## Chapter 6: HRV Measurement and Interpretation

Heart-rhythm analysis is more than a measurement of heart rate; it is a much deeper measurement of the complex interactions between the brain, the heart and multiple systems in the body. It's important to understand that the heart rhythm can be measured from two perspectives that offer different levels of information about the client's psychophysiological status.

The most common measurement of HRV involves quantifying the amount of HRV over a given time period. Although the *amount* of HRV is clearly an important factor to measure, the *rhythms and patterns* contained in the HRV are more reflective of emotional states. Therefore, when considering HRV, it's possible to assess 1) how much variability is occurring (the amplitude of the wave) and 2) the pattern of the heart rhythm (coherent or incoherent).

### Measuring the Overall Amount of HRV

The amount of HRV (amplitude) is related to age. Younger individuals have a greater range in the natural beat-to-beat variation than older individuals. Abnormally low HRV, relative to one's age, is a strong and independent predictor of future health problems, including all causes of mortality. In addition, low levels of HRV are considered a psychophysiological marker of impaired emotional regulation and psychological adjustment. Thus, HRV is an important indicator of both physiological resiliency and behavioral flexibility, reflecting the individual's capacity to adapt effectively to stress and environmental demands. The amount of HRV one has, relative to age, is therefore an indicator of overall vitality or system depletion. Overall system depletion does not typically occur over short time periods unless the patient has been exposed to an extreme trauma. Rather, reductions in the amount of overall HRV, in the absence of a clinical disorder such as diabetes, tend to occur over months and years, often because of the cumulative effects of chronic depletion stemming from emotional stress.

If the goal of the HRV measurement is assessment, it is best to assess the overall amount of HRV a client or patient has over a 24-hour period with an ambulatory ECG recording device. However, if an individual has chronically low HRV, a shorter 10-minute measurement can be done as a screening test. The amount of HRV can vary considerably during different times of the day and night because of a wide range of state-specific factors, including the current emotional state, heart rate and mental workload. Therefore, if screening indicates a low HRV, a 24-hour test should be performed before any medically relevant conclusions are reached (e.g. assessment of risk for sudden cardiac death, diabetic neuropathy and other patient-specific risks.)

The emWave PC is primarily designed as a heart-rhythm coherence training tool and cannot be used for clinical short-term measurement of a patient's HRV. Although they are calculated internally, the emWave PC does not provide the specific power-spectrum values for the various HRV frequency bands or the standard deviation values of the beat-to-beat intervals which are the primary measures used to quantify the amount of HRV in a differential diagnosis. This is to insure that the emWave PC is used for education and training and short-term data collection and not as a diagnostic tool in a medical context.

**Measuring the Patterns in the Heart Rhythm**

While the amount of HRV can and often does covary with specific emotional states, *we have found that it is the **pattern** of the heart's rhythm that is primarily reflective of the emotional state.* Furthermore, we have found that changes in the heart-rhythm pattern are independent of heart rate; One can have a coherent or incoherent pattern at high or low heart rates. Thus it is the rhythm, rather than the rate, that is most directly related to emotional dynamics and physiological synchronization.

## Overview of HRV Measurement Protocols

There are basically four elements, or levels of analysis of the heart rhythm that can be monitored and tracked. The number and types of levels of analysis you choose to assess and track will depend on the patient's health status, outcome goals, time availability and the context you are working within.

## Resting Coherence Ratio Measurement

The first and simplest type of measurement is monitoring the patient's normal or natural coherence-level ratios while sitting quietly. This is called the Resting Coherence Ratio Measurement.

## Resting HRV Range Measurement

The second measurement is to determine the range between the peaks and valleys occurring in heart rhythm (range of variation in the beat-to-beat heart rate) during the same period (while the patient sits quietly). This is called the Resting HRV Range Measurement. You should record the data for these measurements for five minutes.

## Stress Recall Measurement

The third measurement involves activation of the ANS through recalling a personally relevant stressor. Typically, this process takes five minutes.

## Six Breaths Measurement

The fourth measurement, which will be of the Six Breaths Protocol, is the last measurement in the series or it can be done as a standalone protocol. It introduces a physiological challenge to assess the maximum HRV range (amplitude). This measurement takes one minute.

**Procedure for HRV Measurement**

Note: When selecting a client's file for a second session you use the **select user** option in the file menu. When selecting a client's file, the names of all the clients in the database are viewable. To protect your other clients' confidentiality, open up the appropriate file before the client comes for training or make a habit of assigning initials or a number for each user.

### 6.5.1 Computer Settings

1. Before starting a baseline recording session with a new client using the emWave PC, enter the client as a New User under the File tab.
2. Set the challenge level to its lowest setting (1) under the Challenge Level menu.
3. Turn the sound off. This can be done in the emWave PC settings menu (select the music and sound option) or you can simply mute the sound on your computer.

