УДК 612.172.2

HEART RATE VARIABILITY: DIAGNOSTICAL VALUE AND PERSPECTIVES OF APPLICATION

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Introduction

Heart rate variability (HRV) is the physiological phenomenon of variation in the time interval between heartbeats. It is measured by the variation in the beat-to-beat interval. Since last decade the amount of publications is increased about perspectives of HRV application as it has prominent clinical significance and diagnosis low cost [1].

Purpose

To perform the literature analysis on perspectives of HRV application for diagnostics of cardiovascular diseases (myocardial infarction, congestive heart failure, coronary artery disease, hypertension), and non-cardiovascular diseases (sepsis, stroke, diabetes, cancer, glaucoma, etc) [2, 3].

Materials and methods

This literature review was carried out using the recent publications on the perspectives and diagnostic value of HRV. With search tools such as PubMed, Medline, and Scopus, the literature search was conducted.

Study results

The HRV spectrum contains two major components: the high frequency (0.18–0.4 Hz) component, which is synchronous with respiration. The second is a low frequency (0.04 to 0.15 Hz) component that appears to be mediated by both the vagus and cardiac sympathetic nerves and can be used for diagnosis [2, 3].

The studies revealed that HRV analysis is important for clinical diagnosis for diseases related to endocrinal, respiratory, cardiac and neuropsychological systems.

Endocrine factors. It was revealed that concentration of some hormones has significant influence on HRV. Thyroid hormones have direct effects on the myocardium by increasing its contractility but also on the ANS by altering the sympathetic response. A recent controlled study reported that thyroxin treatments for epithelial cancers can decrease HRV significantly. On another side, estrogen levels were significantly correlated with HRV measures in healthy women, thus confirming the cardioprotective effect of feminine sexual hormones. Additionally, masculine androgens have a beneficial effect (parasympathetic) on the heart autonomous modulation (higher HRV with high testosterone levels) while estradiol tends to preferably induce a parasympathetic activity [1, 2].

Liver cirrhosis is associated with decreased HRV. Decreased HRV in patients with liver cirrhosis has a prognostic value and predicts mortality. Loss of HRV is also associated with higher plasma pro-inflammatory cytokine levels and impaired neurocognitive function in this patient population [1, 2].

Respiratory factors. Chronic Obstructive Pulmonary Disease (COPD) is a high mortality disease coexists with cardiovascular diseases (CVD). According to recent studies patients with COPD and heart failure exhibit alteration in autonomic modulation of heart rate at rest and during respiratory arrhythmia maneuver compared with healthy individual. HRV aims for early diagnosis at a very low cost. It is well known that patients with COPD and CVD have reduced HRV and consequently deterioration of their symptoms. Based on these models, it is logical to stipulate that respiratory pathologies may in turn affect HRV. In fact, and for example, asthma has been linked to reduce HRV in children. Respiratory arrhythmia is associated with respiration and faithfully tracks the respiratory rate across a range of frequencies [2].

Sepsis. HRV is decreased in patients with sepsis. Loss of HRV has both diagnostic and prognostic value in neonates with sepsis. The pathophysiology of decreased HRV in sepsis is not well understood but there is experimental evidence to show that partial uncoupling of cardiac pacemaker cells from autonomic neural control may play a role in decreased HRV during acute systemic inflammation [2, 3].

Cardiovascular diseases (CVD). To detect CVD is as important as understanding their etiology. For many years, several research teams have used HRV as an indicator of these types of pathologies. In their systematic review,' Thayer et al' studied in detail the risk factors of CVD and noted that epidemiological studies tend to confirm that HRV is lower for subjects with high blood pressure rather than for subjects with normal blood pressure. A similar relationship could be established with a high level of blood cholesterol or glucose (diabetes) and a decreased HRV. This review coupled with other studies and reviews confirmed that a decreased HRV is an indicator of CVD [3, 4].

Myocardial infarction (MI): Depressed HRV after MI may reflect a decrease in vagal activity directed to the heart. HRV in patients surviving an acute MI reveal a reduction in total and in the individual power of spectral components. The presence of an alteration in neural control is also reflected in a blunting of day-night variations of RR interval. In post-MI patients with a very depressed HRV, most of the residual energy is distributed in the VLF frequency range below 0.03 Hz, with only a small respiration-related variations [3, 4].

Neuropsychological factors. Another group of endocranial structures was identified and behavior (social, intentional, affective, executive) by modulating motivation from external and internal stimuli. Among this network, there are the anterior cortex, the amygdala, the insula, the periaqueductal grey matter, which are also structures regulating HRV. Consequently, and from a general point of view, HRV is linked to personality but a list of neuropsychological factors influencing HRV is not limited to this aspect and actually includes stress, depression and negative emotions [4]. In psychology, neuroticism is associated with the experience of negative emotions and concerns patients suffering from anger, depression or anxiety. A transversal study on 33 healthy subjects confirmed the significant correspondence between weak neuroticism (negative emotions) and low HRV and the inverse as well. While negative emotions, such as anger, anxiety, frustration and worry produce every irregular ECG and a reduced HRV. HRV has been shown to be reduced in individuals reporting a greater frequency and duration of daily worry. In individuals with post-traumatic stress disorder (PTSD), HRV and its high-frequency (HF) component is reduced compared to controls whilst the low-frequency (LF) component is elevated. Furthermore, unlike controls, PTSD patients demonstrated no LF or HF reactivity to recalling a traumatic event [4, 5].

Conclusion

Heart rate variability corresponds to the adaptation of the heart to any stimulus. The system of factors affecting HRV can be divided into the following categories: physiological and pathological factors, environmental factors, lifestyle factors. In fact, among the pathologies affecting HRV the most, there are the cardiovascular diseases and depressive disorders.

REFERENCES

1. HRV measurements and clinical use/ R. D. Berger [et al.] // Circ ahajournals. — 2003. — Vol. 93. — P. 1043–1065.
2. Influence diagram of physiological and environmental factors affecting heart rate variability: an extended literature overview / J. Fatisson [et al.] // Heart International. — 2016. — Vol. 11. — P. 32–40.
3. Linear HRV risk stratification in heart failure patients / Schroeder [et al.] // Sciencedirect. — 2008. — Vol. 35. — P. 957–959.
4. HRV-neuropsychological and cardiac defects / G. A. Reyers del Paso [et al.] // International journal of yoga. — 2013. — Vol. 50. — P. 477–487.
5. *Kemp, A. H.* The relationship between mental and physical health: insights from the study of heart rate variability / A. H. Kemp, D. S. Quintana // Int J Psychophysiol. — 2013. — Vol. 89. — P. 288–296.