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Metabolomic investigation of human blood products using Raman-Trapping Microscopy

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Background: In recent years, the safety of blood transfusion has shifted focus to detection of bacterial contamination in platelet concentrates as well as to the stability and functionality of blood components during storage in an attempt to make transfusion safer and better. Currently, it is not possible to test all blood products for sterility or integrity of the cellular components using the available methods for sterility release, which requires an incubation time for up to seven days. This is significant when considering how platelet concentrates have a limited shelf life of 5 days, forcing patients to receive outdated preparations while using the commercial microbial detection systems. The aim of the present study is to use Raman spectroscopy to develop a minimally invasive, innovative point-of-care technology for a faster, simpler and highly reliable quality control analysis of blood products.

Methods: Raman spectroscopy is based on detection of light inelastically scattered by molecules and shifted to the red (long-wave) range. The photons, which are changed in wavelength, are subsequently detected by a spectrograph. As all the molecules within a cell contribute to the Raman spectrum, the spectral sum is as characteristic as a fingerprint. In this project we want to generate Raman profiles of red blood cells and platelet concentrates during the normal storage process. The identified Raman parameters are a quality feature for blood products with regard to aging/functionality.

Results: We were able to show that both erythrocytes and thrombocytes have their own Raman profile, which will allow the identification of residual leukocytes in the preparation since the spectra of leukocytes should be different when compared to erythrocytes and thrombocytes. Quality control studies of platelet concentrates during storage showed the expected decrease in platelet activation capacity as well as the correlation in metabolic consumption by decrease of glucose and citrate and increase in lactate and lactate dehydrogenase (LDH). At once an area (1000-1100 cm-1) was identified in the Raman spectrum that defines the age of the cells.

Conclusions: The use of Raman spectroscopy may lead to essential improvements in the field of transfusion medicine. For the first time, the opportunity opens up to ensure a functional and quality control analysis of blood products immediately before transfusion, thus minimizing contamination risks.

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