

Mini-invasive extracorporeal CO₂ removal system

ProLUNG®



ProLUNG® 3D
for the Aquarius™ System

A LUNG-PROTECTIVE STRATEGY



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 **NORRDIA**

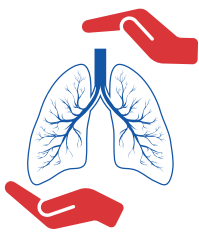
 **ESTOR**

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ProLUNG®

A LUNG-PROTECTIVE STRATEGY

ENABLE PROTECTIVE VENTILATION



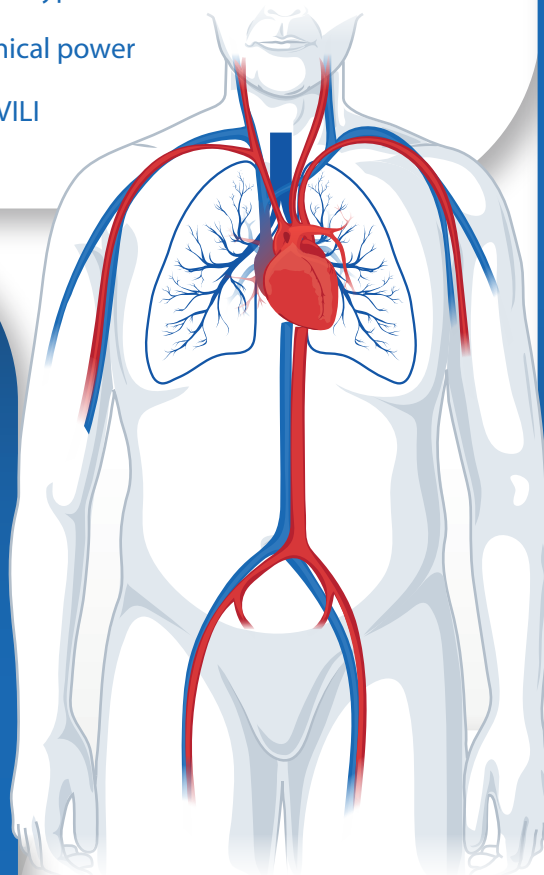
- ↓ Tidal volume/plateau pressure
- ↓ Dynamic hyperinflation
- ↓ Mechanical power
- ↓ Risk of VILI

PREVENT INTUBATION

- ↓ Hypercapnia
- ↓ Respiratory acidosis
- ↓ Ventilator-associated risks (VILI, VAP)

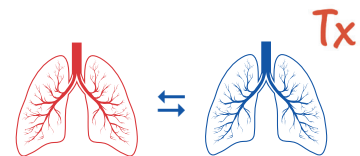
FACILITATE EXTUBATION

- ↓ Respiratory acidosis
- ↓ Diaphragm work effort
- ↓ Inspiratory effort
- ↓ Ventilator-associated risks (VILI, VAP)



BRIDGE TO TRANSPLANT^{10,11}

- ↓ Hypercapnia
- ↓ Respiratory acidosis
- ↓ Risk of transplantation failure



PROLUNG®

QUALITY AND INNOVATION

ProLUNG® is the reference system for mini-invasive extracorporeal CO₂ removal (ECCO₂R). ProLUNG® has all the features necessary to guarantee quality ventilatory support with a clinical rationale: high CO₂ removal capacity ($\text{VCO}_2 > 100 \text{ mL/min}$), low invasiveness for the patient (13-14 Fr bilumen catheter).



What characteristics should the ideal ECCO₂R system have?

- ☐ High CO₂-removal performance
- ☐ Prolonged kit duration
- ☐ Biocompatibility
- ☐ Minimal invasiveness
- ☐ Reduced priming volume

Why choose ProLUNG®?

