Facilitative weaning with less restrictive criteria in VVECMO

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Conflicts of interest

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No conflict of interest

Outline

Randomized trials in VV ECMO

Randomized trials in VV ECMO weaning

How do we approch weaning from VV ECMO?

Practice for weaning ECMO

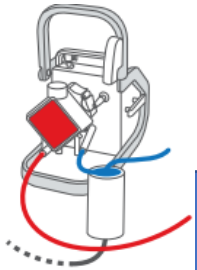
State of art and expert opinions

Factors associated for failed weaning of VV ECMO

Others approach than weaning ECMO before mechanical ventilation

Facilitative weaning for specific population

Randomized trials in VV ECMO



Zapol, JAMA, 1979
Peek, Lancet, 2009
Combes, NEJM, 2018

Aubron, CCM, 2019
Panigada, CCM, 2020
ECMO PT, ICM, 2020
Supady, Lancet Resp Med, 2021
Guervilly, Critical care, 2022
Schmidt, JAMA, 2023

ECMO liberation
?

Randomized trials in VV ECMO

VV ECMO course

Implantation ✓ **Management** ✓ **Weaning** ✗

- No randomized Trials completed
- One randomized trials recruiting about protocolized versus standard of care

(NCT05486559 update in clinicals trials: june 2024)

How do we approch weaning from VV ECMO?

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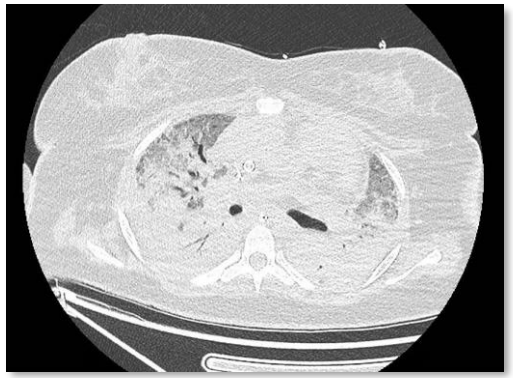
Lung recovery defined:

- Better respiratory system compliance
- Better oxygenation
- Better PCO2 clearance



A sweep gaz off trial

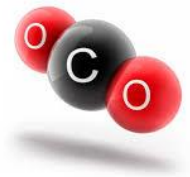
With low risk of ventilator-induced lung injury

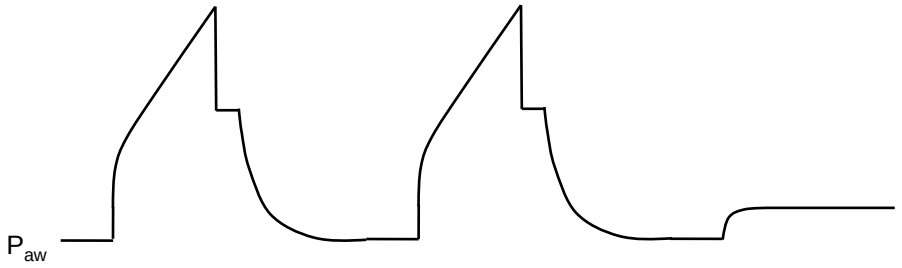
Heteregenous practice

ECMO weaning process:

When?

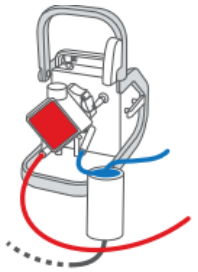
- PaO2 PCO2
- PEEP
- Respiratory system compliance
- FIO2
- Low Gaz flow
- Low ECMO blood flow
- Importance of dead space ventilation





How?

