



## Chiropractic and Heart Rate Variability

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## Introduction

The demand for biofeedback is growing. General practitioners, chiropractors, acupuncturists, etc. are looking for tools that best suit their needs. You may be wondering which one best fits your clients and your practice. Chiropractic is for the optimum functioning of the nervous system; imagine showing your clients exactly how and when you are making positive adjustments to their nervous systems. This will increase patient satisfaction by demonstrating success of the chiropractic treatment. It will also show which adjustments increase their “flight or fight” system and which increases their “rest and digest” system. You can increase revenues by providing an additional service and/or reselling the software and equipment.

## The Nervous System

The biofeedback provided by SweetWater Health is based on a vital sign known as heart rate variability (HRV). We have provided you with an in-depth explanation of HRV later in this paper, but first let’s review information on the nervous system.

The autonomic nervous system (ANS) consists of two branches: the sympathetic and parasympathetic. Changes in the subsystems of the ANS are caused by everyday activities: orthostatic (standing/sitting), environment (hot/cold), brainwork (thoughts/feelings), stress, etc. The sympathetic nervous system creates changes in the body that can be useful during exercise and harmful during rest:

Increases: heart rate, blood pressure, blood flow to muscles, cortisol, adrenaline and nonadrenaline. (This neurotransmitter is released into the blood from the brain's adrenal glands and from nerves to regulate the body’s response to stress.)

- Inhibits: the body’s ability to repair itself, flow of saliva, peristalsis and secretion, bladder contraction, digestion
- Other changes: dilates pupil and bronchi, conversion of glycogen to glucose

This might seem familiar because we experience it every time our bodies go into “fight-or-flight” mode. Our bodies switch to this mode during exercise, stressful situations, fighting, etc., to keep up our heart’s demand for blood flow. During parasympathetic activity, our bodies respond in the opposite manner:

- Stimulates flow of saliva, peristalsis and secretion, release of bile, digestion
- Decrease in heart rate, blood pressure
- Other changes—allows our body to repair itself and contracts bladder

The body is constantly meeting the demands of our environment through proper regulation of autonomic tone, creating what we call heart rate variability. **A flexible ANS gives a high HRV reading.** This is important, not only because balance is vital to all systems, but because this flexibility or elasticity creates resilience. A resilient ANS allows us to respond to high-stress situations. If the ANS is weak, then a stressful situation could create lasting damage from an over-stimulated sympathetic system. When the ANS is strong, people are more likely to bounce back and their bodies can continue the

natural sympathovagal balance. The concept of “sympathovagal balance” reflects the autonomic state resulting from the sympathetic and parasympathetic influences.

**Chiropractic and the ANS:** The parasympathetic nervous system arises from the cell bodies of the motor nuclei of cranial nerves III, VII, IX, X, and XI in the brainstem and from the second, third, and fourth sacral segments of the spinal cord. The parasympathetic nervous system is known as the craniosacral flow. The cell bodies of the sympathetic fibers are in the lateral horns of the spinal segments T1 through L2, the so-called thoracolumbar outflow. Because of the proximity of the upper cervical vertebrae to the brainstem, parasympathetic influences dominate these segmental levels; and therefore, a cervical adjustment could likely result in a parasympathetic response.

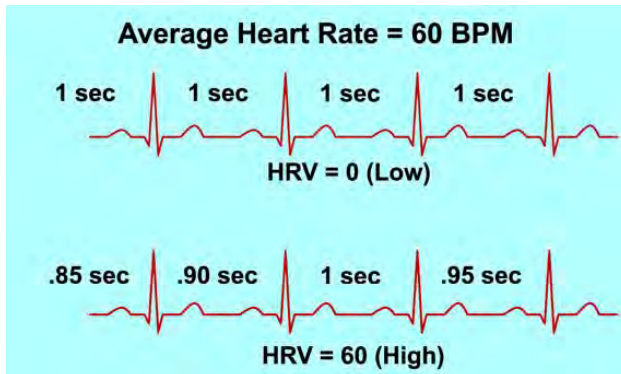
In the Welch and Boone study<sup>1</sup> referenced at the end of this paper, it was hypothesized that if a thoracic segment was adjusted, a sympathetic response would be elicited because the sympathetic fibers go through the L2-3 interspace and because the upper thoracic, especially the C7-T1 junctions, involve the stellate ganglion that stimulates the sympathetic chain ganglia. Because of the relationship of the C1 and C2 vertebrae to the parasympathetic nerve fibers associated with the brainstem, it was hypothesized that if an upper cervical segment were adjusted, a parasympathetic response would be elicited.

