

REST AND PROTECT™  
*with Respiratory Dialysis®*

# HEMOLUNG® RAS

*A minimally invasive approach to extracorporeal CO<sub>2</sub> removal*

Pioneered by **ALUNG®**

# RESPIRATORY DIALYSIS:

Providing new options for the treatment of acute respiratory failure.

Extracorporeal CO<sub>2</sub> Removal (ECCO<sub>2</sub>R) provides an alternative or supplement to mechanical ventilation by removing carbon dioxide directly from the blood, reducing the risk of ventilator-associated events and facilitating lung rest, protection, and ultimate recovery.<sup>1</sup>

## REDUCING THE NEED FOR MECHANICAL VENTILATION WITH RESPIRATORY DIALYSIS

*A Minimally Invasive Approach to ECCO<sub>2</sub>R*

Respiratory Dialysis is a simple, minimally invasive approach to ECCO<sub>2</sub>R only available with the HEMOLUNG RAS. The system can remove 30-50% of metabolically produced CO<sub>2</sub>, reducing ventilation requirements in patients who are either failing non-invasive ventilation (NIV) or who are already invasively ventilated.

Unlike extracorporeal membrane oxygenation (ECMO), Respiratory Dialysis is not a rescue therapy. In fact, the simplicity and minimally invasive nature of the HEMOLUNG RAS allow it to be used much earlier, even before intubation and IMV.

## Applications for Respiratory Dialysis

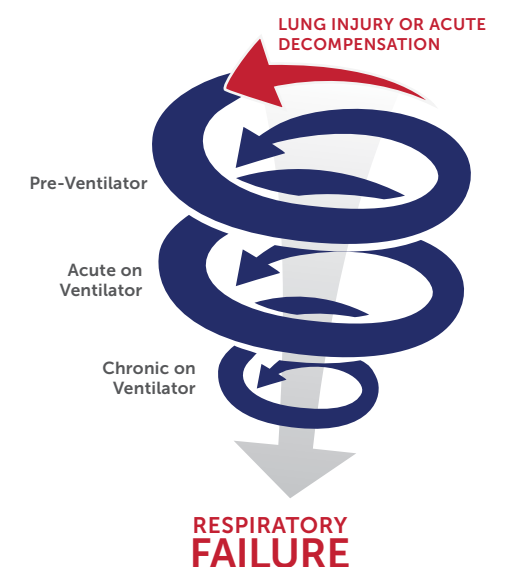
### PRE-VENTILATOR

The HEMOLUNG RAS is used in cases of acute exacerbation of COPD when non-invasive ventilation is failing and invasive mechanical ventilation is considered undesirable. By removing CO<sub>2</sub> directly from the blood, Respiratory Dialysis reduces ventilation requirements and provides relief of dyspnea, interrupting the cycle of respiratory failure before it leads to intubation and invasive mechanical ventilation.

### ACUTE AND CHRONIC ON VENTILATOR

The HEMOLUNG RAS enables the application of protective and ultra-protective ventilation strategies, minimizing the risk of ventilator-induced lung injury (VILI) without the complexity and invasiveness of ECMO. Ultra-low tidal volumes and plateau pressures are made possible while the patient's CO<sub>2</sub> level is easily controlled.

### Stop the Downward Spiral of Respiratory Failure



# Rest the Lungs. Recover the Patient.

**COPD** Rapidly correct hypercapnia to avoid mechanical ventilation.

**ARDS** Protect against ventilator induced lung injury.

## BENEFITS OF RESPIRATORY DIALYSIS IN EXACERBATED COPD<sup>6</sup>

- Avoid intubation and mechanical ventilation
- Rapidly correct hypercapnia
- Relieve dyspnea
- Reduce work of breathing
- Improve respiratory mechanics—reduce minute ventilation and dynamic hyperinflation
- Patients remain awake and mobile, with increased quality of life

Respiratory Dialysis rapidly corrects respiratory acidosis and hypercapnia, relieves dyspnea, and reduces work of breathing, helping COPD patients failing noninvasive ventilation (NIV) to rest and recover while their exacerbation is treated. For COPD patients already mechanically ventilated, Respiratory Dialysis can facilitate more protective ventilation settings, such as lower minute ventilation to reduce dynamic hyperinflation.