- Stopping gaz flow duration
- Protocolized or clinician’s discretion



Ricardo Teijeiro-Paradis, CCM, 2023

State of art and expert opinions

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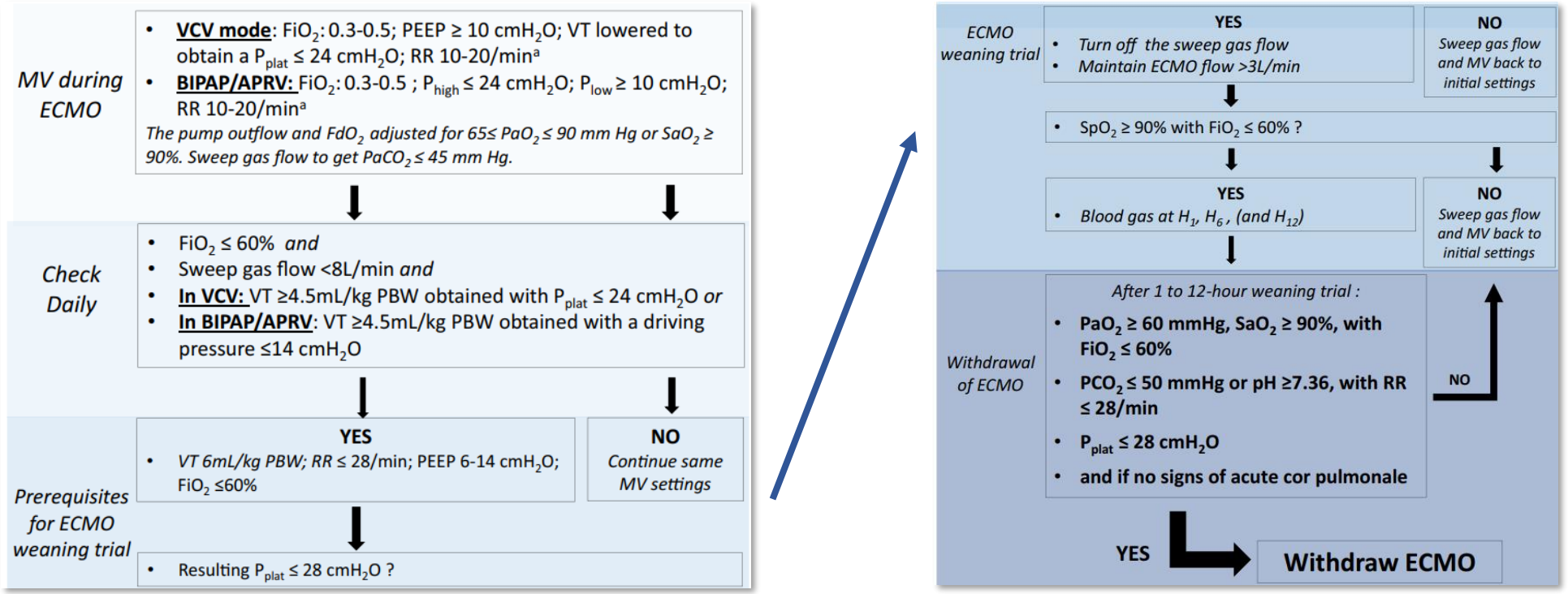
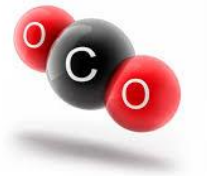
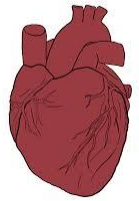


Combes ICM 2020

Factors associated for failed weaning of VV ECMO





Tidal Volum **Driving pressure** **Plateau pressure**	**Respiratory rate** **P 0.1** **Ventilation minute** **Respiratory drive**	**P/F**	**End-tidal partial carbon dioxide pressure ($P_{ET_{CO2}}$)/Pa_{CO2} ratio** **Lung dead space** **Ventilatory ratio**	**Heart rate**
Ricardo Teijeiro-Paradis, ICM, 2021 Al-Fares, Chest, 2021	Lazzari, AJRCCM, 2022 Hartley, perfusion, 2020	Ricardo Teijeiro-Paradis, ICM, 2021	Lazzari, AJRCCM, 2022 Hartley, perfusion, 2020 Ricardo Teijeiro-Paradis, ICM, 2021	Al-Fares, Chest, 2021

But did we have to wean VV ECMO before mechanical ventilation?

