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Editorial

Heart Rate Variability as an Early Diagnostic Tool of Pre-Eclampsia

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Pre-Eclampsia (PE) is a complex multisystem disease, diagnosed by sudden-onset hypertension (>20 weeks of gestation) and at least one other associated complication, including proteinuria, maternal organ dysfunction or uteroplacental dysfunction (for example, Fetal Growth Restriction (FGR) or angiogenic imbalance).[1] PE remains a leading cause of maternal and perinatal morbidity and mortality worldwide, with its early diagnosis being crucial for better clinical outcomes. The pathophysiology of PE is complex, involving endothelial dysfunction, oxidative stress, and an imbalance in the Autonomic Nervous System (ANS). Among the various markers being explored for early detection, Heart Rate Variability (HRV) has gained attention due to its ability to reflect the ANS's status, which plays a significant role in the pathogenesis of PE.

HRV represents the physiological variation in the time interval between consecutive heartbeats, mediated by the sympathetic and parasympathetic branches of the ANS. A healthy individual typically exhibits a dynamic balance between these two branches, resulting in higher HRV. However, conditions like PE, characterized by increased sympathetic activity and reduced parasympathetic activity, lead to decreased HRV. This sympathovagal imbalance is a hallmark of autonomic dysfunction in PE and can be detected early through HRV analysis.[2]

Studies have shown HRV as a predictor factor for development of PE.[3] A decrease in time-domain measures, such as the Standard Deviation of NN intervals (SDNN) and the Root Mean Square of Successive Differences (RMSSD), has been observed in early pregnancy among women who later develop PE. Additionally, frequency-domain measures, such as Low-Frequency (LF) and High-Frequency (HF) components, reveal a shift towards increased LF-HF ratio, indicative of heightened sympathetic activity.[4]

These findings suggest that non-invasive assessment of autonomic functions in the early stages of pregnancy could play a crucial role in predicting and diagnosing preeclampsia. This timely intervention allows for effective management, reducing the risks of side effects and preventing end-organ damage associated with the condition. Early detection through autonomic function analysis, such as heart rate variability, offers a non-invasive and proactive approach to improving outcomes for both mother and fetus.[5]

The clinical utility of HRV in predicting PE lies in its ability to identify at-risk individuals before the onset of overt symptoms. The implications of using HRV as a marker extend beyond early detection. It also opens the door to personalized management strategies. This early identification allows for the implementation of preventive strategies, such as lifestyle modifications, pharmacological interventions, or closer monitoring, mitigating the progression of the disease. Moreover, the integration of this marker into routine prenatal care could enhance our understanding of the pathophysiology of gestational hypertension. It may reveal new therapeutic targets and refine our approaches in the management of cardiovascular health during pregnancy. Furthermore, combining HRV with other biomarkers, like angiogenic factors and endothelial function tests, could enhance the predictive accuracy and provide a comprehensive risk assessment for PE.[6] This shift towards a more nuanced understanding of autonomic function in pregnancy could ultimately lead to better maternal and fetal outcomes.

However, further research is needed to establish standardized HRV parameters specific to PE and to validate these findings across diverse populations. Large-scale longitudinal studies should be conducted to confirm the predictive value of HRV and to explore its integration into existing screening protocols. Additionally, advancements in wearable technology could facilitate real-time HRV monitoring, making it more accessible and practical in clinical settings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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