In the study, adjustments were administered according to the diversified technique methodology. The data from the cervical adjustments revealed a significant decrease in diastolic, but not systolic, pressure in those subjects receiving cervical adjustments. This observation has clinical applications because diastolic pressure has been shown to be a predictor separating patients with isolated versus essential hypertension.

The conclusion of the study suggested that “cervical adjustments may result in parasympathetic responses, whereas thoracic adjustments result in sympathetic responses. Furthermore, it appears that these responses may demonstrate the relationship of autonomic responses in association to the particular segment(s) adjusted.” These adjustments could have a benefit in preventing or reducing organ dysfunctions regarding the nervous system.<sup>1</sup> Following the research provided by this study, you will be able to decrease or increase sympathetic and parasympathetic responses in your patients, depending on which adjustments they need. For patients with low HRV, you might recommend cervical adjustments to raise parasympathetic values.

**Heart Rate Variability:** HRV is a function of the changing balance between the sympathetic and parasympathetic branches of the ANS. During sympathetic mode, the heart rate increases, creating less variability between the heartbeats. When the parasympathetic system is working, the heart rate slows down and there is more time between heartbeats. HRV is the naturally occurring variation in the time interval between one heartbeat and the next. For an example, see Figure 1, in which the first EKG reading has no variability, giving it an HRV of 0. In the second EKG (.85, .90, 1.0, .95) there are millisecond differences between heartbeats, giving this HRV a value of 60.

**Figure 1.** Heart rate variability is the variation between heartbeats.



Source: SweetWater Health, LLC

A chiropractor can use an accurate HRV reading to assess the baseline of a patient's resting state versus the patient's pain levels. These readings can then provide the patient with a sense of how effective the treatment has been when he or she can compare the before and after numbers.

In our HRV measuring tool, SweetBeat™, we use time and frequency domains to measure HRV and stress. First, we will discuss standard measurements of HRV. Then, we will cover SweetBeat and how you can use it to improve patient satisfaction and increase revenues.

**R-R Intervals:** QRS complex is the name for the combination of three of the graphical deflections seen on a typical EKG. It is usually the central and most visually obvious part of the tracing. The Q, R, and S waves occur in rapid succession, reflecting a single event, therefore, they are usually considered together. The interval between adjacent QRS complexes is termed as the normal to normal (NN) or the R to R (RR) intervals. (NN intervals are referred to as the RR Intervals because they represent the distance between the highest wave (R wave) to the next highest (R wave). The time variation between RR intervals is the heart rate variability.<sup>2</sup>

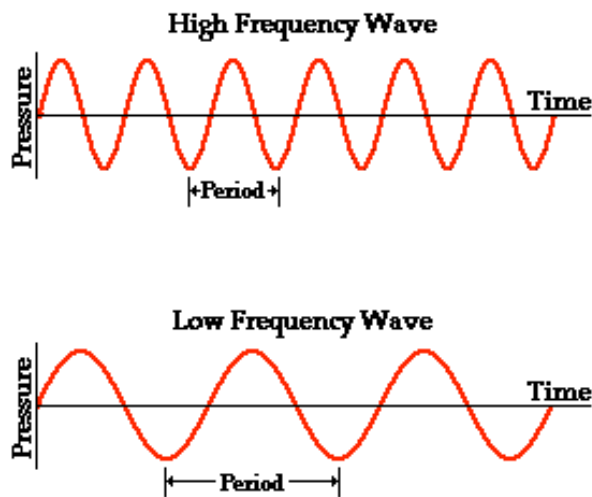
HRV monitoring is a non-invasive technique to assess the sympathovagal balance at the sinoatrial level. The "sinoatrial node" is our heart's natural pacemaker, allowing our heart muscle to contract and relax without the nerves. Left on its own, the sinoatrial node would keep a constant beat at an invariable speed, but ANS provides accelerators and brakes. In other words, the sinus node is subject to both sympathetic and parasympathetic (vagal) effects. Measuring from the sinoatrial level is important because it allows us to see how the ANS is affecting HRV. HRV uses the ratio of low-frequency (LF) to high-frequency (HF) power to determine sympathovagal balance. If the parasympathetic nervous system dominates, the heart rate drops below the RR (or NN) interval and vice versa.

**Time Domains:** This is where the math comes in. SweetBeat uses rMSSD for HRV quantification. Time domain measures used for analysis are very complicated; the standard deviation of all NN intervals (or RR intervals) in seconds is the SDNN, while square root of the mean squared difference of successive NN intervals in milliseconds (ms), is the rMSSD.

