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СЕКЦІЯ XXVI.
МЕДИЧНІ НАУКИ ТА ГРОМАДСЬКЕ ЗДОРОВ'Я

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HEART RATE VARIABILITY IN THE ASSESSMENT OF PATIENTS WITH CARDIOVASCULAR DISEASES

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Introduction. Heart rate variability (HRV) is a non-invasive tool that records variations in the time intervals between consecutive heartbeats (R-R or NN intervals). The HRV method has become an important instrument for assessing the functional state of the autonomic nervous system (ANS) due to the direct relationship between heart rhythm and the balance between the sympathetic and parasympathetic branches of the nervous system. A decrease in HRV is considered a highly significant marker of autonomic dysfunction and correlates with an increased risk of developing and progressing a wide range of cardiovascular diseases (CVDs), including arterial hypertension, heart failure (HF), ischemic heart disease (IHD), and post-myocardial infarction conditions. [1, 2].

An important factor in the initiation of arrhythmias is the dynamic interaction between the heart and the autonomic nervous system (ANS), which is precisely what heart rate variability (HRV) reflects. Atrial fibrillation (AF) is the most common arrhythmia, and HRV serves as an independent marker for assessing the risk of its onset, progression, and recurrence. Studies emphasize that paroxysms of AF can be triggered not only by increased sympathetic activity but also by instability of the autonomic balance. [3, 4].

Heart rate variability (HRV) analysis is a non-invasive method that allows for the assessment of how stress affects different levels of cardiovascular regulation. Psychological stress is a significant trigger and aggravating factor in the course of cardiovascular diseases (CVD). A meta-analysis by O. El-Malahi et al. demonstrated that interventions aimed at reducing stress lead to significant positive changes in HRV, particularly an increase in the SDNN index. [5, 6].

Despite the long history and widespread use of HRV in various fields of clinical medicine, the scope of its implementation continues to expand. A fundamentally important aspect is that HRV analysis represents a multifunctional tool used to address a wide range of diagnostic and prognostic tasks, which determined the purpose of the present study. [7, 8].

Purpose of the study. To determine the role of heart rate variability in the assessment of patients with cardiovascular diseases.

Materials and Methods. We analyzed the scientometric databases PubMed, Scopus, and Web of Science and conducted a retrospective review of the literature from 2015 to 2025. The most relevant sources on this topic were selected for analysis.

Results and Discussion. The simplicity and accessibility of the HRV method, along with its high informativeness and the advancement of computer technologies, will undoubtedly continue to expand the scope of its application. Currently, the practical implementation of HRV analysis methods and the indications for their use are most developed for assessing autonomic regulation of heart rhythm in healthy individuals and in patients with various cardiovascular diseases. [9, 10].

Arterial hypertension is pathogenetically inseparable from dysregulation of the autonomic nervous system (ANS), which leads to persistent vasomotor disturbances and an increased cardiovascular risk. The key manifestation of this imbalance is heightened sympathetic nervous system activity accompanied by a simultaneous reduction in parasympathetic tone. This results in an elevated resting heart rate, increased peripheral vascular resistance, and sustained vasoconstriction, all of which directly contribute to the progression of hypertension. Therefore, heart rate variability (HRV) assessment can serve as a critically important diagnostic tool for detecting autonomic nervous system imbalance. [11].

Heart failure remains one of the most significant challenges in modern cardiology. Despite progressive improvements in outcomes due to the implementation of comprehensive, state-of-the-art pharmacotherapy, the prognosis for patients with heart failure (HF) remains unsatisfactory. High rates of mortality and rehospitalization highlight the urgent need for noninvasive, reliable tools for accurate risk stratification. Reduced cardiac output activates baroreceptors and chemoreceptors, sustaining persistent sympathetic activation and elevated circulating catecholamine levels. Vagal depletion leads to an increased heart rate and a marked reduction in heart rate variability (HRV). Successful HF therapy requires not only hemodynamic improvement but also positive neurocardiac modulation, making HRV an important tool for assessing treatment efficacy in patients. [12].

