IntelleWave

THEORETICAL REVIEW AND CLINICAL USE

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Edition 1.5

INTELLEWAVE THEORETICAL REVIEW

Quantitative Assessment of
the Autonomic Nervous System
Based on R R- Intervals Variability Analysis.

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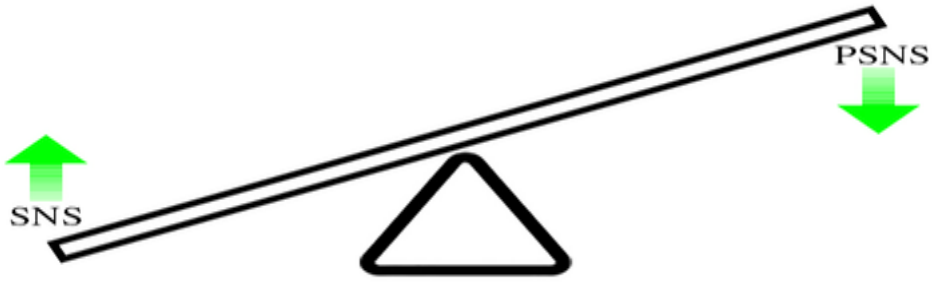
CONTENT:

THE METHOD OF QUANTITATIVE ASSESSMENT OF THE RELATIONSHIP BETWEEN SYMPATHETIC AND PARASYMPATHETIC ACTIVITIES LEVEL BASED ON SPECTRAL ANALYSIS OF R-R INTERVALS VARIABILITY.

INTRODUCTION.

Traditionally, doctors and physiologists around the world imagine the relationship between sympathetic and parasympathetic activities as a system of one dimension.



This is represented in the image above, where SNS activity increases as the PSNS activity decreases or vice versa. This assumption, however, is completely FALSE. Take for example a case of degenerative joint disease, in which autonomic nervous centers degenerate as a result of both SNS and PSNS simultaneously going down. Or a different example of an athlete waiting to start the competition. In this case PSNS activity level has to be high as an athlete must be totally relaxed. At the same time, sympathy-adrenergic activity must also function at a high level in order for the athlete to be able to immediately start on time.

As demonstrated in the above examples, ANS function should be represented in two dimensions, but until now there was no method to quantitatively assess the levels of activity of SNS and PSNS in a system of two coordinates.

Intellewave system is the first such of fully automatic system for quantitative assessment of the Autonomic Nervous system based on spectral analysis of R - R interval variability derived solely from ECG data stream. See US Patent N 7,826,892 B2 from November 2, 2010. The physiology behind this method is based on the fact that medulla's vasomotor center by autonomic innervation to the Sino-atrial node (SA node) change time-interval between each consecutive R – wave, and Spectral analysis of such of R-R intervals variability can demonstrated modulation of SNS and PSNS activity as well as all other physiological modulations onto spectral function. By analyzing the relationship between the values of all the spectral function components we can find indirectly information about activity level of SNS and PSNS modulation. To begin a practical approach of spectral analysis we must first choose the right method of graphical visualization of R-R variability.

1.0 METHODS OF GRAPHICAL VISUALIZATION OF R-R INTERVALS VARIABILITY

1.1 THE TACHOGRAPH METHOD.

about 60 years ago the only method of graphical visualization of the HRV analysis was a method of Tachography. This method graphically represented variability of the Heart Rate, not of R-R intervals and it was based on a specific time interval of data collection, usually 5 min. Actually, this method coined the name Heart Rate Variability which became very popular, but unfortunately not very accurate, because directly from the body we do not received Heart rate, we do receive R-R intervals derived from ECG reading or pulse intervals derived from some Pulse oximeter used usually Photopletizmography method (PPG method).
NOTE 1: For R-R intervals we have to take the R-wave signal derived from the ECG reading, because only by

ECG method we can recognize Parasympathetic (High Frequency) modulation to the S-A node. To recognize High Frequency modulations by using Pulse intervals (PPG method) data is theoretically impossible. Thus, for ANS testing Medicare will ONLY PAY if R-R intervals are derived from an ECG reading only.

