What is Respiratory Dialysis?

Respiratory Dialysis is a simple, minimally invasive approach to extracorporeal CO₂ removal (ECCO₂R), only available with the Hemolung Respiratory Assist System (RAS). Using blood flows of 350-550 mL/min, the Hemolung RAS removes 30-50% of metabolically produced CO₂, reducing ventilation requirements in patients who are either failing non-invasive ventilation or who are already invasively ventilated.

This patient selection guide is designed to assist physicians and nurses with maximizing the clinical benefit of Hemolung RAS therapy. The guide helps answer common questions, such as:

- What are the indications for Hemolung therapy?
- How are appropriate patients for Hemolung therapy identified?
- When is the best time to initiate Hemolung therapy?

How is the Hemolung RAS used?

Indications for Use:
The Hemolung RAS is approved for the following indications:

1) Severe COPD patients failing non-invasive ventilation (NIV) where no alternative established therapy is available.

2) Application of lung protective ventilation strategies for patients who are invasively mechanically ventilated (IMV).

The Hemolung RAS is not indicated for patients needing assistance in weaning from invasive mechanical ventilation, patients with severe asthma, and patients preparing for and following lung transplantation.

Contraindications:
Patients with known sensitivity to heparin (e.g. history of heparin-induced thrombocytopenia). The Hemolung Cartridge membranes are coated with heparin and systemic anticoagulation is required when using the device.

Use of the Hemolung 15.5 Fr Femoral Catheter is contraindicated for patients with an inferior vena cava filter.
Hemolung RAS for COPD Patients

When should the Hemolung RAS be utilized during an acute exacerbation of COPD (AECOPD)?

The Hemolung RAS can be used to correct hypercapnia and respiratory acidosis for COPD patients failing non-invasive ventilation, or to improve ventilator management for COPD patients who are invasively mechanically ventilated. Early initiation of Hemolung therapy can help prevent intubation and mechanical ventilation. Avoidance of IMV is associated with reduced mortality and morbidity in AECOPD. Avoidance of IMV is associated with reduced mortality and morbidity in AECOPD.

Clinical benefits: Respiratory Dialysis during AECOPD

- Avoid intubation and mechanical ventilation
- Rapidly correct hypercapnia and acidosis
- Relieve dyspnea
- Reduce work of breathing
- Patient remains awake and mobile, with increased quality of life

Patient selection: Respiratory Dialysis during AECOPD

- Failing NIV
  - pH < 7.25 and PaCO₂ > 55 mmHg (7.3 kPa)
  - pH < 7.3, PaCO₂ > 55 mmHg (7.3 kPa) without improvement on NIV
  - Increasing respiratory rate and patient discomfort
  - Clinical signs of respiratory muscle fatigue or increased work of breathing
- Invasively mechanically ventilated
  - Clinical signs of poor respiratory mechanics (dynamic hyperinflation, requirements for high pressures or minute volumes)

Abbreviations:
AECOPD: Acute exacerbation of chronic obstructive pulmonary disease
IMV: Invasive mechanical ventilation
NIV: Noninvasive ventilation
Case study: Hemolung RAS during AECOPD

- 59 year old male admitted to the hospital with AECOPD.
- Despite high level NIV support, the patient developed hypercapnia with increasing dyspnea, tachycardia and disorientation.
- ECCO₂R was implemented using the Hemolung RAS to avoid intubation and IMV.
- Within 30 minutes of initiating ECCO₂R, the patient’s respiratory distress began to diminish, and his condition continued to improve throughout the course of Hemolung therapy (Table 1).
- The patient was weaned off the Hemolung after 4.5 days, and ultimately discharged to home 7 days later.

Read the entire case report at ALung.com

<table>
<thead>
<tr>
<th>pH</th>
<th>PaCO₂ (mmHg)</th>
<th>PaO₂ (mmHg)</th>
<th>HCO₃⁻ (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-ECCO₂R</td>
<td>7.31</td>
<td>63</td>
<td>68</td>
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<tr>
<td>Post-ECCO₂R</td>
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<td>58</td>
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<tr>
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<td>55</td>
</tr>
<tr>
<td></td>
<td>2 days</td>
<td>7.45</td>
<td>52</td>
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<tr>
<td></td>
<td>3 days</td>
<td>7.47</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>4 days</td>
<td>7.48</td>
<td>49</td>
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</table>

Table 1. Changes in pH, blood gases and bicarbonate over the 4 day course of Hemolung RAS therapy.

Goals achieved:
- Avoided intubation and IMV
- Corrected hypercapnia and respiratory acidosis
- Lung recovery facilitated

“The very early application of this technique in patients with...chronic obstructive pulmonary disease exacerbations may prevent the need for mechanical support”

Hemolung RAS for ARDS Patients

When should the Hemolung RAS be utilized during ARDS?

The Hemolung RAS can be used in conjunction with IMV to facilitate protective and ultra-protective ventilation strategies for patients presenting with ARDS without refractory hypoxemia. Extracorporeal CO₂ removal using the Hemolung RAS safely allows reduction in tidal volumes, inspiratory pressures and respiratory rates while maintaining safe PaCO₂ and pH levels.

