

Non-invasive, Quantitative, Measurements of Autonomic Nervous

System Activity Levels: I. Chronic Patient Care Approaches

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ABSTRACT

Introduction: Spectral analysis of respiratory activity (RA) concurrent with spectral analysis of heart rate variability (HRV), known as real-time HRV, is now a generally accepted means of non-invasive autonomic nervous system (ANS) monitoring. Spectral analysis of RA is accepted as a measure of Vagal outflow and Vagal influence on HR. It can be regarded as a measure of the strength of the respiratory sinus arrhythmia component of the instantaneous HR signal (the cardiogram). Together, RA and HRV spectral analyses provide for separating the sympathetic nervous system (SNS) from the parasympathetic nervous system (PSNS) resulting in a direct, simultaneous, independent, non-invasive measures of both ANS branches.

Method: A more robust spectral analysis method is presented: a continuous wavelet transform (CWT). The CWT-based approach includes several clinical challenges over a 15:35 minute time period. These are, in order of presentation: 1) a five minute resting baseline to determine the patient's ANS levels at rest, 2) a one minute relaxed deep breathing period to challenge the PSNS, 3) a one minute baseline to allow the ANS to return to baseline values, 4) a series of five short Valsalvas over a 1:35 minute period to simply challenge the SNS, 5) a two minute baseline to allow the ANS to settle, and 6) a quick postural change (seated to standing) followed by a five minute period of quiet standing.

Results: Expected results are presented with sample adult and child data.

Discussion: The CWT-based ANS monitor is found to be the best mode of analyzing ANS abnormalities in an out patient setting and for longitudinal analyses. Through ANS provocative challenges, the SNS and PSNS responses and interactions were assessed. ANS abnormalities were found to be the etiology in idiopathic clinical syndromes and associated with chronic illnesses like diabetic and metabolic dysfunctions. Early detection of pre-clinical states allows intervention in chronic illnesses preventing long term consequences. We observed that ANS dysfunction, particularly parasympathetic, could be a primary abnormality or a secondary pathophysiologic manifestation in endocrine, autoimmune disorders, and chronic illnesses. Modifying and resetting ANS dysfunction also led to improvement of the primary disease manifestations and response to therapy. The CWT approach seems suited for assessment and the affects of chronic illnesses on the ANS. The authors noted that the CWT based assessment of ANS balance

can provide physicians with the detailed analysis of ANS balance and a basic understanding of the stability of a patient in response to disease state, lifestyle, and therapy plan. Patient and disease instability tends to result from of autonomic imbalances. ANS imbalance has been found to create additional symptoms, and additional symptoms have been shown to be a manifestation of ANS dysfunction. From our observations, typical standard therapies using conventional drugs known to affect the ANS (*e.g.*, central Beta-blockers) have been effective in resetting ANS dysfunction. We have also observed that maintenance therapy may be required in chronic conditions and secondary ANS dysfunction.

Conclusion: Physicians have been manipulating the ANS for decades (*e.g.*, α -blockers, β -blockers, ACE-Inhibitors, ARBs, Vasopressors, Tricyclics, and SSRIs). The results of these manipulations can now be seen objectively, measured scientifically, and quantified directly. ANS monitoring provides a more precise assessment of disease manifestation and efficacy of treatment, and allows early detection of sub-clinical disease states. Early detection of sub-clinical disease states allows timely intervention in a disease process, preventing long term and often fatal effects of autonomic dysfunction in systemic and metabolic chronic illnesses. Various autonomically active drugs were observed to have a negative effect on the ANS which explains the ineffectiveness and idiopathic adverse reactions seen with some of the drugs (*e.g.*, ACE-Inhibitors). Finally, ANS dysfunction treatment has resulted in better control and treatment responsiveness of disease states such as Diabetes, Cardiomyopathy, and Orthostatic Hypotension.