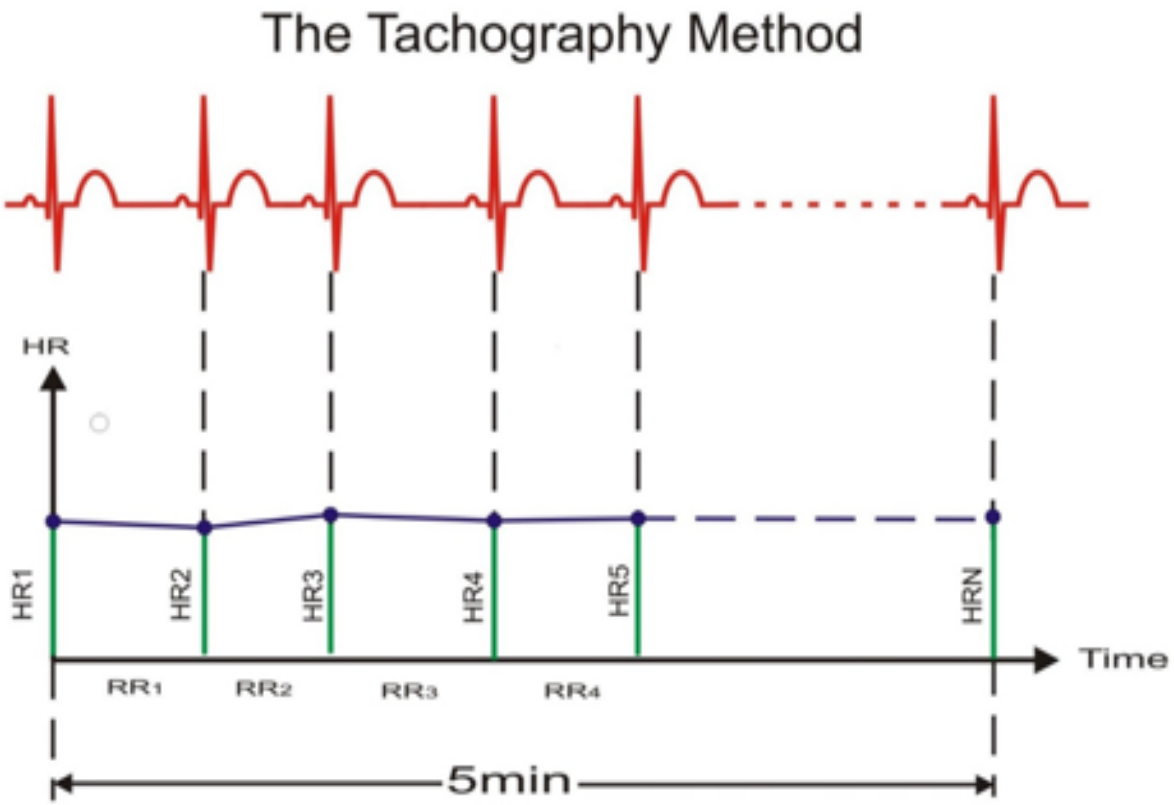


FIG. 1A

As it's already well known this method of data collection played crucial role for Heart Rate Variability analysis by switching most of the studies for next 40-50 years to the absolutely wrong way based on approach of 5-min data collection. NOTE 1: R-R intervals variability by definition is random process and to get consistency of any statistical analysis of random data we must each time takes data segment with absolutely the same number of random events (means same number of R-R intervals), as result any statistical analysis based on a method of 5-min of data collection will not be consistent at all, because each segment of 5-min of data contain different number of R-R intervals, even if it's collected from the same person.

NOTE 2: Unfortunately, mean time based on this wrong method of 5-min of data collection was done a hundred even a thousand studies and we must clarify that there was just waisted time and money.

