

Analysis of Surface-Enhanced Raman spectra of blood serum in patients with COPD

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Currently, the study of biofluids and biological tissues by optical methods is of great interest in clinical practice. One of the most accessible methods for the initial assessment of the human body state is the blood serum analysis. The features of the serum optical characteristics are due to the multicomponent nature and variability of individual differences. The study of the spectral features of serum in various diseases based on a combination of surface-enhanced Raman spectroscopy (SERS) and multivariate analysis can allow for evaluating the specificity of such analysis for detecting various pathologies and comprehensive monitoring of the human body state. Thus, the aim of the current work is testing the serum SERS characteristics of patients with chronic obstructive pulmonary disease (COPD) with the identification of spectral differences from the control group samples. The database of experimental data was formed on the basis of registering the spectral characteristics of the blood serum of 39 patients with COPD and 30 subjects of the control group. Subjects for analysis were selected by stratified random sampling. For SERS analysis, each serum sample in a volume of 1.5 μl was applied to aluminum foil with a silver substrate and dried for 30 minutes. Analysis of the serum spectral characteristics was performed on an experimental stand consisting of a spectrometric system (EnSpectr R785, Spekr-M, Chernogolovka, Russia) and a microscope (ADF U300, ADF, China). The spectra were excited in the near infrared range using a laser module with a central wavelength of 785 nm. The resulting spectra were subjected to multivariate analysis by means of the method of projections onto latent structures (PLS-DA) and visualization of the most significant spectral bands to construct discrimination between a patient with COPD and a control group. The constructed discrimination model is characterized by a specificity of 0.91, a sensitivity of 0.98, and an accuracy of 0.95. Cross-validation of the k-fold type demonstrated the stability of the COPD discrimination model. Analyzing the distribution of the variables importance of the serum spectrum in the construction of the PLS-DA discrimination model for the control group and the group of patients with COPD made it possible to identify spectral differences in the 1055 cm^{-1} and 1395 cm^{-1} bands. The obtained results can expand the study of the specificity of the SERS analysis of human blood serum in the tasks of the health state monitoring and identifying various pathologies.