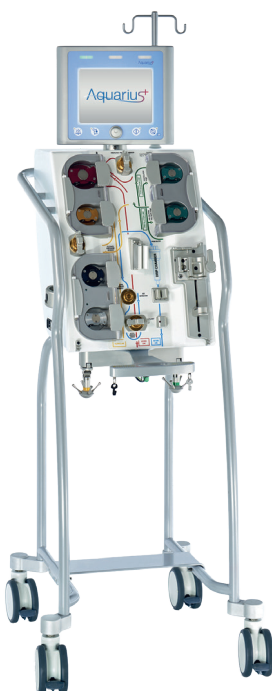


ProLUNG® 3D

- ☒ Optimal CO₂-removal capacity ($\text{VCO}_2 > 100 \text{ mL/min}$ at $\text{Qb} = 400 \text{ mL/min}$)
- ☒ 1.81 m² membrane in polymethylpentene (PMP) covered with phosphorylcholine
- ☒ Priming volume of 125 mL (artificial lung)
- ☒ 3 days therapy (3D)

Double lumen catheter

- ☒ Low invasiveness: double lumen catheter $\geq 13 \text{ Fr}$
- ☒ Femoral, jugular or subclavian vascular access



PROLUNG®

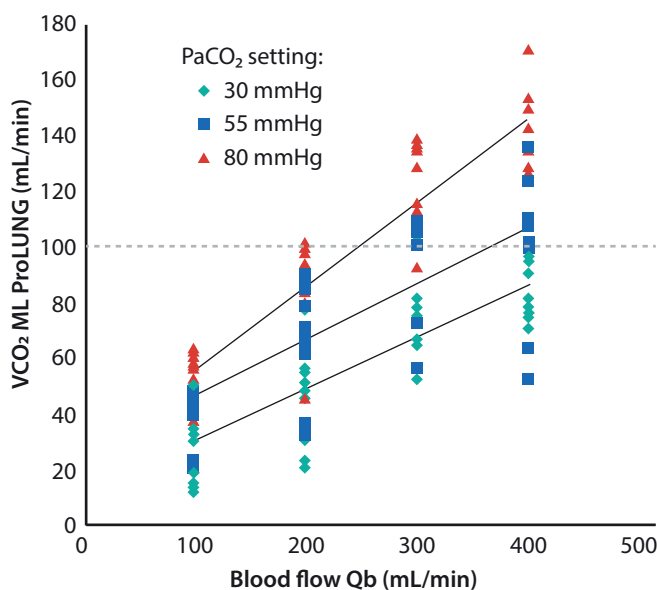
FROM THEORY TO PRACTICE

The research group of Gattinoni and Quintel at UMG carried out an animal study in 2018 to evaluate the CO₂-removal capacity of the ProLUNG® system under different conditions¹. The study included 8 adult pigs with a body weight of 57 kg. The animals were sedated, ventilated and treated with ProLUNG® using a 13 Fr catheter. The CO₂-removal capacity of the VCO₂ ML system (membrane lung) was measured under different conditions of PaCO₂, blood flow (Qb) and medical air flow.

High CO₂-removal capacity VCO₂ > 100 mL/min

The measured VCO₂ reached a maximum value of 171 mL/min.

Typically, a removal of VCO₂ > 100 mL/min can be obtained with PaCO₂ settings between 55 and 80 mmHg, an extracorporeal blood flow (Qb) of 400 mL/min and a gas flow greater than 6 L/min.

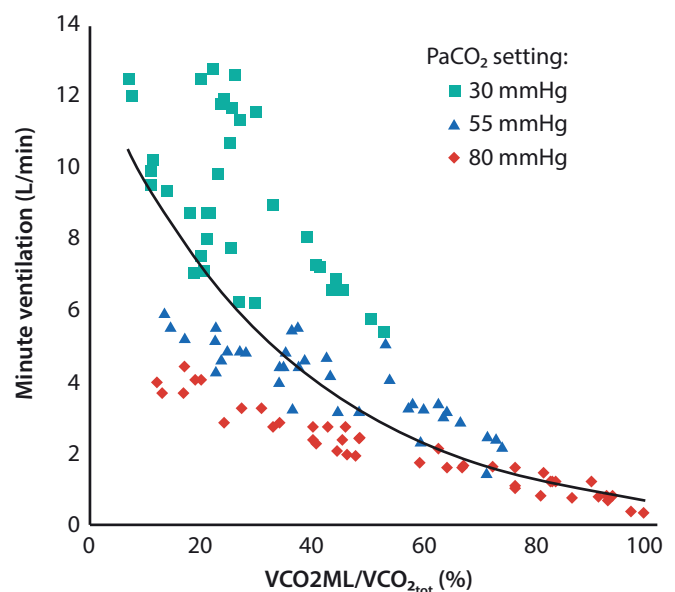


VCO₂ (ML) as a function of blood flow (Qb) and three different settings of PaCO₂: 30, 55 e 80 mmHg.

