Mechanical Ventilation during VV ECMO

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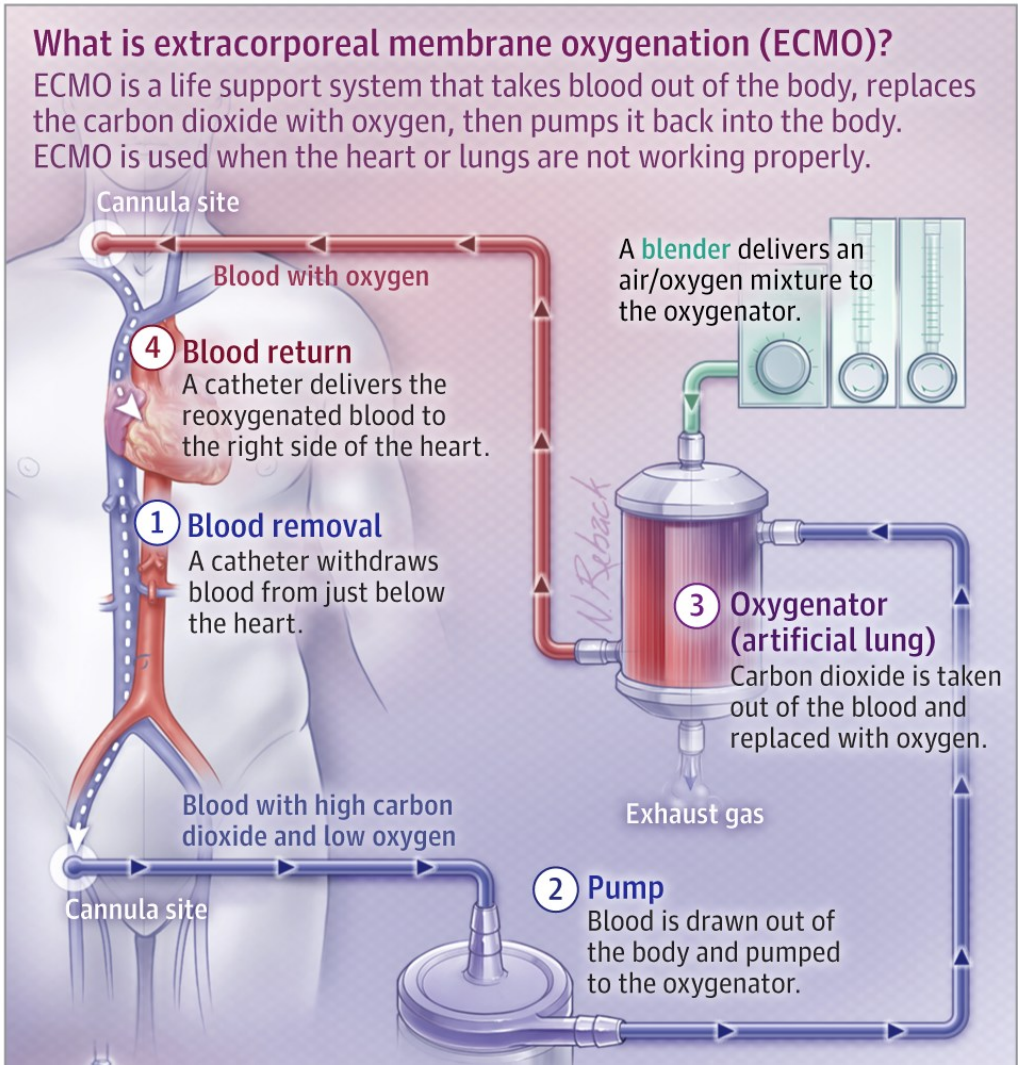
What is ECMO?

- Extracorporeal Membranous Oxygenation
- VA ECMO vs. VV ECMO
- VA ECMO = Cardiac ECMO
- VV ECMO = Respiratory ECMO

How does VV ECMO work?



JAMA. 2020;323(24):2536

Mechanical Ventilation prior to VV ECMO in ARDS patients

- Lung protective mechanical ventilation

1. Plateau pressure ≤ 30 cmH2O
2. Tidal volume – 6ml/kg (PBW)
3. PEEP set to PEEP table

- Prone Positioning

- Neuromuscular blockade

Benefits of VV ECMO
(Theoretical)

- **Rescue strategy**

- **Prevention of VILI**

<u>Risk factors of VILI</u>

1) High tidal volume
2) High airway pressure/driving pressure
3) High mechanical power

Concept of Lung Rest

- Minimizing risk factors of VILI (Pressure, Volume, RR) during VV ECMO

- Animal study showed that apnea may decrease lung injury and suppress fibroproliferation in ARDS

Am J Respir Crit Care Med. 2019;199:603-612. PMID: 30216736.