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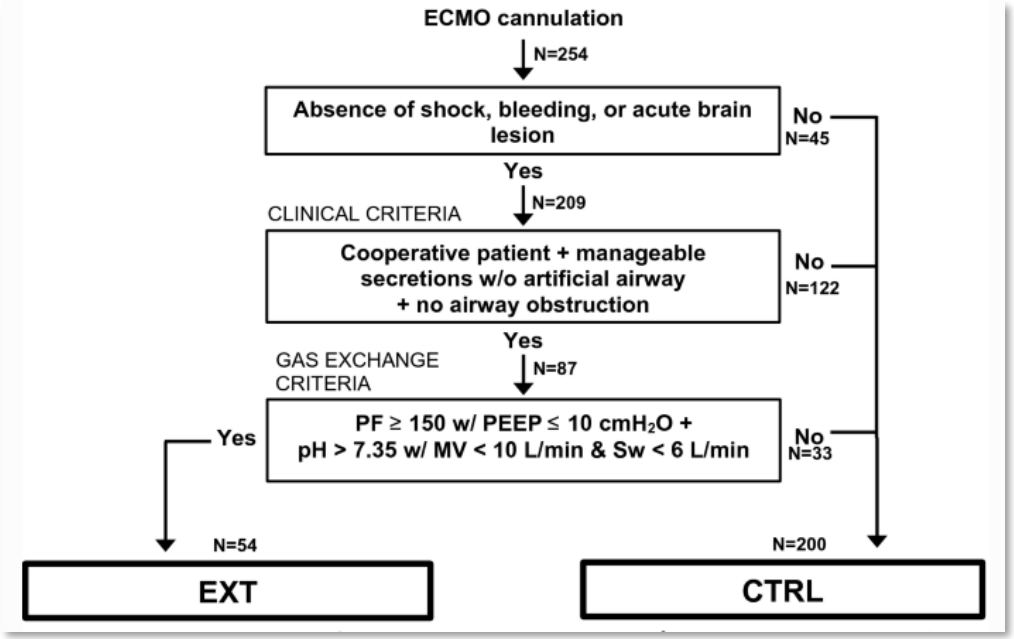
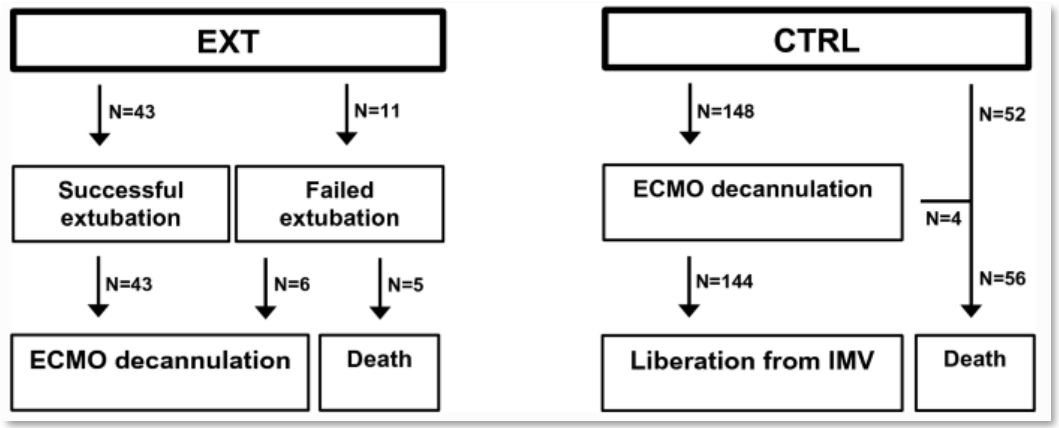




