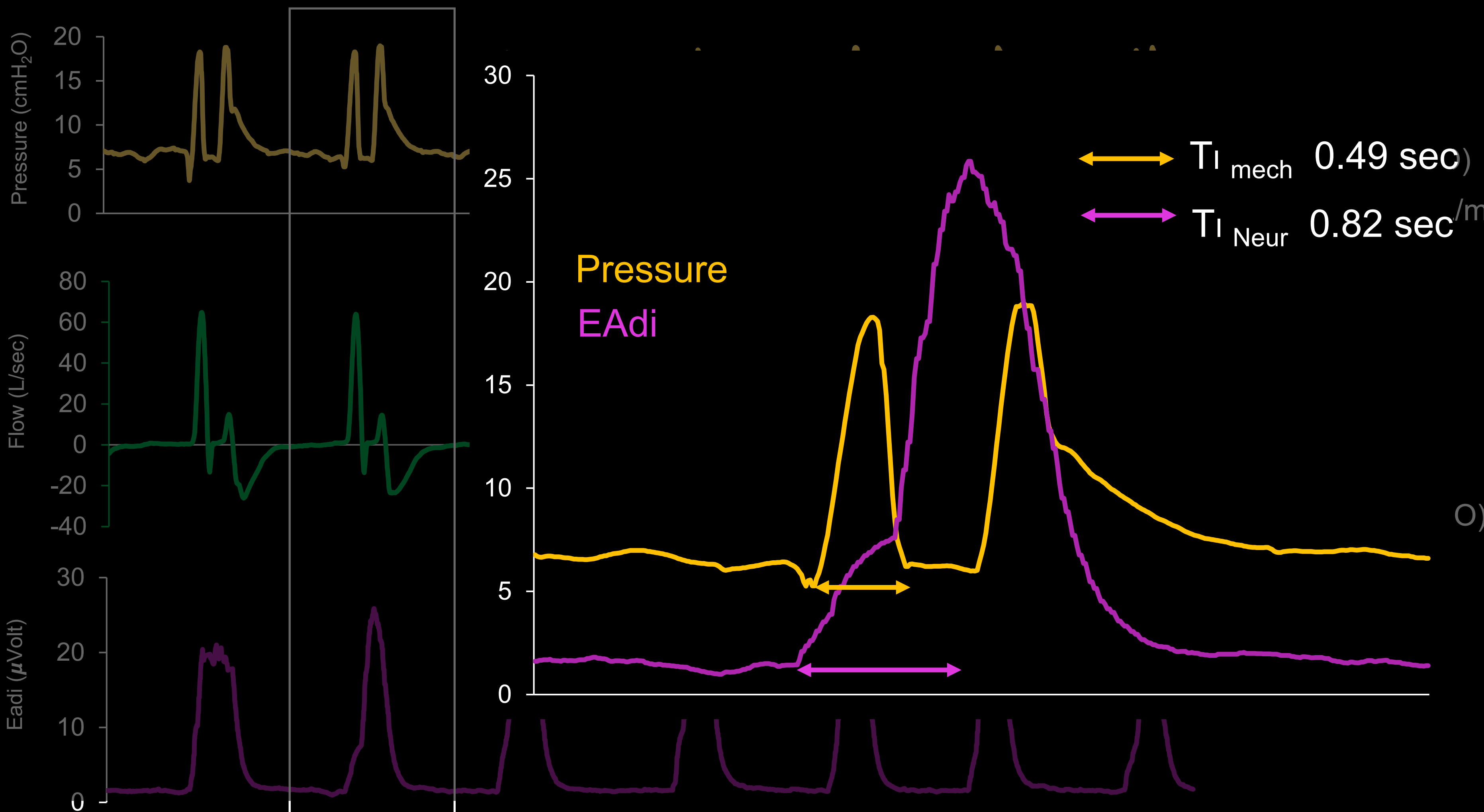


C-ARDS after 3 weeks of evolution



And so… the Paella is ready

Děkuji mnohokrát!! / Muchas Gracias!!

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