SUPERNOVA study

SEVEN-DAY PROFILE PUBLICATION

Feasibility and safety of extracorporeal CO_2 removal to enhance protective ventilation in acute respiratory distress syndrome: the SUPERNOVA study

Use of ECCO2R to enhance ultra-protective lung ventilation (TV 4.2 ± 0.5 ml/kg) in patients with ARDS (Single-arm study)

-> Lower TV, Lower DP, and Lower Plateau pressure were achieved
-> **RR was around 24-25/min. Mechanical power remained high (19-20 J/min).**

Intensive Care Med. 2019; 45(5):592-600. PMID: 30790030.

REST Trial

Research

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Lower Tidal Volume Ventilation Facilitated by Extracorporeal Carbon Dioxide Removal vs Standard Care Ventilation on 90-Day Mortality in Patients With Acute Hypoxemic Respiratory Failure

The REST Randomized Clinical Trial

Use of ECCO2R to enhance ultra-protective lung ventilation (TV 4.5 ± 1.6 ml/kg) in patients with ARDS did not show any mortality benefit nor shorter MV duration.

-> Lower TV, Lower DP, and Lower Plateau pressure did not improve clinical outcomes.
-> **However, RR was around 24-25/min. Mechanical power remained high (25-26 J/min).**

JAMA. 2021; 326(11):1013-1023. PMID: 34463700.

EOLIA Trial

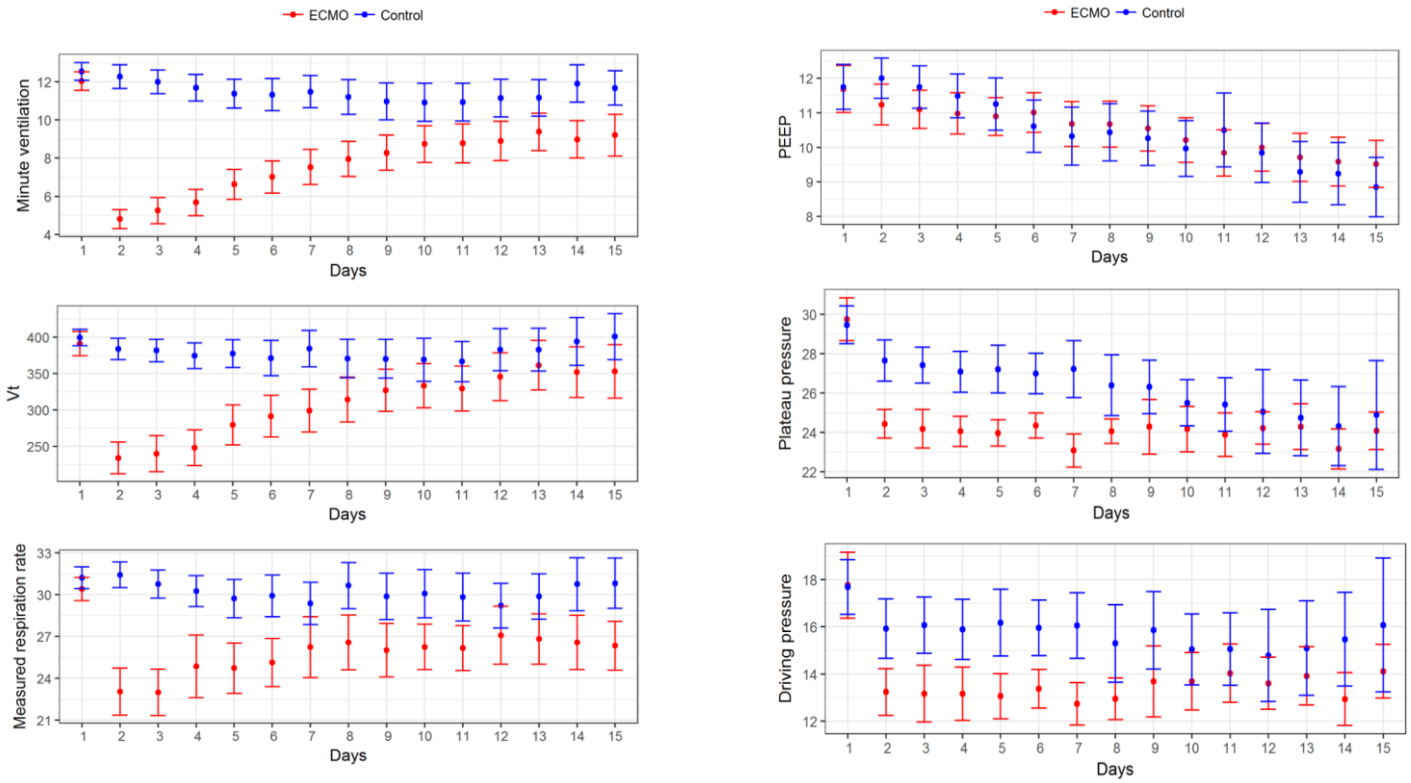
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 24, 2018 VOL. 378 NO. 21

