Heart Rate Variability as a Biomarker to Classify Autonomic Responses to Different COVID-19 Vaccine Technologies Under Orthostatic Stress

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The rapid deployment of various COVID-19 vaccine platforms, viral vector, inactivated virus, and messenger RNA (mRNA), has raised questions regarding their specific impacts on the autonomic nervous system (ANS). This study investigates whether heart rate variability (HRV) metrics, extracted during a standardized stressor, can serve as a functional biomarker to identify and classify autonomic regulation differences associated with these technologies.

We evaluated 19 volunteers (18-75 years old) with no history of COVID-19 or heart disease. Participants were grouped by vaccine type: Viral Vector (Vaccine A), Inactivated Virus (Vaccine B), and mRNA (Vaccine C). A 50-minute Tilt Test protocol was conducted (15 min horizontal, 15 min at 70° inclination, 20 min recovery) using a TEB PC1000 ECG to capture cardiac signals.

The results demonstrate that heart rate variance serves as a sensitive biomarker for distinguishing vaccine-induced autonomic profiles. Vaccine A (Viral Vector) showed the lowest variance (54.72 ± 40.94) and a failure to produce the expected heart rate increase during orthostatic stress, suggesting possible autonomic blunting. Conversely, Vaccine C (mRNA) exhibited a robust physiological response with the highest variance (199.35 ± 107.92) and an adequate heart rate plateau. Vaccine B (Inactivated Virus) presented intermediate variance values (141.93 ± 17.21). Other time-domain metrics, such as SDNN (126.38 ms for A vs. 176 ms for C), further support the use of HRV as a discriminatory biomarker.

In conclusion, HRV metrics derived during orthostatic stress function as a reliable biomarker to classify the functional integrity of cardiovascular regulation across different vaccine platforms. The findings indicate that while mRNA and inactivated virus technologies maintain expected autonomic reactivity, viral vector platforms may be associated with reduced autonomic responsiveness, warranting broader computational validation.