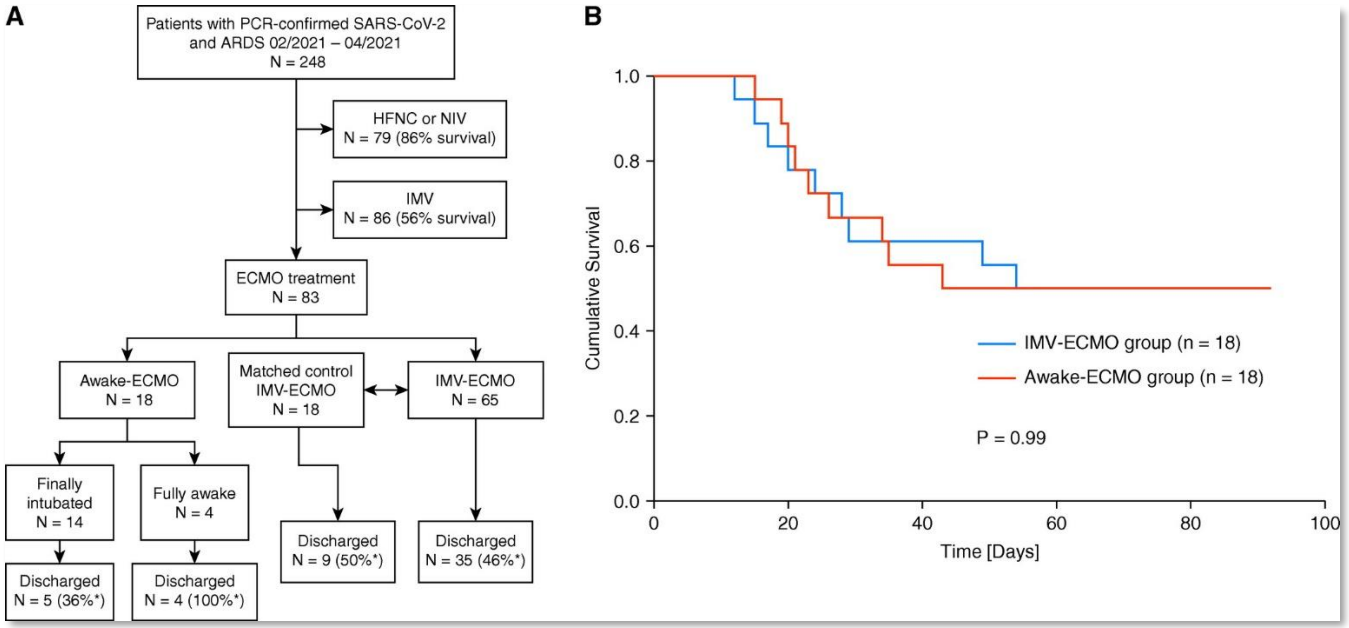
Feasible, but with 20% incidence of failed extubation.

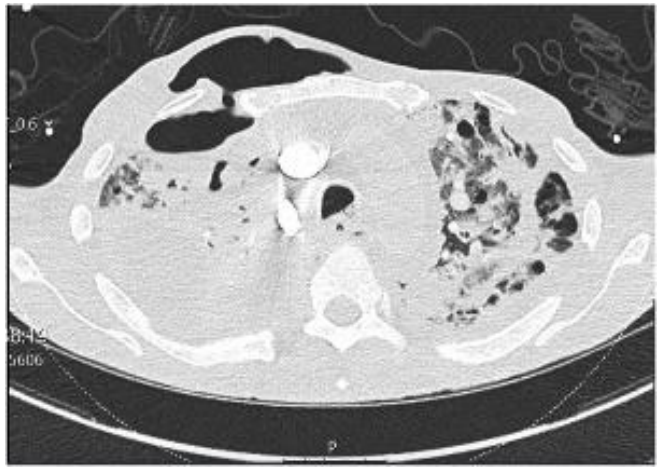
Mostly used as a bridge to lung transplantation?
Preferred single access dual stage right atrium to pulmonary artery cannula?