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

Standardized MV protocol during VV ECMO:

PEEP ≥ 10mmHg
Plateau pressure < 25 mmHg
FiO2 0.3 – 0.5



N Engl J Med. 2018; 378(21):1965-1975.
PMID: 29791822.

LIFEGARDS study

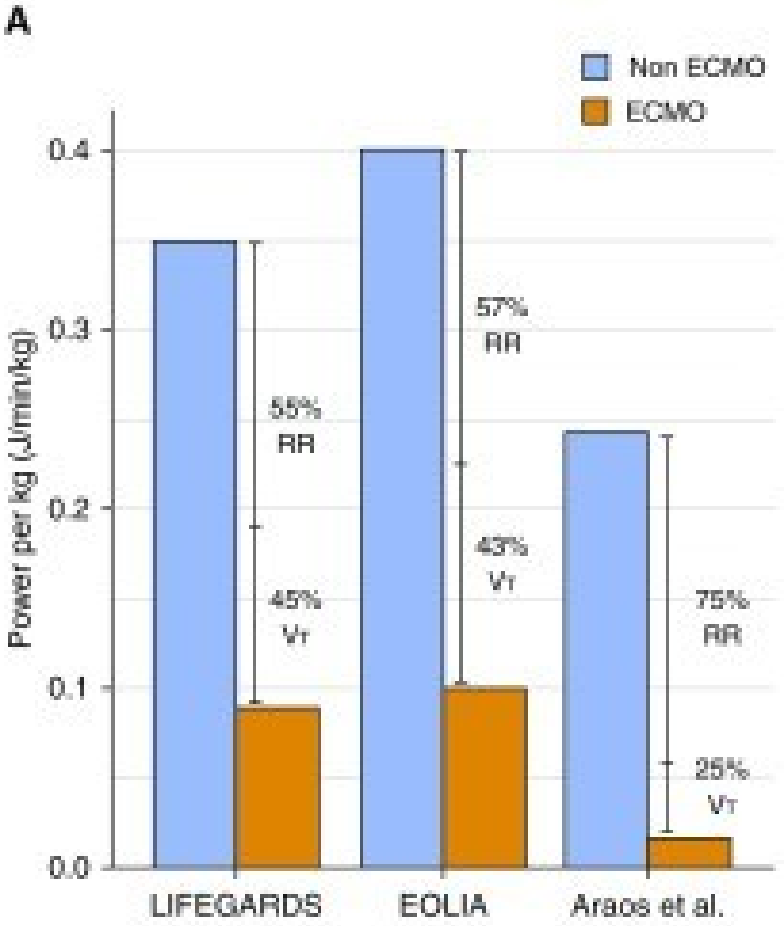
ORIGINAL ARTICLE

Mechanical Ventilation Management during Extracorporeal Membrane Oxygenation for Acute Respiratory Distress Syndrome
An International Multicenter Prospective Cohort

	FiO2	Pplt (cmH2O)	PEEP (cmH2O)	RR (/min)	DP (cmH2O)	TV (ml/kg/PBW)	MP (J/min)
Pre-ECMO	1.0	32±7	12±4	26±8	20±7	6.4±2.0	26±12.7
Post-ECMO	0.5	24±7	11±3	14±6	14±4	3.7±2.0	6.6±4.8

Am J Respir Crit Care Med. 2019; 200(8):1002-1012. PMID: 31144997.

What's important to reduce MP?



Am J Respir Crit Care Med. 2019; 200(8):954-956. PMID: 31216180.

What are downsides of Lung Rest?

- Atelectasis/de-recruitment

-> Atelectrauma and uneven ventilation (overdistention of non-atelectatic lung).