Another mathematical equation used in HRV is known as the pNN50. pNN50 is measured by the proportion of NN50 divided by the total number of NNs. SweetBeat uses the time domain of rMSSD to measure HRV, along the low frequency (sympathetic)/high frequency (parasympathetic).

**Frequency Domains:** HRV is made up of multiple frequencies. The two main frequency components that represent ANS activity are the LF (0.04 to 0.15Hz) components and HF (0.15 to 0.4 Hz) components. Frequency domain measures confirm that the LF and HF oscillatory components are relative indices of cardiac sympathetic and parasympathetic activity, while HF and rMSSD indicate parasympathetic activity. In Figure 2, you can see the difference between the two frequencies. Using the RR Intervals, rMSSD, LF and HF, we have created a clinical-grade algorithm that detects stress and monitors HRV.

**Figure 2.** High-frequency and low-frequency waves



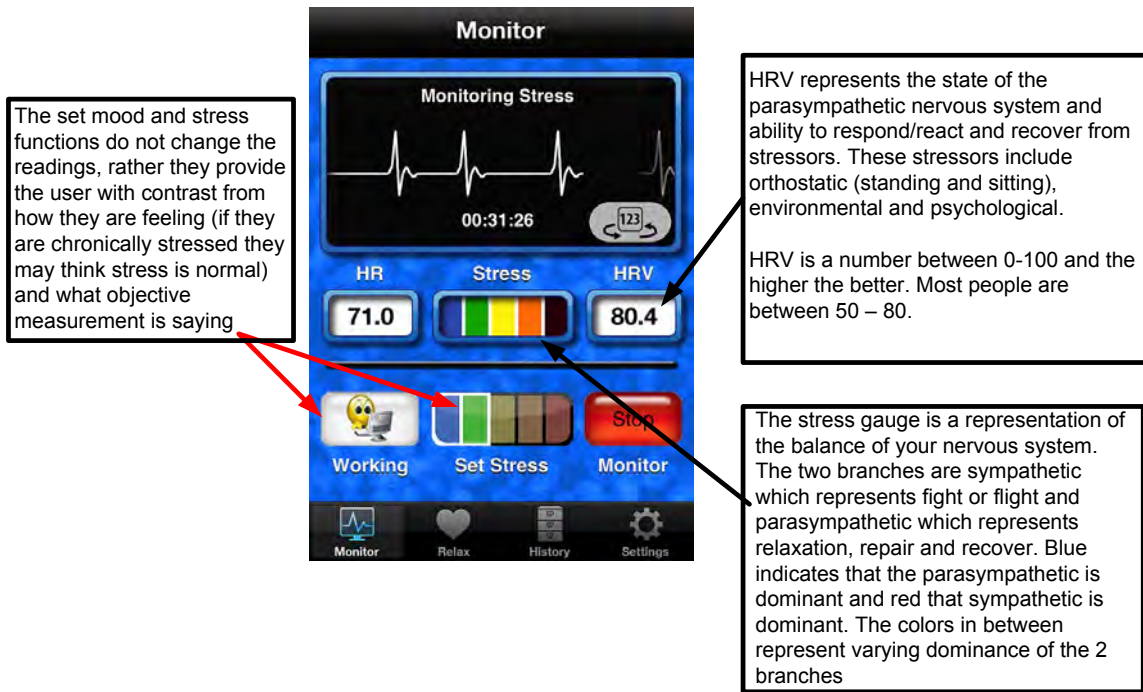
Source: [thephysicsclassroom.com](http://thephysicsclassroom.com)

### SweetBeat Description

In the past, HRV measurement required expensive hardware and software connected to your PC. Now SweetBeat, the biofeedback iPhone app from SweetWater Health, can measure HRV on your iPhone, iPod Touch or iPad using off-the-shelf heart rate monitors.