Reduction of ventilatory burden

Minute ventilation is reduced proportionally to the quantity of CO₂ removed by ProLUNG® (VCO₂ (ML)/VCO_{2tot}).

With a PaCO₂ of 74 mmHg and pH 7.3, it was possible to remove up to 138.8 mL/min of CO₂ allowing a reduction of ventilation from 7.4 to 1.9 L/min with no complications. This corresponds to a reduction in mechanical power from 9.3 to 2.6 J/min.



Minute ventilation at 3 different settings of PaCO₂ plotted as a function of VCO₂(ML)/VCO₂tot.

"Minimally invasive extracorporeal CO₂ removal removes a relevant amount of CO₂ thus allowing mechanical ventilation to be significantly reduced depending on extracorporeal blood flow and inflow PCO₂. Extracorporeal CO₂ removal may provide the physiologic prerequisites for controlling ventilator-induced lung injury.

The main result of this study was that a considerable amount of CO₂ was removed by the Estor ProLUNG system using only a minimally invasive cannulation and a blood flow rate similar to that used in renal dialysis".

PROLUNG®

CLINICAL APPLICATIONS

ECCO₂R is a minimally invasive extracorporeal support for the management of ventilatory insufficiency². ECCO₂R can facilitate protective ventilation at low tidal volumes or low plateau pressures in patients in mechanical ventilation, as well as facilitating rapid extubation³. In patients undergoing non-invasive ventilation (NIV) at risk of failure, ECCO₂R can prevent the invasiveness and complications of intubation³⁻⁵.

COPD⁶⁻⁹

In COPD patients with exacerbations initially managed in NIV and at risk of failure, ProLUNG® reduces the risk of intubation, thus avoiding the associated comorbidities and the prolonged hospitalisation associated with invasive mechanical ventilation. In COPD patients already in invasive mechanical ventilation, ProLUNG® contributes to protective ventilation with the aim of facilitating weaning from the ventilator.

ARDS^{6,7}

In patients with moderate ARDS where it is not possible to pursue protective ventilation because of hypercapnic respiratory acidosis, ProLUNG® allows the setting of adequate tidal volumes and plateau pressures, thus avoiding the onset of volutrauma and barotrauma.

TRANSPLANTATION^{10,11}

In all phases of lung transplantation (pre-intra-post), the use of ProLUNG® protects the lung, avoiding excessive ventilator load and allowing a better management of the transplantation procedure, thus avoiding the risk of having to resort to ECMO in an emergency.

TISSUE LESIONS¹²

In the presence of tissue lesions of the respiratory system (broncho-pleural fistulas, ruptures of the trachea or diaphragmatic lesions), the use of ProLUNG® facilitates protective ventilation.

REFRACTORY ASTHMA – EXACERBATION OF BRONCHIECTASIS^{2,13}

In patients with refractory asthma or with exacerbation of bronchiectasis, ProLUNG® facilitates protective ventilation by reducing the load induced by invasive mechanical ventilation and normalising blood pH values.



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ProLUNG® PLAQUA3D

Treatment modality	Hemoperfusion
Blood flow	Qb ≤ 450 mL/min (Aquarius™ system)
Membrane type	Polymethylpentene covered with phosphorylcholine
Membrane surface	1,81 m ²
Priming volume	Around 250 mL (artificial lung (125 mL) + blood lines)
Sterilisation	Ethylene oxide
Duration of single circuit	3 days
Rinsing and priming	2 L physiological solution with 10,000 IU of heparin
Vascular access	≥ 13 Fr double lumen central venous catheter



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