Intellewave Heart Rate Variability System
with clusterization
of Spectral Function
Components
Intellewave system with clusterization of Spectral Function Components

Alexander Riftine, Ph.D

Intellewave HRV System (Version 1.4) is a fully automated cardiac monitoring device that provides quantitative assessment of Heart Rate Variability and continuous Blood Pressure data.

Intellewave HRV System 1.4 allows physicians to monitor physiological activity and assess the state of a patient's data and autonomic status through analysis of Spectral Function Components of R-R intervals Variability and Blood pressure data. On the one hand, HRV testing with Intellewave HRV System 1.4 enables a physician to detect specific types of autonomic dysfunction linked to a multitude of clinical diagnoses. On the other hand, Intellewave HRV System 1.4 is a tool for overall, general assessment of patient's physiology, and as a physiologic monitor it provides a comprehensive, in-depth patient evaluation, which standard medical practice is often missing. Such an ability to assess patient's physiology determines the wide range of Intellewave HRV System 1.4 clinical applications and distinguishes it favorably from all other diagnostic devices based on HRV analysis of low-frequency (LF) and high-frequency (HF) components.

Intellewave HRV System 1.4 's proprietary algorithm (US Patent 7,826,892 B2) uses novel artificial intelligence techniques to differentiate between HF and LF components of spectral function. This unique representation of test results allows physicians to recognize up to 81 variations of the relationship between LF and HF components. For visualization of test results Intellewave HRV System 1.4 uses Cartesian system of coordinates with high-frequency (HF) intensity on the horizontal axis and low-frequency (LF) intensity on the vertical axis.

NOTE: The final decision about autonomic function can be made only by a physician and is based on the combined analysis of HF and LF relationships, and blood pressure data.

The system includes Electrocardiogram and Blood pressure measuring device. A variety of data collected during the test (HRV, blood pressure and Electrocardiogram readings) enables doctors to evaluate (more accurately) patients' Autonomic Nervous System activity/status. The Intellewave HRV System 1.4 is distinguished by its high accuracy, speed and reliability, and is very easy to operate.

An earlier version of the Intellewave HRV System 1.4(under different name) was validated with excellent results by Columbia University validation studies in 1998, 1999 and 2001.

System Components

- ECG wireless Acquisition Device or ECG wired device.
- Automatic blood pressure-measuring device.
- Computer with integrated Bluetooth and a portable printer.
- ECG and R-R interval variability Analyzer Software
Clusterization of the High and Low frequency components of HRV

by Alexander Riftine, Ph.D
DEVICE CONFIGURATIONS

Intellewave HRV System 1.4 is available in two configurations:

1. Intellewave HRV System 1.4 with Wired Connection.
   This option includes an ECG wired device made by Pulse Biomedical, Inc.

2. Intellewave HRV System 1.4 with Wireless Connection. This configuration includes a wireless BT3/6 Bluetooth device made by Corscience GMBX or PBI QRS-card.
Data input visualization (ECG, Heart Rate variability, Blood Pressure) during the HRV test.
Moreover, Intellewave HRV System 1.4 can also monitor HRV activity by a "real-time" quantitative assessment of Spectral function components (HF and LF).

NOTE: All clinical correlations of HRV analysis data and is made by a physician only.

Example - Healthy patient, Valsalva maneuver combined with Deep Breathing.
Example of Test Results of the slight decrease of HRV activity during Orthostatic test

- For Data Interpretation only, NOT A DIAGNOSIS; must be interpreted by a Physician.

**Assessment of Spectral Analysis during Orthostatic test**

**Conclusion**
- HF is decreased moderately while LF activity on average is increased slightly.
- HF is decreased significantly while LF is increased slightly.

**Example Test Results**
- Systolic Blood Pressure (SBP): 120
- Diastolic Blood Pressure (DBP): 80
- Heart Rate (HR): 60
- HR trend during the test:
  - Max HR: 80
  - Min HR: 60
- HR/RR Ratio: 0.80
- RR Intervals:
  - Supine: 1.0, 1.5
  - Upright: 1.0, 1.5

**Graphs and Data**
- LF and HF power in different states (Supine, Upright).
- Power spectral density plot with LF and HF components.
Example of Test Results of the slight decrease of HRV activity during Valsalva maneuver combined with Deep Breathing
Example of Test Results of significant decrease of HRV activity during Orthostatic test
Example of Test Results of significant decrease of HRV activity during Valsalva maneuver combined with Deep Breathing
Example of significant decrease of HRV activity during Orthostatic test
Example of significant decrease of HRV activity during Valsalva maneuver combined with Deep Breathing
Previously Diagnosed Chronotropic Incompetence Case

Decrease LF and HF Components

NOTE. All those examples cases were clinically confirmed by physician.
Example of Real-time Heart Rate Variability Analysis
(every 2-4 minutes)
Example of Orthostatic Test-to-test Trends of HRV components
## SPECIFICATION

<table>
<thead>
<tr>
<th>COMPUTER</th>
<th>IBM Compatible Desktop or Notebook</th>
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<tbody>
<tr>
<td>OPERATING SYSTEM</td>
<td>Windows 7 PRO or 8.1 or 10</td>
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<tr>
<td>SCREEN RESOLUTION</td>
<td>Min. 1024X768</td>
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<td>COMPUTER PORTS</td>
<td>1 USB ports</td>
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<td>HEART RATE</td>
<td>Determined by the accuracy of the R wave triggering device</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td>Frequency and Time Domain Approach; Artificial Intelligence Techniques</td>
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</tbody>
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**TEST**

1. Orthostatic test (Supine Modalities stage, Transition period and Upright stage).
2. Valsalva Test (Normal Breathing stage, Valsalva maneuver stage and Deep Breathing stage).
3. Real-time test (HRV analysis), which includes only Main stages.

**TESTS DURATION**

Data collection and results calculation takes 7-8 minutes for Orthotest and Valsalva test. Real-time test (HRV analysis) is up to 24 hours.

**FREQUENCY DOMAIN PARAMETERS**

- HF (0.15 - 0.5 Hz)
- LF (0.033- 0.15 Hz)
- LF1 (0.07 - 0.15 Hz)
- LF2 (0.033- 0.07 Hz)
- TP
- HF/LF1
- HF/LF
- Smax (HF)
- Smax (LF)
- Smax (MF)
- Fmax (HF)
- Fmax (LF)
- Fmax (MF)
REFERENCES


5. Benhur Aysin, Elif Aysin “Effect of Respiration in Heart Rate Variability (HRV) analysis.

