Methods of determining the most informative features in the heart rate variability analysis

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There are different methods in the heart rate variability analysis (HRV). The main ones are statistical, pulsometrical and spectral [1]. Each method describes the state of the autonomic nervous system but they have different sensitivity in different functional states of human. In this paper we propose a method to reduce the dimension of the HRV informative features space and to determine the most sensitive features.

At the first stage reviewed the results of HRV research of 30 healthy patients aged 18 to 21 years. We estimated the HRV in a state of functional rest using 13 variables: three measures of variation pulsometry - the stress index of regulatory systems (SI), the vegetative balance index (VBI) and vegetative rhythm indicator (VRI); five spectral measures - the intensity of high-frequency (HF), low-frequency (LF), very low frequency (VLF) components, the total capacity of the spectrum (TP) and the parameter of autonomic balance, determined by the ratio LF / HF; two statistics measures - standard deviation (SDNN), the square root of the sum of squared difference between the values of successive pairs intervals (RMSSD) [2,3] and three wavelet transform indicators of the dysfunctions of functional F [LF / HF] - the number of dysfunctions (N), the maximum value of dysfunctions (Amax) and the intensity of dysfunction on the observation interval (A) [4].

Using principal component analysis (PCA) and calculation eigenvalues of the correlation matrix, produced the following groups of features: group “1” - N, A, Amax, LF / HF; group “2” - SI, VBI, VRI; group “3” - SI, VBI, VRI. The analysis of the factors shows that group “1” is composed of dysfunctions indicators of functional F [LF / HF] and the ratio LF / HF; in the group “2” there are indicators of variation pulsometry, in the group “3” there are statistics features.

At the second stage, to assess the effectiveness of the treatment process, investigated HRV parameters of patients with different stages of hypertension and dysfunction of the autonomic nervous system. Parameters assessed in the initial state and during the treatment process using the apparatus “SIMPATOKOR-01” after 1, 5 and 10 treatments procedures. As information parameters selected features of “1” group as the most informative on the results of the PCA. In Fig. 1 there are two histograms shows changes of two compact clusters centers produced by K-means, in the initial state, after 1, after 5 and after 10 treatments procedures, as well as the number of patients in each cluster.

Histograms shows that after 5 treatment procedure the dysfunctions parameters of functional F [LF / HF] decrease in both clusters, most patients becomes in “1” cluster with the lowest parameters, while after 10 treatments procedures cluster centers are significantly increase.

Thus, using integrated factor features allows to significantly reduce dimension of the informative features space and to identify the most informative of them for further analysis and patient's condition prediction.

References