The deleterious side effects of IMV in acute exacerbation of COPD (AE-COPD) patients are well known, with a 29% in-hospital mortality rate.<sup>2,5</sup> These side effects include intubation complications, tracheostomies, sedation that prevents communication, inability to take oral fluids or nutrition, lack of mobility, neurological disorders, and ventilator associated pneumonia (VAP). VAP is a significant complication that affects up to 25% of patients on IMV and has a mortality rate of 60-64%.<sup>3,4</sup> These patients can suffer from dynamic hyperinflation leading to cardiopulmonary compromise, and often experience ventilator dependency and prolonged weaning. The risk of mortality increases with every day on the ventilator.

Avoiding IMV decreases mortality rates in AE-COPD patients by 50-69%<sup>2,5</sup> and reduces ICU length of stay by 3 days.<sup>5</sup> According to a recent study, patients with NIV failure avoided intubation with Respiratory Dialysis, and the HEMOLUNG RAS was well tolerated.<sup>6</sup>

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

*Del Sorbo L, et al. Crit Care Med. 2010, 38(10 Suppl):S555-558.*

**“If correctly performed, mechanical ventilation ‘buys time’ to allow other therapies to take effect; if performed incorrectly, it may kill the patient.”**

*Gattinoni L, Protti A. CMAJ. 2008, 178(9):1174-1176.*

Despite advances in IMV modes and protective ventilation settings, ARDS mortality remains between 27-45%.<sup>7</sup> Few interventions have proven effective at improving outcomes in ARDS, a notable exception being the use of low tidal volume ( $\leq 6$  mL/kg PBW) along with limiting plateau pressure to less than 30 cmH<sub>2</sub>O and providing adequate PEEP. The goal of this strategy is to limit ventilator-induced lung injury. This strategy was shown to reduce mortality in ARDS patients by 23% (from 40% to 31%).<sup>8</sup>

Practically however, implementing protective ventilation can be challenging. Reducing minute ventilation can lead to respiratory acidosis and a range of potentially adverse physiologic effects including cardiovascular instability and remote organ damage. Additionally, patient discomfort due to tachypnea and concerns about oxygenation are frequently cited as practical barriers to optimized protective ventilation.<sup>9</sup>

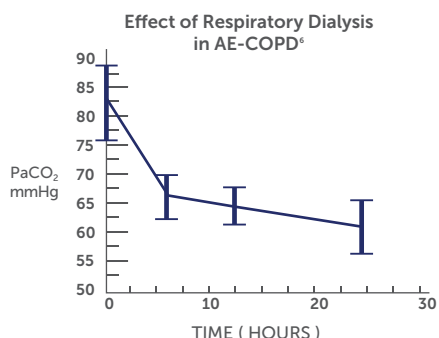
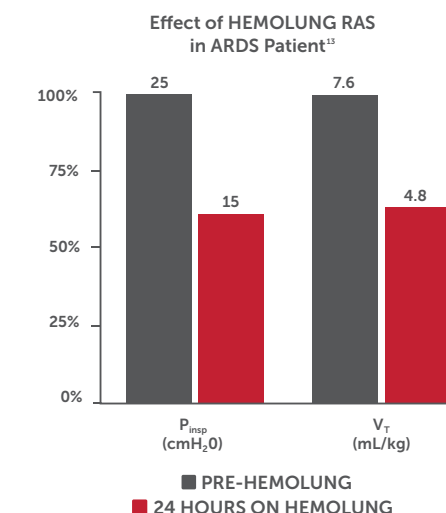
Respiratory Dialysis with the HEMOLUNG RAS effectively facilitates lung protective ventilation strategies while mitigating the adverse effects of respiratory acidosis and hypercapnia that can develop when minute ventilation is reduced. Protective tidal volumes and pressures can be achieved while maintaining control of the CO<sub>2</sub> levels. Evidence even suggests that “ultra-protective” ventilation, with tidal volume < 6 mL/kg and PPLAT < 30 cmH<sub>2</sub>O, may also be beneficial, further reducing ventilator induced lung injury (VILI).<sup>10</sup>

*“The use of very low VT combined with extra-corporeal CO<sub>2</sub> removal has the potential to further reduce VILI compared with a ‘normal’ lung protective management.”*

