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Venovenous ECMO weaning failure. Utilization of extracorporeal CO_2 removal ($ECCO_2R$) as a bridge therapy in ECMO weaning: a case report

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Venovenous ECMO weaning failure. Utilization of extracorporeal CO_2 removal ($ECCO_2R$) as a bridge therapy in ECMO weaning: a case report.

Title: Utilization of extracorporeal CO_2 removal as a bridge therapy in Venovenous Extracorporal Membrane Oxygenation weaning failure: A case report.

Short title: $ECCO_2R$ to facilitate ECMO weaning.

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To the Editor,

Although invasive mechanical ventilation is a keystone in the management of acute respiratory distress syndrome, it has been shown to cause pulmonary damage (ventilator-induced lung injury) [1].

Therefore, extracorporeal ventilation techniques have gained reputation, with venovenous extracorporeal membrane oxygenation (VV-ECMO) and extracorporeal CO_2 removal ($ECCO_2R$) being the most notable ones [2,3].

Despite their popularity there is no evidence supporting their combined use. Here, we present a case in which $ECCO_2R$ was employed as a bridge technique to enable complete liberation of VV-ECMO in a challenging weaning situation.

We report the case of a 24-year-old patient admitted with acute respiratory failure. The patient had a history of tuberculous lymphangitis ten years prior. On arrival, she was in poor clinical condition, with a baseline oxygen saturation of 55%, fever, and tachypnea. Orotracheal intubation and initiation of invasive mechanical ventilation were performed. Nasopharyngeal cultures obtained at arrival were positive for influenza B virus. A chest X-ray revealed extensive bilateral lung consolidations (Additional supplemental files, figure 1).

Despite treatment, patient's respiratory status continued to deteriorate, and she was considered a candidate for VV-ECMO. Cannulation was performed through the right femoral vein (21-Fr cannula) and right jugular vein (17-Fr cannula).

Lung stiffness with static lung compliance below 20 ml/cmH_2O was observed. After seven days of VV-ECMO therapy, successive trials of temporary disconnection were performed, showing a marked increase in respiratory effort and pCO_2 levels, preventing ECMO withdrawal (Table 1). Additionally, the patient experienced tracheal bleeding, requiring the discontinuation of systemic anticoagulation. Around day 12, a clot emerged in the oxygenation membrane, accompanied by a progressive loss of its effectiveness.

Due to ECMO weaning failure and a lack of improvement in pulmonary compliance, at day 16 we decided to initiate $ECCO_2R$ therapy using the PrismaLung+® system (Baxter International Inc.). This veno-venous extracorporeal CO_2 removal system consists of a polymethylpentene membrane coated with phospholipid, with a surface area of 0.8 m2, coupled with a renal replacement therapy (RRT) system (PrisMax2®, Baxter International Inc.). A 13Fr double-lumen catheter was inserted into the left femoral vein and PrismaLung+® system was started with a gradually increasing blood flow of up to 400 ml/min and a gas sweep flow of 10 lpm. Instead of systemic anticoagulation, we employed anticoagulation of the extra-corporeal circuit with a fixed dose of 500 IU/h of unfractionated heparin.

Within the next 24 hours, a decrease in pCO_2 was observed, and ECMO was successfully removed. $ECCO_2R$ was removed three days later without complications derived from its use.

The patient was transferred to a regular hospital ward after 26 days and 4 days later, she was discharged home.

Despite current recommendations there is a reported ECMO weaning failure rate of 40%. Main predictors for weaning failure were an increased pCO_2 level and increased respiratory rate [4].

Advances in technology to deliver $ECCO_2R$ therapy have simplified this approach, making feasible the allocation of a membrane lung within a conventional RRT circuit to allow simultaneous removal of fluids, metabolites and CO_2. Therefore, this low-flow technique, based on the use of less invasive catheters with lower anticoagulation requirements could potentially decrease the number of adverse events compared to ECMO [3,5].