- Increase in PA pressure

-> RV injury

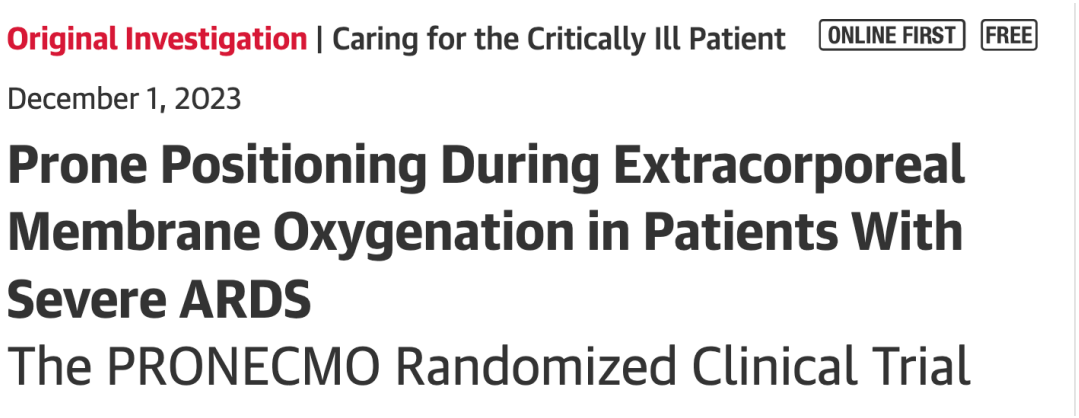
What is the optimal PEEP during VV ECMO?

- Guidance by Transpulmonary pressure resulted in significantly lower TV, DP, and MP, while it resulted in significantly higher PEEP (14.7 vs. 12.5).

- Transpulmonary pressure guided group also had significantly lower inflammatory markers and more successful weaning from VV ECMO.

Crit Care Med. 2020; 48(9):1280-1288. PMID: 32590385.

What about Prone Positioning?



Original Investigation | Caring for the Critically Ill Patient ONLINE FIRST FREE

December 1, 2023

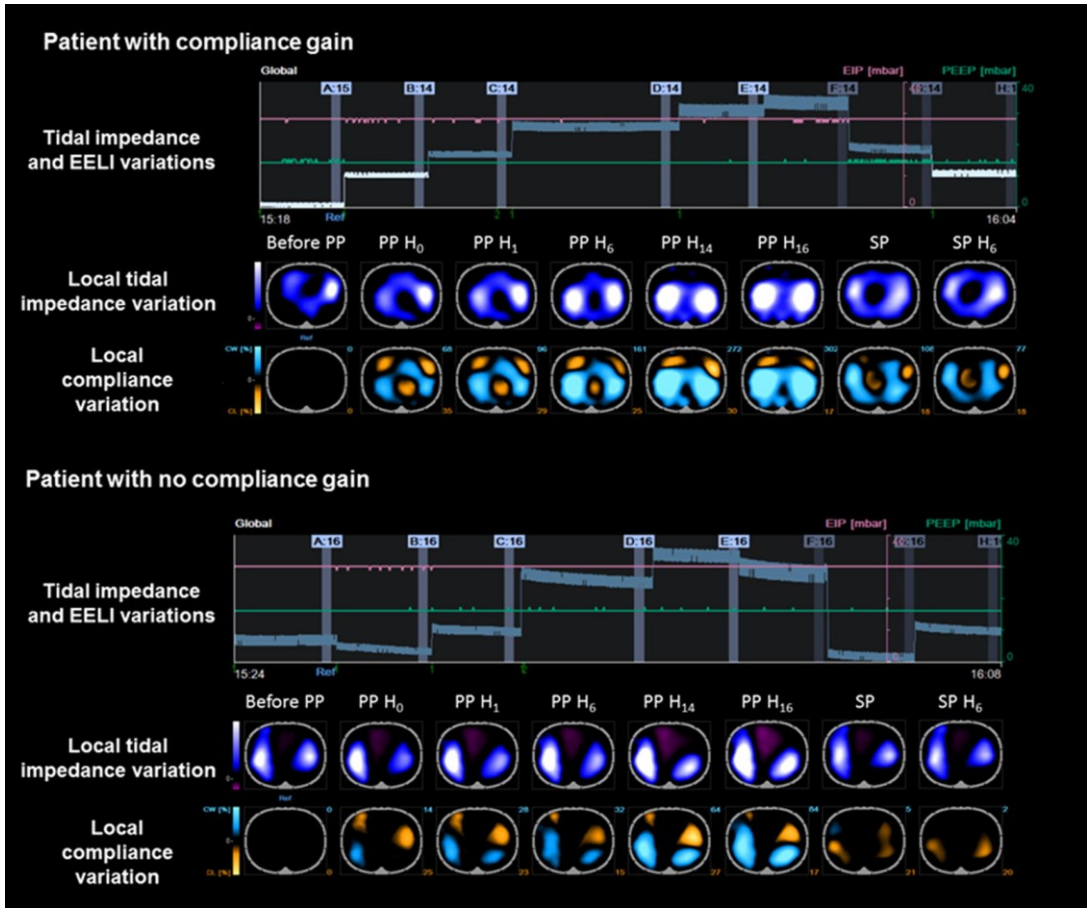
Prone Positioning During Extracorporeal Membrane Oxygenation in Patients With Severe ARDS

The PRONECMO Randomized Clinical Trial

- No clinical difference between Prone vs. Supine position in Patients with severe ARDS requiring VV ECMO

JAMA. 2023; 330(24):2343-2353. PMID: 38038395.