*Bein, T et al. Intensive Care Med 2013, 39(5):847-56.*

## BENEFITS OF RESPIRATORY DIALYSIS IN ARDS<sup>10,11</sup>

- Safely allows tidal volume and plateau pressure to be reduced while maintaining normocapnia
- Reduces time on mechanical ventilation (in patients with P/F < 150)
- Facilitates lung protection as evidenced by improved morphological markers of lung protection and the reduction of pulmonary cytokines
- Improves spontaneous breathing
- Reduce the need for sedatives and analgesics



## WHEN TO USE RESPIRATORY DIALYSIS IN AE-COPD

### AE-COPD PATIENTS FAILING NIV

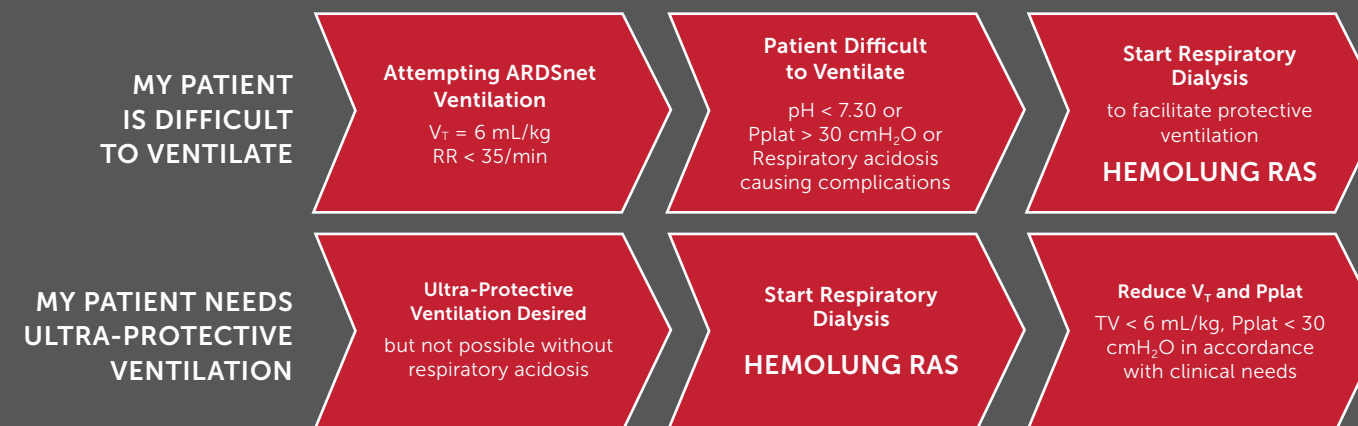
Respiratory Dialysis can be used in patients failing NIV for whom intubation and mechanical ventilation are deemed undesirable. To prevent intubation, Respiratory Dialysis should be initiated as soon as the patient shows signs of NIV failure.

### INDICATORS OF NIV FAILURE IN AE-COPD<sup>6,12</sup>

Consider Respiratory Dialysis after 2 hours of NIV if:

- pH < 7.25 and PaCO<sub>2</sub> > 55 mmHg
- pH < 7.3, PaCO<sub>2</sub> > 55 mmHg without improvement on NIV
- Worsening acidosis
- Increasing respiratory rate
- Clinical signs of respiratory muscle fatigue or increased work of breathing

## ALGORITHM FOR ARDS PATIENTS



Respiratory Dialysis powered by the

# HEMOLUNG<sup>®</sup> RAS

The HEMOLUNG RAS is the world's first fully integrated Respiratory Dialysis system, providing simple, minimally invasive ECCO<sub>2</sub>R. An alternative or supplement to mechanical ventilation, the HEMOLUNG RAS removes CO<sub>2</sub> directly from the blood, allowing the patient's lungs to rest and heal.

*"Compared with ECMO systems used for full respiratory or cardiopulmonary support, the HEMOLUNG was substantially simpler to operate."*

Bonin F, et al. J Thorac Cardiovasc Surg. 2013, 145(5):e43-e44.3-4.



## Safe, Simple, and Effective Extracorporeal CO<sub>2</sub> Removal

### SIMPLE AND EASY TO USE

A combination of advanced technology and thoughtful design make the HEMOLUNG RAS easy to use. Simplicity starts with an integrated design approach: the HEMOLUNG Cartridge, Catheter, and Controller work together seamlessly.

