Avoidance of intubation during acute exacerbation of chronic obstructive pulmonary disease for a lung transplant candidate using extracorporeal carbon dioxide removal with the Hemolung

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For patients with severe chronic obstructive pulmonary disease (COPD) experiencing an acute exacerbation, the necessity for invasive mechanical ventilation (IMV) not only is associated with high mortality^{1,2} but also can be particularly disadvantageous to a patient also awaiting lung transplantation.³ In this case report, we describe our use of a novel extracorporeal carbon dioxide removal (ECCO₂R) device for partial respiratory support in such a patient who was failing support with noninvasive ventilation (NIV). The Hemolung Respiratory Assist System (ALung Technologies, Pittsburgh, Pa) provided ECCO₂R at a blood flow of approximately 500 mL/min through a single 15.5F venovenous cannula inserted percutaneously through the left femoral vein.^{4,5} This case was conducted as part of the first human clinical feasibility study of the Hemolung device and was the first time the device was used at our facility.⁶

CLINICAL SUMMARY

A 50-year-old man was admitted for infection-induced exacerbation of severe COPD. The patient had a history of emphysema before and after bulla and right apex pulmonary resection, pulmonary cachexia, past nicotine abuse, and a diagnosis of Global Initiative for Chronic Obstructive Lung Disease grade IV COPD (forced expiratory volume in 1 second of 14% predicted). He was receiving long-term oxygen therapy with intermittent NIV. One month before hospital admission, the patient was listed for bilateral lung transplant with normal priority status because of increasing deterioration of COPD. After admission, the patient's condition worsened, requiring antibiotic treatment and continuous NIV. Three days after admission, the patient decompensated and was transferred on an emergency basis to the intensive care unit with an arterial carbon dioxide tension (Paco₂) of

90 mm Hg and pH of 7.23. A thoracic x-ray revealed a left spontaneous pneumothorax. After immediate thoracic drainage, the lung expanded and the pulmonary leakage was eliminated. Overnight, despite continuous optimized NIV, there was no improvement. The Paco₂ remained between 72 and 85 mm Hg, the respiratory rate was 30 to 40 breaths/min, and the pH was less than 7.3. The patient was exhausted, and intubation seemed imminent but was contraindicated because of the pneumothorax.

The patient was informed about alternative methods of extracorporeal carbon dioxide elimination that our hospital could provide, including the Hemolung, which had been approved for an investigational feasibility study by our local and national ethics committees. Detailed information was provided regarding the benefits and risks of ECCO₂R therapy with the Hemolung. The patient opted for and gave his consent to be treated with this device.

A 15.5F dual-lumen catheter was inserted percutaneously without complication via the left femoral vein, and heparin was administered in accordance with study protocol guidelines for anticoagulation (initial bolus of 80 U/kg, followed by continuous systemic infusion at 18 U/kg/h, with a target activated partial thromboplastin time of 1.5-2.3 times baseline). Immediately after initiation of ECCO₂R therapy with the Hemolung, the patient's respiratory rate decreased, at times to less than 10 breaths/min. The patient became increasingly active and intolerant of the NIV minimum set breathing rate and was found to be comfortable and stable without a minimum set rate. The Hemolung circuit blood flow ranged from 422 to 520 mL/min. The rate of carbon dioxide removal measured by the Hemolung controller averaged 89 ± 8.7 mL/min. Arterial Paco₂ decreased from 75 to 60 mm Hg after commencing therapy, but remained within a range of 60 to 55 mm Hg for the duration of therapy, as shown in Table 1. The clinical status improved steadily and continuously during 6 days of treatment.

At the beginning of Hemolung therapy, discontinuing NIV was not possible. By day 3, the patient was off NIV 5 to 6 times for 15 minutes at a time. Drinking and recovery from pressure sores were possible. By day 5, the patient was able to breathe for 16 hours. On day 6, the patient had compensated to such a degree to wean from Hemolung support. The catheter was removed with normal coagulation values and no additional bleeding. The patient was then supported intermittently with NIV.

The primary complication was bleeding due to higher than targeted activated partial thromboplastin time values.

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TABLE 1. Summary of arterial blood gases and noninvasive ventilatory parameters before and during extracorporeal support with the Hemolung (ALung Technologies, Pittsburgh, Pa)

	On admission to ICU	During Hemolung therapy			
		Hour 2	Hour 24	Hour 48	Hour 132 (weaning)
pH	7.23	7.34	7.40	7.40	7.38
Paco ₂ (torr)	90	67.4	61.7	55.9	56.2
Peak inspiratory pressure (mm Hg)	—	20	20	20	20
Peak expiratory pressure (mm Hg)	—	6	5	5	5
Fio ₂	—	—	26%	32%	28%
Respiratory rate	30-40	18	16	13	14
Minute ventilation	—	8.0	6.4	4.8	8.7

ICU, Intensive care unit; Paco₂, arterial carbon dioxide tension; Fio₂, inspired oxygen fraction. Data from Burki and colleagues.⁶

After titrating the heparin dosage, the bleeding ceased within 2 hours and did not reappear; no transfusion was necessary. There were no other complications during or after extracorporeal support. Plasma-free hemoglobin levels remained below the baseline measurement of 6.5 mg/dL. Platelet counts decreased over the course of extracorporeal therapy as expected without serious effects.

During treatment with the Hemolung, the patient was given a high-urgent status for the transplant waiting list. The patient successfully received a bilateral lung transplant 31 days after Hemolung support and was discharged 63 days post-transplant.

CONCLUSIONS

The risk of bleeding is present with any form of extracorporeal support, including hemodialysis. The alternative to EC-CO₂R therapy would have been IMV, which is associated with different but more serious risks, as well as significantly greater patient discomfort and quality of life. Compared with ECMO systems used for full respiratory or cardiopulmonary support, the Hemolung was substantially simpler to operate.

Oxygen demand was met by NIV support with positive end airway pressures and supplemental oxygen.

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Swyer–James–MacLeod syndrome with renal ectopy misdiagnosed as pneumothorax and chest tube drained: Case study

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Swyer–James–MacLeod syndrome is characterized by hyperlucency caused by an increase in aeration and a decrease in vascularity in a lung lobe. The syndrome usually develops as a result of recurrent pulmonary infections in childhood and should be discriminated from pneumothorax and other diseases causing unilateral hyperlucency on chest radiography. We present a patient with a diagnosis of Swyer–James–MacLeod syndrome with a renal anomaly who received a mistaken diagnosis of pneumothorax and had a chest tube inserted.