In our case, $ECCO_2R$ therapy allowed us to reduce the risk of bleeding and improved active mobility of the patient enabling the shift from controlled ventilation to pressure support.

We propose the use of $ECCO_2R$ as a bridge therapy for ECMO-VV liberation in patients with lung stiffness (defined as static lung compliance <20 ml/cmH2O) who failed weaning trials due to increased work of breathing and/or hypercapnia rather than hypoxemia. To achieve this, we propose the following management algorithm (Additional supplemental files, figure 2).

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CRediT authorship contribution statement

Emilio Burgui Gualda: Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.

Ignacio Sáez de la Fuente: Investigation, Writing – original draft, Writing – review & editing.

José Ángel Sánchez Izquierdo Riera: Investigation, Writing – review & editing.

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Artificial intelligence involvement: None.

1. Bellani G, Laffey JG, Pham T, et al. Epidemiology, Patterns of Care, and Mortality for Patients With Acute Respiratory Distress Syndrome in Intensive Care Units in 50 Countries. JAMA. 2016;315(8):788–800. doi:10.1001/jama.2016.0291
2. Combes A, Hajage D, Capellier G, et al. Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome. N Engl J Med. 2018;378(21):1965-1975.
3. Taccone FS, Malfertheiner MV, Ferrari F, et al. Extracorporeal CO2 removal in critically ill patients: a systematic review. Minerva Anestesiol. 2017;83(7):762-772.
4. Fisser C, Gerhardinger F, Müller T, et al. Predictors for successful weaning from V-V ECMO. Eur. Respir. J 2020 56: 3432
5. Liu Z, Duarte RV, Bayliss S, Bramley G, Cummins C. Adverse effects of extracorporeal carbon dioxide removal (ECCO2R) for acute respiratory failure: a systematic review protocol. Syst Rev. 2016 Jun 7;5:98

	Day 1		Day 2		Day 3				Day 4			Day 5	Day 6			Day 7
	Baseline	Weaning trial	Baseline	Last unsuccesful Weaning trial	Baseline		2h post	6h post	Baseline	Weaning trial		6am	6am		2h post	6am
PaO_2 (mmHg)	103	109	69	102	72		92	86	96	87		87	150		129	118
pCO_2 (mmHg)	41	52	48	55	51		32	42	37	44		42	45		48	45
pH	7,45	7,35	7,40	7,36	7,40		7,52	7,42	7,44	7,39		7,40	7,36		7,37	7,4
Vent Mode	PRVC	PSV	PRVC	PRVC	VCV		VCV	VCV	PSV	PSV		PSV	PSV		PSV	PSV
PSV (cmH_2O)		17							17	17		17	17		17	17
Pplat (cmH_2O)	22		24		24											
PEEP (cmH_2O)	6	6	8	8	8		8	8	7	7		7	7		7	5
TV(ml)/IBW	5,4	4,4	4,6	4,6	5,2		5,2	5,2	4,2	4,4		4,8	5,4		5,6	5,6
RR (bpm)	16	36	14	34	16		16	16	18	20		18	20		21	20
ECMO (pump flow/ gas sweep Flow))	3,3/5	3,3/0	3,2/4,5	3,2/0	3,5/5		3,5/5	3,2/1	3,2/1	3,2/0		-	-		-	-
$ECCO_2R$ (blood flow, ml/min)	-	-	-	-	-	Initiation $ECCO_2R$	450	450	400	400	ECMO withdrawal	300	200	$ECCO_2R$ withdrawal	-	-

Table 1. Gasometric, ventilatory, and extracorporeal circulatory support values prior to and during ECMO weaning trials. Abbreviations: $ECCO_2R$, extracorporeal CO_2 removal; ECMO, extracorporeal membrane oxygenation; IBW, Ideal Body Weight; PEEP, positive end expiratory pressure; PRVC, pressure regulated volume control; PSV, pressure support

ventilation; Pplat, plateau pressure; RR, respiratory rate; TV, tidal volume; VCV, volume control ventilation; Vent Mode, mode of mechanical ventilation.