Prone positioning monitored by electrical impedance tomography in patients with severe acute respiratory distress syndrome on veno-venous ECMO



N=21

PP responders =13
(Cstat increase ≥ 3mL/cH2O)

PP nonresponders = 8
(Cstat increase < 3mL/cH2O)

Ann Intensive Care. 2020; 10(1):12. PMID: 32016593.

Prone-Positioning for Severe Acute Respiratory Distress Syndrome Requiring Extracorporeal Membrane Oxygenation

Crit Care Med. 2022; 50(2):264-274. PMID: 34259655.

What about Spontaneous breathing during VV ECMO?

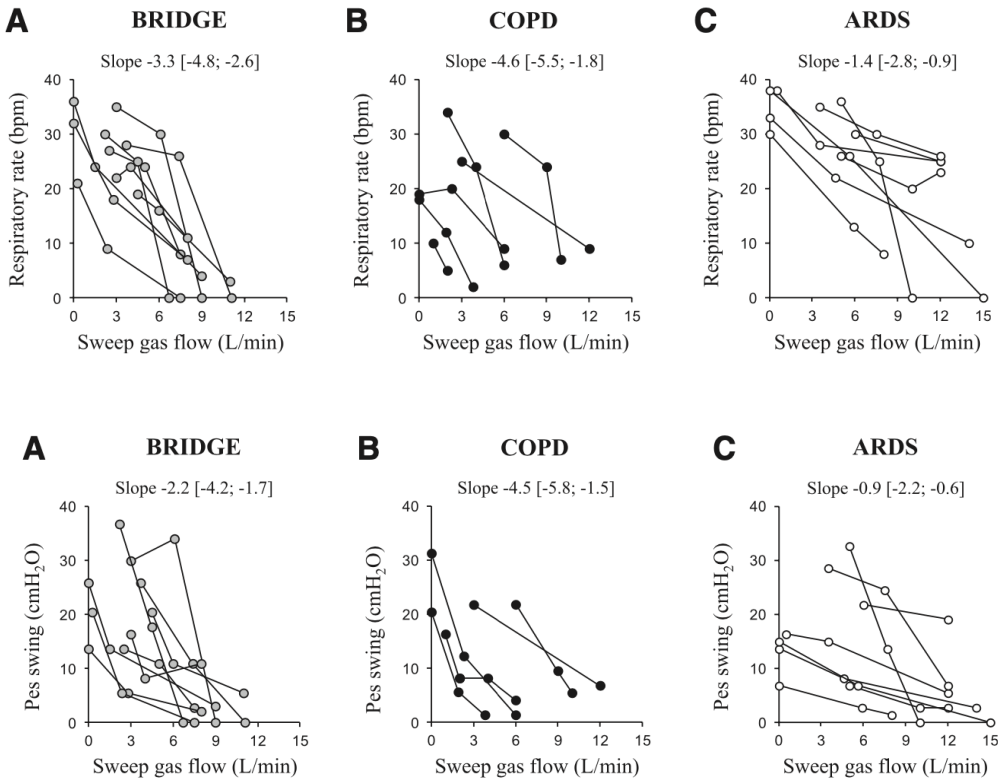
- Good:

1. Prevention of ICU-acquired weakness
2. Prevention of diaphragm atrophy
3. Allowing communication
4. Promotion of PT/OT

- Bad:

1. Risk of P-SILI (Especially when lung is still strongly inflamed)

Spontaneous Breathing during Extracorporeal Membrane Oxygenation in Acute Respiratory Failure



Anesthesiology. 2017; 126(4):678-687. PMID: 28212205

What I do

- In very acute phase after VV ECMO initiation

- Lung Rest (PEEP 10-15, Pi <10, RR <10)

- Typically require deep sedation

- Maintenance phase

- Gradually wean sedation. Allow spontaneous breathing slowly (Allow RR to be 10-20). Pi <10. PEEP 10-15.

- ECMO weaning phase

- Wean sweep gas keeping RR within reasonable range

Thank you