	Intubated Patients	Non-Intubated Patients
Oxygenation*	■ FiO_2 consistently ≤ 60% ■ PEEP ≤ 10 cmH_2O ■ $P_aO_2 \geq 70$ mmHg	■ $P_aO_2 \geq 70$ mmHg on no more than a moderate amount of supplemental O_2 (example: ≤6 LPM NC or facemask, or ≤40LPM with $F_iO_2 \leq 0.3$ on high flow nasal cannula)
Ventilation	■ Tidal volume ≤ 6mL/kg PBW ■ Plateau pressure ≤ 28 cmH_2O ■ Respiratory rate ≤ 28 bpm ■ ABG demonstrates acceptable pH and P_aCO_2 based on the patient's clinical condition without excessive work of breathing	■ ABG demonstrates acceptable pH based on the patient's clinical condition without excessive work of breathing
Imaging	Chest radiograph demonstrates improvement in appearance	

Roncon-albuquerque, AIC, 2023
Biscotti, Ann thorac Surg, 2017
Mustapha, JAMA surg, 2020
Tonna, ASAIO, 2021

ECMO without IMV?





Between 40 to 70% of ECMO awake strategy failures.

Useful for avoiding or worsening barotrauma?
For immunocompromised patients?

Mang, AJRCCM, 2022
Alessandro, CCM, 2023
Correa, Respir Med Case Rep, 2021

Timing of VV ECMO weaning: as soon as possible?

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Benefice:

Duration of ECMO
ECMO-related complication
Oxygenator dysfonction
Cost

Risk:

Recannulation
Injurious mechanical ventilation
Ventilator induced lung injury

As soon as possible or when complications occur?

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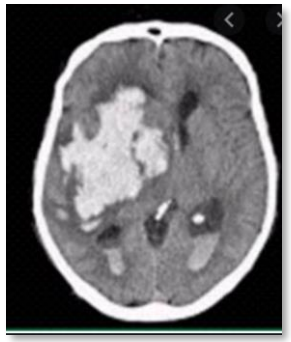
Facilitative weaning protocol

Short and long-term outcomes of patients with COVID-19-associated acute respiratory distress syndrome and difficult veno-venous-ECMO weaning

Paul Masi[1,2†], Samuel Tuffet[1,2†], Laurent Boyer[3,4], Thierry Folliguet[5,6], Armand Mekontso Dessap[1,2] and Nicolas de Prost[1,2*]

Inclusion criterias:

- Prolonged support of ECMO (> 10 days)
- Serious ECMO complication
- Patients who haved recovery a satisfactory native lung oxygenation
- Unsuccessful weaning test *(EOLIA criteria)*



facilitative weaning VS conventional weaning

Patients' characteristics

Parameters	Facilitative weaning ($n = 18$)	Conventional weaning ($n = 16$)	P value
Age, years	53 (45–57)	50 (44–58)	0.92
Male gender (%)	11 (61)	11 (69)	0.70
SAPS 2 score	35 (27–54)	35 (29–50)	0.98
BMI, kg/m^2	29.1 (26.1–31.9)	34.5 (26.10–35.8)	0.40
Corticosteroids during ICU stay			
Dexamethasone	11 (61)	9 (56)	>0.99
Hydrocortisone/Fludrocortisone	8 (44)	4 (33)	0.30
Methylprednisolone pulse therapy	2 (11)	1 (6)	>0.99
Renal replacement therapy	7 (39)	5 (31)	0.73
Ventilator-associated pneumonia	17 (94)	10 (63)	0.030
Major bleeding[c]	13 (72)	4 (25)	0.015
ECMO support duration, days	24 (16–43)	10 (7–14)	<0.001

Masi, critical care, 2021

Facilitative weaning, ECMO complications:

Major bleeding 13 patients

CRI 2 patients

Severe hemolysis 2 patients

Patients' characteristics

Parameters	Facilitative weaning ($n = 18$)	Conventional weaning ($n = 16$)	*P* value
Ventilator settings during ECMO weaning			
Tidal Volume, mL/kg PBW	5.6 (4.8–5.9)	5.8 (5.5–6.1)	0.20
Respiratory rate, breaths/min	34 (30–38)	29 (26–32)	0.002
Plateau pressure, cmH_2O	31 (29–34)	25 (22–26)	< 0.00
Driving pressure, cmH_2O	24 (22–27)	13 (12–16)	< 0.00
RS compliance, mL/cmH_2O	14 (12–17)	27 (22–35)	< 0.00
PEEP, cmH_2O	5 (5–8)	10 (7–12)	0.003
Arterial blood gases during weaning			
pH	7.35 (7.27–7.38)	7.42 (7.36–7.44)	0.008
$PaCO_2$, mmHg	47 (42–55)	41 (37–44)	0.001
PaO_2/FIO_2 ratio, mmHg	166 (145–202)	200 (156–254)	0.25
Chest CT-scan at time of weaning[e]			
Reticular pattern	3 (21)	1 (8)	0.60
Ground glass opacity	11 (78)	12 (100)	0.13
Alveolar condensation	12 (86)	9 (75)	0.53
Traction bronchiectasis	12 (86)	5 (12)	0.038
Tracheal distorsion	1 (7)	0 (0)	> 0.99
Scissural distortion	4 (29)	2 (16)	0.59

Masi, critical care, 2021

Consequences of facilitative weaning?

Parameters	Facilitative weaning ($n = 18$)	Conventional weaning ($n = 16$)	P value
Rescue therapy after weaning			
Prone positioning	9 (50)	1 (6)	0.008
Inhaled nitric oxide	4 (22)	1 (6)	0.34
Methylprednisolone pulse therapy	1 (5)	0 (0)	–
RS mechanics on the day of MV weaning			
Pressure support level, cm H_2O	11 (8–14)	10 (8–13)	0.60
Tidal volume, mL	520 (411–609)	471 (397–622)	0.75
Tidal volume, mL/kg PBW	7.2 (6.3–8.4)	7.0 (5.9–8.7)	0.98
Compliance[g], mL/cmH_2O	44.7 (35.2–62.4)	48.9 (34.1–77.8)	0.78
Total MV duration, days	55 (38–86)[h]	21 (14–31)	0.0002
MV duration after ECMO weaning, days	26 (16–36)[h]	5 (3–12)	<0.0001
ICU length of stay, days	55 (40–91)[h]	27 (19–32)	<0.0001
In-ICU mortality	2 (13)[h]	1 (6)	0.60

Masi, critical care, 2021

In long term?

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	Facilitative weaning ($n=6$)	Conventional weaning ($n=7$)	*P* value
Pulmonary hypertension[a]	0 (0)	0 (0)	–
Pulmonary function tests			
K_{CO}, % predicted	88 (75–100)	104 (88–111)	0.11
DL_{CO}, % predicted	57 (44–73)	70 (57–72)	0.29
FVC % predicted	77 (59–85)	82 (52–91)	0.92
TLC, % predicted	75 (65–79)	77 (64–94)	0.70
Chest CT-scan at long-term			
Reticular pattern	1 (12)	1 (14)	>0.99
Ground glass opacity	5 (71)	4 (50)	0.60
Alveolar condensation	0 (0)	1 (12.5)	>0.99
Tractionbronchiectasis	4 (57)	4 (50)	>0.99
Tracheal traction	0 (0)	0 (0)	–
Scissural distortion	2 (29)	1 (13)	0.57
6-min walking test			
Walked distance, m	433 (348–503)	506 (480–548)	0.08
% of predicted distance, %	67 (62–74)	90 (78–97)	0.009
Room air saturation	97 (96–98)	98 (96–98)	0.82
Dyspnea (MRC scale)			0.07
0	0 (0)	4 (57)	
1 or 2	6 (100)	3 (43)	

[a]Assessed by transthoracic echocardiography; *KCO* CO transfer coefficient; D_{LCO} haemoglobin value (Hb) corrected diffusion capacity with CO; *FVC* forced expiratory vital capacity; *TLC* total lung capacity

- More dyspnea
- Equivalent in the entire cohort
  (in a second analysis)

Conclusion

- Weaning ECMO with less restrictive criteria is feasible and safe
- In a specific population (oxygenation improvement with fibrosis evolution)
- Useful when ECMO complications occurred
- Small cohort
- Need to be confirmed in a larger population