NOTE 3: For Intellewave algorithm we took for spectral analysis data segment of 192 R – R intervals.

1.2 METHOD OF RHYTHMOGRAPHY

The right method of graphical representation of R-R intervals variability was developed by Dr. D. Zheimaitite. ("The methodology for automatic analysis of rhythmograms and its clinical applications." PhD thesis, Kaunas, Lithuania, 1972.), but unfortunately was not widely known for scientific community until now. Dr. Zhemaitite's" Method of Rhythmography", represented on FIG. 1B, is based on representing the time intervals between consecutive heartbeats as straight vertical lines. The longer interval between two heartbeats (R - R), the longer the corresponding vertical

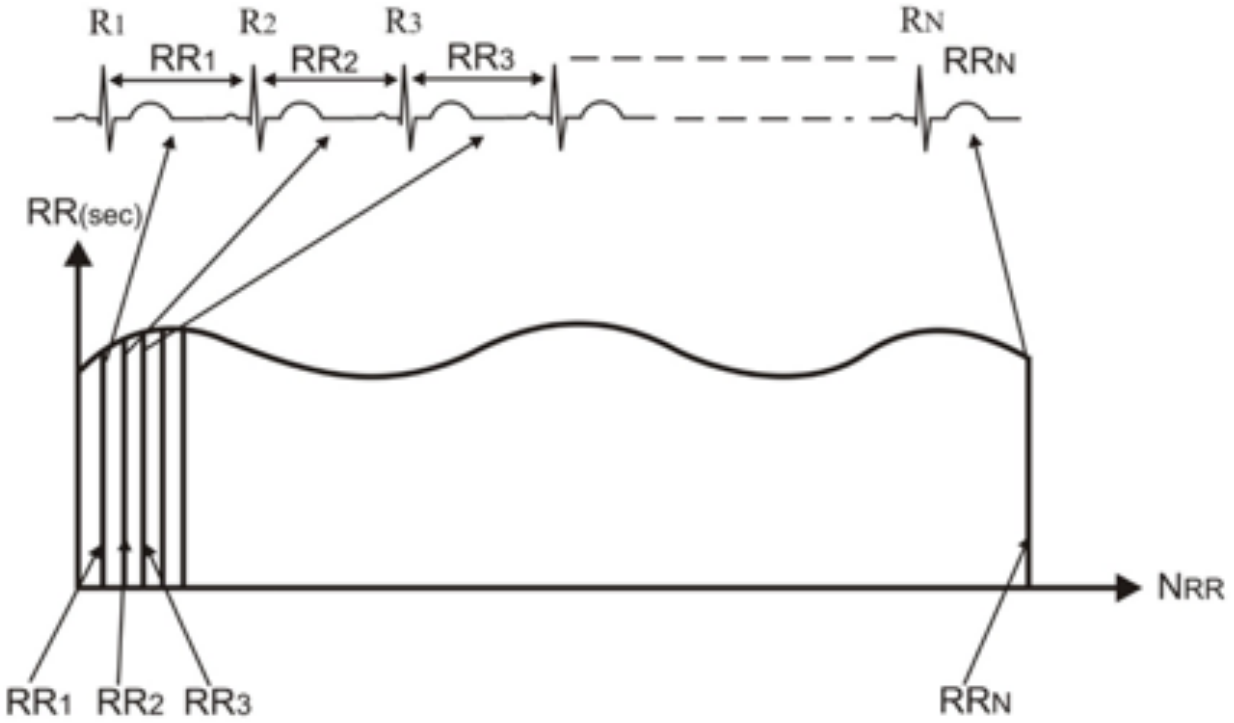


FIGURE 1B.

RR intervals are recorded in a "Method of Rhythmography"
When these lines are graphed sequentially, they form a Rhythmogram—a curve-specific wave portrait of R - R intervals variability shown on Fig. 1B. Rhythmographic representation allows a great deal of information to be compressed in a simple picture and look like a fingerprint of individual type of regulation mechanism.