MODELING OF THE CARDIO-PULMONARY SYSTEM ASSISTED BY ECMO

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Introduction

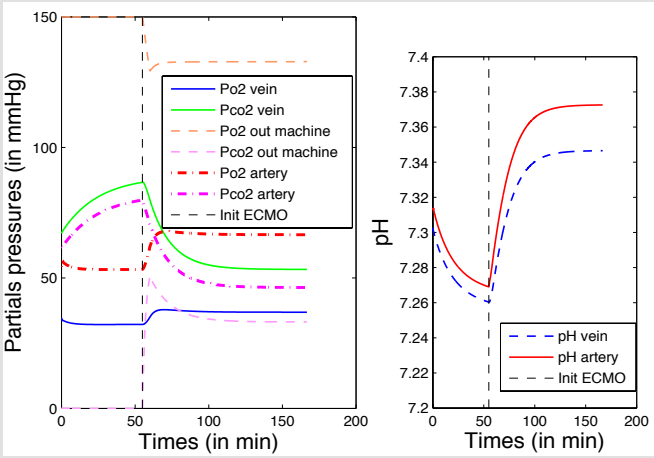
- Extra-Corporeal Membrane Oxygenation (ECMO) is crucial for helping people with severe pulmonary diseases.
- There are just a few articles* which are concerned with the modeling of the cardio-pulmonary system.
- The model that was developed could be helpful to optimize medical device like veno-venous ECMO.

Methods

- The cardio-pulmonary system is reduced to a small number of "compartments" (*lumped parameter model*).
- We consider 8 compartments:
  - 6 compartments for the cardio-vascular system: pulmonary artery, pulmonary vein, left ventricle, aorta, vena cava and right ventricle.
  - 2 compartments for the respiratory system: tissues and lungs
- 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-.

Results

- The results presented on the right 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.
- ECMO actually allows to decrease the patient CO2 partial pressure and to increase its blood pH to physiological values.



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

Reference

*- Batzel et al. Cardiovascular and respiratory systems: modeling, analysis, and control, *SIAM,* 2007.

- Ellwein LM et al. Patient-specific modeling of cardiovascular and respiratory dynamics during hypercapnia. Mathematical biosciences. 2013.

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