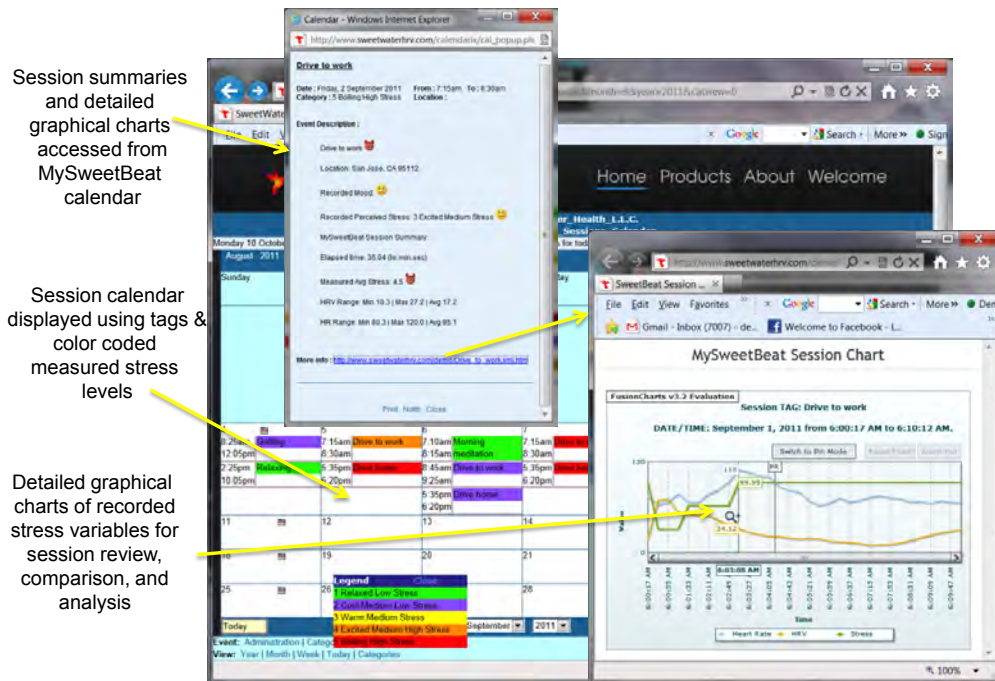
SweetBeat consists of the SweetBeat app and the MySweetBeat web portal. Sessions run on the app can be uploaded to a secure and private web portal for tracking and reviewing from any Internet enabled computer or mobile device. Figure 3 provides a brief description of the SweetBeat app and Figure 4 shows some of the tracking tools available in MySweetBeat.

**Figure 3: MySweetBeat App Description**



Source: SweetWater Health, LLC

**Figure 4: MySweetBeat Tracking Tools**



Source: SweetWater Health, LLC

HRV is a reflection of the ANS and in SweetBeat it is expressed as a number between 0-100. Note that the average person's HRV reads between 50 and 80, and a high HRV is desirable.

The stress level is a representation of the balance between the sympathetic and parasympathetic systems. A low stress level indicates that the parasympathetic is dominant. When the sympathetic branch becomes more dominant, the stress level increases.

Stress is one of the greatest problems in our society and in health care. Stress costs billions of dollars a year in health care—and incalculable costs in terms of human suffering. According to the American Psychological Association, three-quarters of all Americans experience symptoms related to stress in a given month, and half of Americans report lying awake at night due to stress. Workplace stress costs more than \$300 billion each year in health care costs, missed work and stress reduction.<sup>3</sup> Stress contributes to heart disease, hypertension, strokes and other diseases. By offering your patients a stress management solution, you offer them a road to a happier, healthier life.

## Research on HRV and Chiropractic

While only recently working its way into the common chiropractic lexicon, heart rate variability has been used in various other professions for more than 30 years. **HRV has been researched as a factor in heart health, stress and athletic training, emotional health, and fitness, to name just a few areas.** Countless papers, articles and books have been published on HRV. Consequently, it has one of the largest bodies of research behind it of any of the modern diagnostic methods. As a result, the term “heart rate variability” has persisted due to the fact that all of the published research uses that term.

Even with more than 46 years of research, use of HRV in chiropractic is relatively new. HRV was first introduced to chiropractic in the late 1990's when Eingorn et. al. focused on the possibility of including HRV as a standard test in chiropractic offices. However, the first studies on the effects of chiropractic care on HRV were published only about five years ago. It was also during this time that commercial testing equipment became available to allow HRV to be used in a chiropractic office.

In addition to Boone and Welch, we have compiled a couple of studies for you to read on the implications of HRV, ANS and chiropractic adjustments:

Zhang et al. chose from a random sample of 149 men and 137 women from the general population as well as from 129 consecutive patients with acute myocardial infarction. He reported a significant HRV difference in normal middle-aged population compared with patients of the same sex and age who had an acute myocardial infarction. They found that all measures of HRV were significantly and substantially lower in patients with acute myocardial infarction than in the general population. The relatively lower LF power indicated an alteration of the sympathovagal balance, and the significantly stronger correlation of HR with HRV may be indicative for a more pronounced effect of sympathetic activation on autonomic modulation in the case of myocardial infarction. From a chiropractic point of view, you could offer treatment using the Boone and Welch



conclusion that a cervical adjustment will raise the parasympathetic nervous system or HF.