- A continuous measurement of HEMOLUNG CO<sub>2</sub> removal is provided, simplifying monitoring and titration of therapy.
- The HEMOLUNG blood circuit is fully closed for safety and simplified priming.
- Smart gas-flow controls reduce workload and enable mobility without a gas source.
- On-screen instructions make setup and priming fast and easy.

### HIGHLY EFFICIENT

The HEMOLUNG RAS is the only device offering highly efficient extracorporeal CO<sub>2</sub> removal at dialysis-like blood flow rates. Efficient CO<sub>2</sub> removal at low blood flow rates is the key to making ECCO<sub>2</sub>R less invasive, enabling the use of a small venous catheter.

- ActivMix technology provides enhanced CO<sub>2</sub> removal at low blood flow rates.
- Integrated centrifugal pump flows 350–550 mL/min with HEMOLUNG 15.5 Fr Catheters.

- Steady gas exchange is ensured with automatic membrane condensation removal.
- An advanced membrane coating (siloxane/heparin) reduces thrombus formation and prevents plasma leakage, ensuring reliable performance.

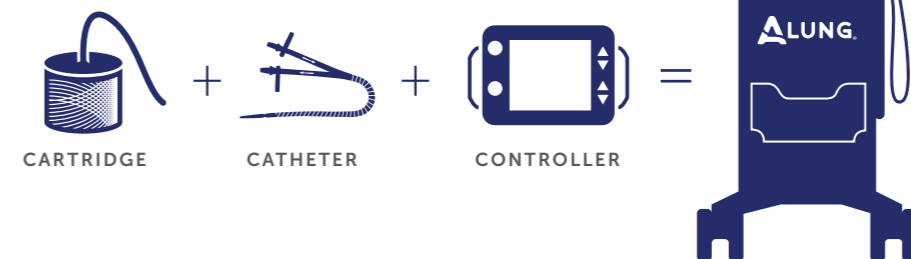
### MINIMALLY INVASIVE

The HEMOLUNG RAS provides uniquely effective CO<sub>2</sub> removal at blood flow rates of just 350–550 mL/min, allowing the use of a single 15.5 Fr dual lumen venous catheter, the smallest of any ECCO<sub>2</sub>R system. Patient mobilization is made possible, particularly when the jugular catheter is used.

- Only a single 15.5 Fr venous catheter is required to provide HEMOLUNG therapy.
- The HEMOLUNG Catheter is inserted using a standard Seldinger technique, just like acute dialysis catheters.
- To improve biocompatibility, priming volume and membrane surface area are minimized.

Ready to optimize ventilation for your patients with acute respiratory failure?

CONTACT ALUNG TO LEARN MORE ABOUT PROVIDING RESPIRATORY DIALYSIS WITH THE HEMOLUNG RAS.



Pioneered by **ALUNG**





### ALung Technologies, Inc.

2500 Jane Street, Suite 1  
Pittsburgh, PA 15203 USA

ph: +1 412-697-3370

fax: +1 412-697-3376

email: sales@alung.com

[www.alung.com](http://www.alung.com)

### ALung United Kingdom

+44 845 835 8558

### ALung Germany

+49 611 977 74-304

### ALung France

+33 4 11 81 97 10

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- <sup>8</sup> Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The Acute Respiratory Distress Syndrome Network. *N Engl J Med*. 2000;342(18):1301-1308.
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- <sup>10</sup> Bein T, Weber-Carstens S, Goldmann A, et al. Lower tidal volume strategy (approximately 3 ml/kg) combined with extracorporeal CO<sub>2</sub> removal versus 'conventional' protective ventilation (6 ml/kg) in severe ARDS: The prospective randomized Xtravent-study. *Intensive Care Med*. 2013;39(5):847-856.
- <sup>11</sup> Terragni P, Del Sorbo L, Mascia L, et al. Tidal volume lower than 6 ml/kg enhances lung protection: role of extracorporeal carbon dioxide removal. *Anesthesiology*. 2009;111(4):826-35.
- <sup>12</sup> Kluge S, Braune S, Engel M, Nierhaus A, Frings D, Ebel H, et al. Avoiding invasive mechanical ventilation by extracorporeal carbon dioxide removal in patients failing noninvasive ventilation. *Intensive Care Medicine* 2012, 38(10):1632-9.
- <sup>13</sup> HEMOLUNG RAS Registry (data on file).

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Always refer to the Instructions For Use for complete indications and clinical instructions.