In stable coronary artery disease and acute myocardial infarction, autonomic imbalance occurs, often manifesting as increased sympathetic tone and reduced parasympathetic activity. This sympathovagal shift is an important pathophysiological factor contributing to myocardial electrical instability and an increased risk of fatal arrhythmias. A decrease in heart rate variability (HRV) has long been recognized as a strong predictor of sudden cardiac death and overall cardiovascular mortality in patients with coronary artery disease (CAD). [13, 14].

Patients with the paroxysmal form of atrial fibrillation (AF) may exhibit either vagal or adrenergic activation. All paroxysms of vagal origin are characterized by excessive reflex influences of the vagus nerve on the heart. The occurrence of adrenergic-type AF paroxysms is associated with increased activity of the sympathetic nervous system. These paroxysms are typically triggered by physical exertion or psycho-emotional stress. There are also vagosympathetic AF paroxysms, in which a synergistic interaction between the parasympathetic and sympathetic nervous systems is observed. Identifying the neurovegetative type of AF paroxysms allows for the selection of the most appropriate medication for preventing recurrences of this arrhythmia. Heart rate variability (HRV) analysis provides an opportunity to assess the state of physiological regulatory mechanisms, the overall activity of control systems, and the balance between the sympathetic and parasympathetic divisions of the autonomic nervous system. [15].

Assessment of changes in heart rate variability (HRV) serves as an objective method for monitoring patients' responses to pharmacological interventions. Effective therapy should aim to restore the balance of the autonomic nervous system (ANS), as reflected by improved HRV parameters.

If a medication fails to improve or even worsens HRV indices, this may indicate a suboptimal cardioprotective profile. [16].

Despite the clinical significance of HRV, the widespread use of this method is constrained by several methodological limitations. To date, there are no universally accepted normative values for HRV. Contemporary scientific literature emphasizes that the interpretation of many HRV indices is far more complex than commonly assumed. The ease of obtaining HRV data using commercial devices has created grounds for unjustified extrapolation of results. This is particularly relevant in clinical applications, where detecting subtle alterations in autonomic regulation (for instance, in diabetes or mental disorders) requires a high level of methodological rigor. A critical assessment of current studies reveals shortcomings that limit the clinical implementation of HRV and call for greater caution in data interpretation. Many studies employ heterogeneous monitoring protocols that differ in recording duration and participant body position. For example, monitoring time may vary from 2 to 15 minutes, and the body position may be supine, sitting, or standing. Consequently, researchers are compelled to describe all conditions in detail. The greater the variability in input data—such as recording length or participant age—the lower the reliability of the output parameters. This inconsistency hampers the validation of HRV as a routine diagnostic tool that could be integrated into everyday clinical practice. [17].

Thus, contemporary studies on HRV parameters focus on risk stratification, detection of subclinical conditions, and objective assessment of therapeutic response. However, as recent systematic reviews indicate, the lack of standardized protocols and clinically validated reference values continues to limit the full integration of HRV analysis into routine clinical practice.

Conclusions

1. Heart rate variability is a highly informative and accessible method for assessing cardiac autonomic regulation, holding significant diagnostic value in cardiovascular diseases.

2. Changes in HRV parameters reflect both the progression of cardiovascular diseases and the effectiveness of therapy. The restoration of autonomic balance, evidenced by improved HRV, indicates a positive cardioprotective effect of the treatment.

3. The further implementation of the HRV method in clinical practice is hindered by the lack of standardized protocols and unified normative values.

Prospects for further research. To overcome the barriers to HRV application, there is an urgent need to standardize protocols, particularly for outpatient practice. To facilitate clinical implementation, future research should focus on developing standardized short-term HRV tests suitable for use in polyclinic and outpatient settings. The advantage of short-term recordings enhances their clinical feasibility, which is a necessary prerequisite for integrating HRV assessment into primary healthcare.

Conflicts of interest: authors have no conflict of interest to declare.

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