# Modeling of the cardio-pulmonary system assisted by ECMO

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## Abstract

In this research, we propose a model of the cardio-pulmonary system for medical purposes. An ECMO is also taken into account in our model. The results simulate a patient with pulmonary insufficiency assisted by ECMO. Thanks to this device, pH and CO2 partial pressures return to physiological values.

Keyword: biomechanics

## 1. Introduction

For helping people with pulmonary diseases, medical environment has designed several devices like *VenoVenous Extra-Corporeal Membrane Oxygenation* (VV-ECMO). Cardio-pulmonary model could be useful in order to optimise the use of such medical supports. Several mathematical models of the lungs [2,4] and of the cardio-vascular system [3] exist. However, few articles are concerned with the cardio-pulmonary system [1].

## 2. Methods

In this study, the cardio-pulmonary system is reduced to a small number of "compartments" (*lumped parameter model*). Here, we consider the following 8 compartments: pulmonary artery, pulmonary vein, left ventricle, aorta, vena cava and right ventricle for cardio-vascular system and tissues and lungs for the respiratory system. A ninth compartment is added to model a VV-ECMO. The model also takes into account the pulmonary shunt, and, in the description of blood, the Bohr effect and the acid-base chemistry of CO2/HCO3-.

## 3. Results

The results presented below correspond to a patient with pulmonary insufficiency. A VV-ECMO is introduced in our model to restore appropriate pH. The left plot represents the time evolution of O2 and CO2 partial pressures in arteries, veins and at the end of the extracorporeal membrane. The right plot describes pH evolution in veins and in arteries. We observe that the ECMO actually allows to decrease the patient CO2 partial pressure and to increase its blood pH to physiological values.
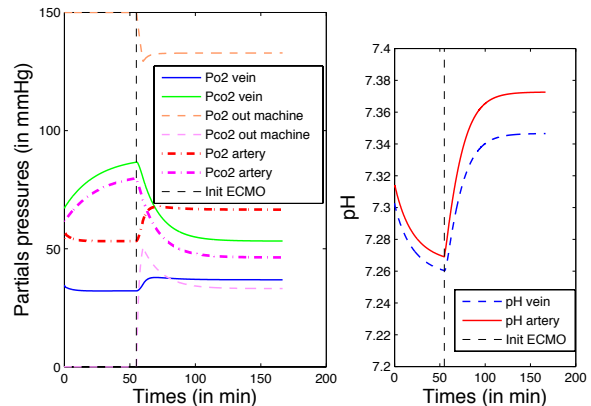


Figure 1 – Partial pressures and pH evolutions for a patient with pulmonary insufficiency. An ECMO is switched on after 50 min.

## 4. Conclusion

A model of the cardiopulmonary system was developed. This model provides a realistic description of the influence of a VV-ECMO on the state of a patient with pulmonary insufficiency.

## Acknowledgments

## References

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