A New Entropy-based Heart Failure Detector

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Heart failure is a common type of clinical cardiovascular disease and has a high prevalence, disability and fatality rate, which is a great threat to human health. Entropy measures, typically as sample entropy (SampEn), has been used for detecting heart failure. However, SampEn values are too sensitive to the selection of threshold *r*, i.e., compared with normal subjects, heart failure patients reported lower SampEn values with a small threshold *r* while reported higher SampEn values with a large threshold *r*, resulting in a difficulty in the clinical interpretation.

This study proposed a new entropy measure named sample difference entropy (SampDEn), for distinguishing congestive heart failure (CHF) from normal sinus rhythm (NSR). Unlike SampEn, the new SampDEn calculated the entropy value by comparing the information increase rate at two threshold settings (r_{max} and r_{min}), to reduce statistical instability of SampEn. The method was tested on the MIT-BIH RR interval databases, which included 54 NSR and 29 CHF long-term RR interval recordings. Each recording was segmented using a fixed time window (N=300 or 1000). Embedding dimension m was set as 2. Non-parametric test was used to test the statistical difference between two groups. For N=300, classification accuracy of SampEn were 69.18% (p=7×10^{-8}), 60.47% (5×10^{-6}), 51.21% (0.1) and 43.27% (0,4) for r=0.1, 0.15, 0.2 and 0.25 respectively. As a comparison, accuracy of SampDEn was 70.46% (2×10^{-8}). For N=1000, accuracy of SampEn were 68.34% (p=3×10^{-7}), 56.09% (0.01), 44.85% (0.3) and 36.76% (003) for r=0.1, 0.15, 0.2 and 0.25 respectively, while accuracy of SampDEn was 75.33% (2×10^{-10}). The results suggest that the new entropy method is more effective than the traditional SampEn.