Clinical benefits: Respiratory Dialysis during ARDS⁸,⁹

- Facilitate lung protective and ultra-protective ventilation strategies
- Maintain safe pH and PaCO₂ levels
- Reduce ventilator induced lung injury
  - Barotrauma
  - Volutrauma
  - Systemic inflammatory response

Patient selection: Respiratory Dialysis during ARDS

- Unable to control pH and PaCO₂ using ARDSNet ventilation
- Tidal volumes < 6 mL/kg desired to meet lung protective goals

Abbreviations:
P/F: partial pressure of arterial oxygen (PaO₂) / fraction of inspired oxygen (FiO₂)
PEEP: positive end expiratory pressure
V₆: tidal volume
Pplat: plateau pressure
PBW: predicted body weight
How is protective and ultra-protective ventilation implemented?

- Adherence to the use of low tidal volume ventilation at the initial onset of IMV improves survival in ARDS.\(^\text{11}\)
- Application of ECCO\(^2\)R with the Hemolung RAS in conjunction with IMV can help safely titrate ventilator settings to protect the lungs and reduce the risk of ventilator induced lung injury.
- This table displays predicted body weights (PBW) and associated tidal volumes based on the ARDSNet protocol\(^\text{10}\) for protective (6 mL/kg PBW) and ultra-protective (3 mL/kg PBW) ventilatory strategies.

> Of all the available forms of extracorporeal gas exchange, partial lung support, also known as ECCO\(^2\)R or respiratory dialysis, is the most promising, because it offers unique advantages while carrying a low potential for complications


### ARDSNet Predicted Body Weight (PBW) and Tidal Volumes

<table>
<thead>
<tr>
<th>Height (in)</th>
<th>PBW (kg)</th>
<th>Protective (V_T) (mL) (6mL/kg PBW)</th>
<th>Ultra-Protective (V_T) (mL) (3mL/kg PBW)</th>
<th>Height (in)</th>
<th>PBW (kg)</th>
<th>Protective (V_T) (mL) (6mL/kg PBW)</th>
<th>Ultra-Protective (V_T) (mL) (3mL/kg PBW)</th>
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</thead>
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<td>48</td>
<td>287</td>
<td>55.1</td>
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<td>34</td>
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<td>60.2</td>
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<td>565</td>
<td>75.2</td>
<td>191</td>
<td>81</td>
<td>484</td>
</tr>
</tbody>
</table>

PBW (male) = 50 + 0.91 x (cm of height - 152.4)
PBW (female) = 45.5 + 0.91 x (cm of height - 152.4)
Case study: Hemolung RAS during ARDS

- 41 year old male admitted to the ICU with severe bilateral traumatic leg injuries, ARDS, and metabolic acidosis from sepsis.

- The patient became difficult to ventilate, high inspiratory pressures (46-50 cmH$_2$O) were necessary in an effort to minimize worsening concomitant respiratory acidosis.

- Hemolung therapy was initiated to reduce peak inspiratory pressure and correct respiratory acidosis.

- Within 4 hours of Hemolung therapy, inspiratory pressure rapidly decreased while acidosis simultaneously improved (Table 2).

- Normocapnia was restored and consistently maintained at low inspiratory pressures over the next 7 days, leading to weaning from the Hemolung, extubation and recovery.

Read the entire case report at ALung.com

Unable to provide lung protective ventilation

Hemolung initiated

Reduction in ventilator settings

Correction of acidosis

Weaning and recovery

<table>
<thead>
<tr>
<th></th>
<th>Pre-Hemolung</th>
<th>Hour 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
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<td>30</td>
<td>15</td>
<td>15</td>
<td>24</td>
<td>24</td>
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<tr>
<td>pH</td>
<td>7.29</td>
<td>7.37</td>
<td>7.47</td>
<td>7.42</td>
<td>7.36</td>
<td>7.41</td>
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<tr>
<td>PaCO$_2$ (mmHg)</td>
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<td>43.0</td>
<td>34.3</td>
<td>40.9</td>
<td>39.7</td>
<td>46.9</td>
<td>42.2</td>
<td>43.8</td>
</tr>
<tr>
<td>Bicarbonate (mmol/L)</td>
<td>20.8</td>
<td>24.8</td>
<td>24.6</td>
<td>26.1</td>
<td>25.5</td>
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<td>30.7</td>
</tr>
<tr>
<td>CO$_2$ Removal (mL/min)</td>
<td>-</td>
<td>83</td>
<td>65</td>
<td>61</td>
<td>64</td>
<td>69</td>
<td>59</td>
<td>56</td>
</tr>
</tbody>
</table>

Table 2. Changes in inspiratory pressure, pH, PaCO$_2$, bicarbonate, and CO$_2$ removal over the 7 day course of Hemolung RAS therapy.

Goals achieved:
- Implemented lung protective ventilation (reduced inspiratory pressures)
- Corrected respiratory acidosis and hypercapnia
- Lung recovery facilitated

“The implementation of ECCO$_2$R devices can represent the missing link between the prevention of ventilator-induced lung injury and pH control”

Clinical Support

Our support team includes clinical specialists and engineers who are committed to ensuring safe and reliable use of ALung’s products to achieve optimal clinical outcomes.

ALung’s support begins with a comprehensive training program delivered by our skilled clinical specialists. We ensure your staff is fully prepared to safely and effectively deliver extracorporeal CO₂ removal with the Hemolung RAS.

When the time comes for your first patient treatment, we’re happy to help. On-Site Case Assistance is offered to every customer and provided at your request.

Our clinical specialists are also available 24/7 to immediately address any questions or issues which you may have. Call us, anytime.

Our technical service team offers comprehensive calibration and preventive maintenance programs to ensure your device is always ready for use.

For immediate support, please call us:

France (toll free): 0800-918846
Germany (toll free): 0800-181-6344
United Kingdom: 0-808-189-1190
All others: +1-724-506-5149

References


Disclaimer

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