Portfolio

By Massimiliano Leoni

Me in a nutshell

- MSc in Mathematical Engineering, Politecnico di Milano (2016)

- Master's thesis at Rolls-Royce (2015)

- Double PhD in Computer Science (KTH) and Mathematics (UPV/EHU) (2020)

- Research Scientist at the Austrian Academy of Sciences

- Software engineer at Proxima Fusion

Three selected projects

- Modelling and simulation of Extra-Corporeal Membrane Oxygenation

- Cardiac Radiofrequency Ablation and function interpolation

- Thermal analysis of a first wall

Modelling and Simulation of Extracorporeal Membrane Oxygenation (ECMO)

Paper

Scientific Reports (Nature Portfolio), 2022

Awarded *Best Paper of the Year* by the Austrian Academy of Sciences.

Overview

Extracorporeal Membrane Oxygenation (ECMO) is an ICU procedure that oxygenates blood externally when pulmonary function is severely impaired. Clinicians had observed a persistent drop in oxygen transfer efficiency during ECMO and suspected **recirculation** —the unintended return of oxygenated blood to the venous system— as the root cause.

I developed a computational model of the ECMO process to test this hypothesis and quantify the contribution of recirculation under realistic physiological and clinical conditions.

Approach

- Developed a Finite Element model of cardiovascular flow dynamics and oxygen transport

- Incorporated cannulation geometry, machine characteristics, and patient physiology

- Ran extensive simulations of clinically relevant configurations

- Compared numerical outcomes to ICU observations to improve clinical understanding

Key Findings

- **Recirculation in a necessary evil** and not even optimal cannula placement can solve it

- **Intrinsic limitations of ECMO design** impose upper bounds on achievable oxygenation

Impact

- Provided clinicians with an explanation for observed oxygenation limits

- Informed interpretation of ECMO performance metrics in ICU practice

- Published in *Scientific Reports* and received **Best Paper of the Year** from the Austrian Academy of Sciences

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