Lecture + Practice (2+2 hours)

DETECTION AND ANALYSIS OF LOW-AMPLITUDE COMPONENTS IN ELECTROCARDIOGRAM

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The development of digital processing of biomedical signals and implementation of information technology in medical practice create conditions for improvement of diagnostic methods in cardiology. The use of special equipment for electrocardiogram registration and digital signal processing techniques provides information that cannot be obtained by visual analysis of the standard electrocardiogram. The classic use of high resolution electrocardiography (HR ECG) is non-invasive detection of markers of myocardial electrical instability to predict cardiac arrhythmias. It is believed that the first signs of electrical instability of the heart reflect the exhaustion of regulatory systems at the level of individual cells of the myocardium. Changes in energy and metabolic processes that occur in the deterioration of electrical stability of the myocardium at the cellular and subcellular levels and microstructural violations cannot be detected by conventional clinical and physiological methods of functional diagnostics. These changes in the first stage of the disease often does not manifest clinically. Development of methods for detection of early signs of heart disorders will not only predict the disease, but by early treatment can help prevent the pathological process flow.

The lecture and practical tasks are devoted to the methods for non-invasive detection of subtle manifestations of heart electrical activity. As examples, we will consider detection of electrical violations of myocardial homogeneity based on registration and analysis of atrial and ventricular late potentials by the systems of high resolution electrocardiography and also beat-to-beat T-wave alternans in electrocardiogram, which are markers of cardiac electrical instability. Also we will focus on noninvasive investigation of atrial electrical activity by its extraction from the surface electrocardiogram recordings in case of atrial fibrillation and dominant fibrillation frequency detection and its tracking using spectral and time-frequency analysis. Finally we will consider another example of the investigation of subtle structure of ECG, which consists in separation of fetal and maternal electrocardiosignals obtained by the abdominal ECG recording, which allows determination of fetal heart rate variability and morphological parameters of fetal cardiac cycles for assessment of fetal condition during pregnancy.

On practical part we will simulate pathological high frequency activity on ECG and consider how we can reveal it using time-frequency spectrograms and wavelet scalograms.