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Extracorporeal membrane oxygenation instead of invasive mechanical ventilation in patients with acute respiratory distress syndrome

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Dear Editor,

Invasive mechanical ventilation with or without additional extracorporeal membrane oxygenation (ECMO) support represents standard treatment for patients with acute respiratory distress syndrome (ARDS). An "awake ECMO" strategy in order to avoid intubation and mechanical ventilation has been implemented as a bridge to lung transplantation in patients with chronic lung disease [1, 2] but has been used only occasionally in patients with ARDS [3].

We conducted a single-center, uncontrolled pilot trial designed to assess the feasibility of veno-venous ECMO in awake, non-intubated, spontaneously breathing patients with ARDS (www.clinical.govNCT01669863). Patients between 18 and 75 years old presenting with moderate or severe ARDS were eligible. The main exclusion criteria were severe bleeding disorders and uncontrolled sepsis with multi-organ failure involving at least two organ systems. The Institutional Review Board (IRB) of Hannover Medical School approved and supervised the study and all patients provided written informed consent prior to ECMO insertion.

Six patients with severe ARDS were enrolled as planned; four of them were immunocompromised. Patient characteristics and outcome parameters are shown in Table 1. All patients suffered from severe ARDS with PaO_2/FiO_2 ratios at most 100 mmHg while receiving noninvasive ventilation. Gas exchange patterns improved immediately after ECMO insertion and noninvasive ventilation could be stopped within 1 h in two patients. Three patients (patients 1, 4, and 5) were successfully weaned from ECMO after 10, 5, and 7 days, respectively, and discharged from the ICU without needing invasive mechanical ventilation. Patient 2 was also successfully weaned from ECMO support but developed respiratory failure due to an iatrogenic pneumothorax 2 days later and required intubation as a result. A protracted ICU course ensued, complicated by ventilator-associated pneumonia and sepsis. The patient was eventually discharged from the ICU after 50 days. Patient 3 improved rapidly on ECMO support, but became increasingly agitated and confused. On the 7th day on ECMO support, he intentionally removed his jugular cannula, resulting in emergency intubation and brief cardiopulmonary resuscitation. He subsequently died 10 days later from

Table 1 Patient characteristics and outcomes

Patient	Sex	Age (years)	Cause of ARDS	Underlying disease	Last measurements before ECMO			ECMO duration (days)	Invasive ventilation	Duration ICU stay (days)	Last status
					FiO_2	PaO_2/FiO_2 (mmHg)	MV (l/min)				
1	M	60	Pneumonia (unidentified organism)	AML	0.8	82	19.7	10	No	13	Alive, discharged from hospital
2	M	56	Pneumonia (unidentified organism)	BLTx	0.9	100	28.0	8	Yes	50	Alive, discharged from hospital
3	M	72	Pneumonia (unidentified organism)	None	1.0	80	18.2	4	Yes	14	Died
4	F	59	Pneumonia (unidentified organism)	ALL	1.0	61	16.5	5	No	7	Alive, discharged from hospital
5	M	53	Pneumonia (*Pneumocystis jirovecii*)	AIDS	1.0	87	24.6	7	No	10	Alive, discharged from hospital
6	M	62	Pneumonia influenza A (H1N1)	None	1.0	51	22.1	27	Yes	28	Died

ARDS denotes acute respiratory distress syndrome, *AML* acute myelogenous leukemia, *ALL* acute lymphatic leukemia, *BLTx* bilateral lung transplantation, *AIDS* acquired immunodeficiency syndrome, *ICU* intensive care unit, *ECMO* extracorporeal membrane oxygenation, *MV* minute ventilation, *NIV* noninvasive ventilation

septic multi-organ failure. Patient 6 showed only modest improvements in gas exchange after ECMO insertion and his pulmonary function did not recover. He was intubated 6 days later because of exhaustion and inadequate oxygenation. The further clinical course was complicated by sepsis and progressive multi-organ failure resulting in death 27 days after ECMO insertion.

The patients in this series were highly selected and suffered from single-organ failure. As such, our experience cannot be extrapolated across patients with presenting with ARDS in the setting of sepsis and multi-organ failure. Although not yet formally studied, an "awake ECMO" strategy appears more suitable in patients with isolated lung injury failing noninvasive ventilation than in patients with multi-organ failure. In addition, most patients in this series were immunocompromised. Those patients may potentially obtain particular benefit from avoiding endotracheal intubation and mechanical ventilation as they are at high risk with invasive mechanical ventilation [4, 5].

In conclusion, an "awake ECMO" strategy appears feasible in selected patients with ARDS and deserves further evaluation as a potential alternative to intubation and mechanical ventilation. To the best of our knowledge, "awake ECMO" is currently not used in other centers as a primary treatment strategy for ARDS. We will continue to explore this concept and are currently planning a larger multicenter study.

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Conflicts of interest Dr. Hoeper and Dr. Kühn have received fees for speaking at conferences from Maquet. All other authors declare that they have no conflicts of interest.

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