**Client Considerations**

The client should be seated in a comfortable chair with a backrest that extends up high enough to provide support for the head and neck. The backrest should be tilted at a slight angle (no more than 15°) – just enough to relax the weight of the head so the neck can relax, but not so much as to encourage drowsiness. The feet should be able to comfortably reach the floor or be supported with a footrest. Ensure that the client cannot see the computer screen during the baseline recording. A private area, exam room or office is suitable for this process. Any location that is relatively quiet and free of distractions will work. Avoid completely closed-off, small, empty areas that can produce a claustrophobic feeling in some individuals.

The client should not have engaged in heavy aerobic exercise for at least one hour prior to the recording (climbing a flight of stairs to reach the recording area

is not a problem), nor should the client have consumed coffee, tea or other caffeinated beverages within a one-hour period prior to the baseline measurement. No cigarettes should be smoked a minimum of 30 minutes before the recording. It is also best to wait at least 1½ hours after a heavy meal to take the measurement. Any medications the individual is currently taking should be noted.

Note: Excessive movement may result in artifacts which will produce unusable baseline readings. Make sure your client is comfortable, to avoid increased muscle tension in the head, neck and shoulders if using the Ear Sensor or in the arms and hands if using the Finger Sensor.

Explain to client that you are gathering information about his or her nervous system. Explain that excessive movement may result in artifacts and ask them to sit quietly without talking, falling asleep, crossing legs or making unnecessary movements. The client should not read printed materials or engage in intense mental activity. It is preferable that clients keep their eyes open, and make sure your client is in a comfortable position that helps avoid muscle tension in the head, neck and shoulders if using the Ear Sensor or in the arms and hands if using the Finger Sensor.

**Resting Coherence Ratio and Resting HRV Range Measurements**

Start the recording for the Resting Coherence Ratio and Resting HRV Range Measurements and collect ten minutes of heart-rhythm data. Stop the session and record the coherence ratio percentages on the HRV measurement form. Excluding artifacts, estimate and record the average HRV range.

**Stress Recall Measurement**

Next, evaluate the client’s response to a specific stressor. Invite the client to silently recall or remember a recent stressful situation (for example, a specific challenging task such as taking a test, what it's like in heavy traffic, a problematic

relationship, etc.) and then attempt to reexperience the emotions or feelings associated with that event. Avoid suggesting a specific event or situation unless relevant to the client's therapeutic goal such as reducing test or performance anxiety. We suggest you do not explain the concepts of emotional self-regulation or coherence before obtaining the baseline data. If the client cannot relate to a specific issue, you can ask them to do serial subtraction (starting at 100, mentally subtract by 7). Typically, you will assess this stress response for a period of five minutes. This will give you a sense of the nervous-system response and help the client understand how thoughts and emotions instantly affect the reactivity of the nervous system.

Note: If you plan to analyze the HRV data in great specificity, be sure to save each measurement as a separate file (e.g. Client_baseline; Client_stressor; Client_6 Breaths).

**Six Breaths Measurement**

If you suspect that the patient has lower HRV than would be expected for his or her age, or it is unusually incoherent, you also may want to perform the Six Breaths Measurement, which involves having the client do the Six Breaths Protocol, described below. This is also a good for doing pre- and post-intervention measurements.

Explain to clients that for this protocol they need to breathe deeply, deeper than they normally do, for one minute at the specific rate of five seconds on the in-breath and five seconds on the out-breath. If they do this correctly, they will do six complete breath cycles and it will take about one minute (We also refer to this at times as breathing at a 5-6 count). It is OK for the client to see the computer screen during this measurement. To facilitate the process, you can open the Coherence Coach and place it on the bottom of the computer screen so the heart-rhythm wave form area is not covered. Make sure the breath-pacer frequency is set to measure six breaths per minute.. Then start the recording

while the client breathes with the rising and falling ball on the graph. After one minute or six full breath cycles are completed, stop the recording and save the file with the appropriate title.

When finished, look at the screen to determine the largest difference between the highest and lowest artifact-free heart rate (peak and valley in the heart-rhythm wave) during one of the artifact-free cycles and record this value.

Note: The Six Breaths Protocol is a one-minute protocol in which the patient or client breathes deeply to a count of five seconds on the inhalation and then exhales to a count of five seconds. This rhythm is repeated six times over a one-minute recording period. The largest difference between the highest and lowest heart rate (peak and valley in the heart-rhythm wave) during one artifact free respiratory cycle are reported.

Note: No specific medical benefits or cures are expressed or implied. None of the feedback or summary data provided by the emWave PC software is to be interpreted as medically or psychologically diagnostic, but rather as adjunctive to established medical diagnosis and treatment. Heart-rate-variability patterns differ widely from one person to another. There are no right or wrong patterns. The coherence scores in the programs and games are intended for tracking one's progress in increasing the ability to maintain a physiologically coherent state. Individuals with heart irregularities such as atrial fibrillation or flutter or intense clusters of premature atrial contractions, and children who are unable to sit still may be unable to use the emWave PC or Personal Stress Reliever successfully. They may benefit, however, from learning the emotional-refocusing-and-restructuring tools and techniques.