

# Determination of changes in plasma structure during extracorporeal circulation – studies by ATR-FTIR spectroscopy and machine learning methods

Sylwia Olsztyńska-Janus<sup>1</sup>, Barbara Kmieciak<sup>2</sup>, Bartosz Krawczyk<sup>3</sup>, Małgorzata Komorowska<sup>1</sup>

<sup>1</sup> Institute of Biomedical Engineering and Instrumentation, Wrocław University of Technology, Wrocław, Poland,

<sup>2</sup> Institute of Materials Science and Applied Mechanics, Wrocław University of Technology, Wrocław, Poland,

<sup>3</sup> Department of Systems and Computer Networks, Wrocław University of Technology, Wrocław, Poland

## Abstract.

In extracorporeal circulation blood is pumped out, purified, and pumped back into the patient's body. A typical system consists of the blood pumps, oxygenators, and cannulas. During extracorporeal blood remains in contact with a foreign surface. This leads to the activation of inflammatory mediators, which can give rise to oxidative stress in cells.

The aim of this study was to estimate how anticoagulant drugs and NIR radiation influence the animal plasma during extracorporeal circulation. The research material was prepared from blood plasma of pigs connected to the ECMO and ECLA (respiratory support) apparatus. Animals were assigned to three experimental groups: animals in group 1 (n=8) received no drug pre-treatment and served as controls; animals in group 2 (n=6) were treated with thrombotic drugs (clopidogrel and aspirin) at least 24 hours before extracorporeal circulation; in animals belonging to group 3 (n=7) the blood was exposed to near infrared (NIR) radiation during extracorporeal circulation. This procedure lasted for 6 hours. Blood samples were collected from all of the animals during circulation at the same stages of the procedure, the plasma was then separated and immediately frozen to -20°C. After thawing, ATR-FTIR spectra of the plasma solution were recorded on a Nicolet 6700 spectrometer equipped with the ATR diamond crystal.

In this work, changes in plasma during extracorporeal circulation have been studied by ATR-FTIR spectroscopy. This technique is useful in the analysis of spectral parameters of bands associated with the CH<sub>3</sub> and CH<sub>2</sub> stretching vibrations in 2996–2800 cm<sup>-1</sup> region. The intensities of proteins bands and those of amino acids and lactate were studied. The spectral data were subjected to advanced statistical analysis using classifier ensemble methods. The results of a classification: C4.5 – 72.04%, Neural Network – 74.11%, SVM - 75.87%, Random Forest – 79.23%, Mixture of Experts – 78.98%.

The results show that extracorporeal circulation causes changes in the parameters of the analyzed bands. They suggest also that anticoagulant drugs can

increase oxidative stress. In contrast, NIR radiation is likely to cause the release of NO (nitric oxide), which can be a rapid intervention at the beginning of oxidative stress. NO plays an important role in inhibiting platelet aggregation. Advanced statistical analysis suggests that NIR effects on the plasma are significant and can strongly change the properties of plasma. Samples, which were influenced by anticoagulant drugs, are in about 40% misclassified as control samples. This indicates that the effects of anticoagulant drugs vary and often may have small or no influence on the properties of examined plasma.

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