Detecting and Quantifying Heart Rate Turbulence via False-Alarm Bounded Binary Neyman-Pearson Test

Ali Ghaffari*, Mohammad Reza Homaeinezhad and Mohammad Mahdi Daevaeiha

Generally, after occurrence of a premature ventricular contraction (PVC), fast fluctuations can be seen in the RR-tachogram sequence called heart rate turbulence (HRT). In this situation, heart rate first increases then spontaneously decreases after incidence of a PVC. Then, the next beat occurs with a faster (HR acceleration) or slower (HR deceleration) relative to mean normal HR. HR acceleration is supposed to be consequence of sudden blood pressure drop sensed by baroreflex system to restore the blood pressure to normal level. The aim of this study is to address a comprehensive methodology based on a multi-lead extracted metric with simple mathematical origin to detect and quantify the parameters of the HRT phenomenon. To meet this end, first three-lead high resolution 24 hour holter data were extracted and then preprocessed using Discrete Wavelet Transform (DWT). Next, for the preprocessed sequence, the curve length in sample by sample sliding window was multiplied by the area under the absolute value of the curve called Area-Curve Length (ACL) quantity. The ACL metric was then used to detect and delineate ECG events. Afterwards, based on the binary Neyman-Pearson radius (two-dimensional) test, a new method to discriminate PVC and (premature atrial contraction-PAC) PAC+normal beats was proposed. to determine HRT parameters, after detection of a PVC incidence using the proposed PVC detection method, its envelope consisting of 4 normal successive beats before and similar 15 beats after the detected PVC was excerpted from R-peaks time series and then the HRT parameters i.e., turbulence offset (TO), compensatory pause (CP), turbulence slope (TS) and turbulence jump (TJ) were calculated. The classification method was applied to DAY general hospital high resolution holter (medset, cardiolight system, sampling frequency 1000 Hz) data and average sensitivity Se=99.94% and positive predictivity P+=99.85% were obtained.