User Report

Respiratory Dialysis®
powered by the HEMOLUNG® RAS

Use of the Hemolung RAS to enable lung protective ventilation in a prior lung transplant patient unable to be extubated following orthopedic surgery: A case report

Susanne Ilkjær, MD, PhD, Reinholdt H. Jensen, MD, and Elisabeth Eggen
Århus University Hospital, Skejby, Denmark

The need to facilitate lung protective ventilation is most commonly associated with the treatment of patients with ARDS, however, there are a many unique cases of acute respiratory failure where lung protective ventilation is necessary but made difficult by retention of carbon dioxide (CO_2). This report describes the case of a patient who had received a lung transplant over a year prior to undergoing the surgical repair of a broken femur. Subsequent to the surgery, the patient was unable to be extubated and became hypercapnic despite maximal ventilatory support at high peak airway pressures. Extracorporeal CO_2 removal ($ECCO_2R$) with the Hemolung Respiratory Assist System (RAS) was successfully utilized to enable reductions in peak ventilator airway pressures and normalization of arterial pH and CO_2 tension.

Case Description

A 50 year old male was admitted to our ICU in acute respiratory failure on invasive mechanical ventilation, unable to be extubated following surgery at an affiliated hospital. The patient had received a double lung transplant 16 months earlier due to methotrexate-induced pneumonitis. The transplant was successful, but the patient subsequently developed a pulmonary aspergillus infection which left his lungs at only 40% of expected function. A year after the transplant, he was readmitted to the hospital because of pancreatitis and aspergilloma. He was treated with relevant antibiotics, including caspofungen, and was later discharged to his home environment. Shortly thereafter, the patient suffered a column femur fracture from a bad fall while at home. He was readmitted acutely in respiratory distress to an affiliated hospital, and surgery was performed under general anesthesia to repair the fracture. Following the surgery he was unable to be extubated. Despite attempts at alternative modes of ventilation, including airway pressure release ventilation (APRV), he developed increasing oxygen needs and difficulty eliminating CO_2. At this point, the patient was transferred to our hospital for specialized lung assist with the Hemolung RAS, a low-flow veno-venous $ECCO_2R$ device.

Upon arrival, the patient was being supported with pressure control ventilation at peak pressures (P_{peak}) of 40 cmH_2O, a positive end expiratory pressure (PEEP) of 10 cmH_2O, and an oxygen fraction of 80%. Despite the high ventilator settings, arterial pH was only 7.2 with an arterial CO_2 tension ($PaCO_2$) of 9.0 kPa. He was hemodynamically unstable on noradrenaline at 0.3 mcg/kg/min. The patient was treated with nitric oxide (NO) and muscle relaxants for stabilization while preparing for initiation of Hemolung therapy. The patient was not eligible for extracorporeal membrane oxygenation (ECMO) due to the chronic infection of his previously transplanted lungs and the higher risks of ECMO compared to low-flow $ECCO_2R$ with the Hemolung.

For Hemolung therapy, a single 15.5 French dual-lumen catheter was inserted percutaneously in the right femoral vein. Extracorporeal support was initiated at a blood flow of 450 mL/min and a sweep gas of 5 L/min, which was gradually increased to 10 L/min over the first minutes. Anticoagulation

with heparin infusion was also initiated to achieve an aPTT between 40-80 seconds. Almost immediately, we were able to reduce P_{peak} from 40 to 28 cmH_2O. During the first few hours of therapy, arterial pH increased to 7.34 and $PaCO_2$ decreased to 6 kPa. With normalization of pH, we were also able to decrease noradrenaline and hemodynamically stabilize the patient after the first two days of Hemolung therapy. Over the course of the next 6 days, we were able to reduce the ventilator to assisted pressure control with a peak inspiratory pressure of 18 cmH_20, a PEEP of 6 cmH_20, and an oxygen fraction 40% (see **Table 1**). At this point Hemolung therapy was weaned and the catheter removed.

Thereafter, the patient was weaned from the ventilator and transferred to the ICU at our affiliated hospital with a tracheostomy and uncuffed cannula. Unfortunately, just as the patient was ready for transfer to a regular ward, he experienced a septic attack related to his prior infection, resulting in death. Despite this outcome, use of low-flow $ECCO_2R$ enabled safer ventilation, normalization of hypercapnia, hemodynamic stabilization and ultimate weaning from mechanical ventilation.

Discussion with Dr. Ilkjær

Q: How would you describe the usability of the Hemolung RAS?

A: Cannulation with the Hemolung catheter was very easy. This catheter was much smaller and easier to insert compared to ECMO. The Hemolung system was simple to setup and operate as well, especially with control of the sweep gas.

Q: What was the goal of using Hemolung therapy, and was this goal achieved?

A: The goal of using Hemolung therapy was to enable reduction of the high peak airway pressures and to normalize the patient's pH and $PaCO_2$. This goal was achieved during the first day of using Hemolung therapy. By improving the pH, we were also able to stabilize the patient hemodynamically, and by reducing the ventilator pressures and correcting the blood gases, we facilitated lung protective ventilation and enabled the patient to finally be weaned from the ventilator.

Table 1

	Pre-Hemolung	1-2 Hours After Hemolung Start	Day 1	Day 2	Day 6
Vent mode	PC	PC	PC	PC	PA
Peak pressure	40	28	30	30	27
PEEP	10	8	6	6	6
Tidal volume	535	380	250	250	560
Minute vent.	10.9	7.8	7.5	6.9	9.0
FiO_2 (%)	80	70	80	75	40
pH	7.2	7.34	7.3	7.34	7.3
$PaCO_2$ (kPa)	9.0	6.7	6.4	6.1	5.8
PaO_2 (kPa)	10.3	8.3	11.3	9.7	10.9
SaO_2 (%)	92	90	96	94	96
Bicarb	19.6	25	23	24	21

PC - pressure control; PA - pressure assist

About the Author

Dr. Ilkjær is a physician at the Århus University Hospital in Skejby, Denmark. She received no compensation in association with this case report and has no conflicts of interest to disclose. Dr. Ilkjær can be reached via email at susailkj@rm.dk.

About the Hemolung RAS

The Hemolung RAS from ALung Technologies provides Respiratory Dialysis®, a simple, minimally-invasive form of extracorporeal carbon dioxide removal ($ECCO_2R$). The system utilizes patented technology to provide highly efficient CO_2 removal at dialysis-like blood flow rates which are achieved through a single 15.5 Fr venous catheter. For more information, please visit http://www.alung.com.

ALung Technologies, Inc.
2500 Jane Street, Suite 1 | Pittsburgh, PA 15203 USA
ph: +1 412-697-3370 | email: sales@alung.com | www.alung.com