The chiropractic care group showed a significant improvement in HRV on both the single-visit and the four-week visit groups. The data collected show promise for HRV analysis as a tool used in chiropractic care. This finding is comparable to studies in related areas. One study examined the effect of moderate exercise on 88 sedentary postmenopausal women in a randomized controlled trial who were assigned to exercise (n = 49) or control (n = 39) groups. It was interesting to note that this eight weeks of exercise produced HRV changes similar to those that were found in Zhang's study with four weeks of chiropractic care. This is a ratio that you can be proud to present to your clients. The most widely used chiropractic technique in the study as reported by participating physicians was diversified technique. The study demonstrated consistent changes in HRV. The researchers reported, "The decreased heart rate and increased total power from the HRV analysis indicated a healthy autonomic nervous system balance after correction of vertebral subluxation."<sup>4</sup>

In a study on, "Heart Rate Variability Modulation after Manipulation in Pain-Free Patients Vs. Patients In Pain," researchers analyzed low frequencies, high frequencies, and their ratios. The abstract reports: "The purpose of this study was to examine heart rate variability (HRV) in the presence or the absence of pain in the lower back, while receiving one chiropractic treatment at L5 from either a manually assisted mechanical force (Activator) or a traditional diversified technique spinal manipulation." Analyzing for five minutes before and after the adjustments, the researchers were able to find that the low frequency decreased in all of the treatment pain groups, showing proof that the chiropractic care relieved tension and stress from their sympathetic nervous system. The researchers concluded, "Adjusting the lumbar vertebrae affected the lumbar parasympathetic nervous system output for this group of participants." They also write that whether the patient is in pain might have an impact on the differences in pre- and post-HRV measurements. The autonomic nervous system response may be specific and sensitive to its effector's organ. The spectral analysis of the tachygram was performed with Kubios software, which we will cover later.<sup>5</sup>

## SweetBeat Implementation

Implementing SweetBeat in your practice is easy. You must purchase one of each type of equipment for every room you will be working. If you only have one room where patients are examined/adjusted, you will need the following: One 8GB iPod Touch (\$187.99 and you will need wifi to upload sessions), one SweetBeat Application (\$1.99), one heart monitor and one receiver/dongle (\$59.99 - \$99.99), and in order to view your sessions online, you will need to subscribe to MySweetBeat (\$29.99/Month). You can find the links on our health sensor partner page at [www.beathealthy.com/healthsensors](http://www.beathealthy.com/healthsensors). Buy the [SweetBeat](#) app on iTunes.com (one copy for each device) <http://itunes.apple.com/us/app/sweetbeat/id492588712?mt=8>.

**Figure 5.** SweetBeat is compatible with several widely available heart monitors, including Wahoo, 60Beat, and NuMetrix smart clothing.

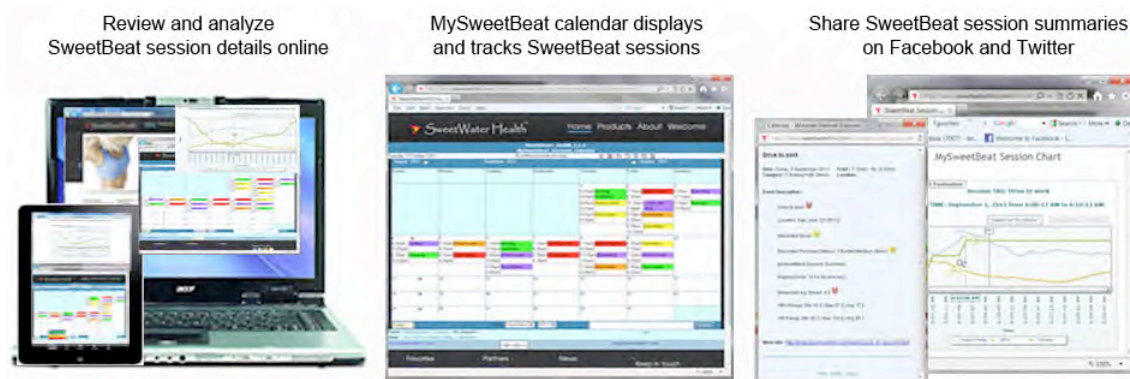


For a first-time patient, you will need to run a five-minute session before the adjustment to establish a pre-treatment baseline. Then run a five-minute session after the adjustment. To run a session, you simply have the client put the heart rate monitor around their lower chest, wet the two pads on either side of the connector piece, and connect the receiver/dongle to the iPod Touch. Open the app and press “Start”. For regular patients, you may want to only run a five-minute session after the adjustment to track progress.

Create an account either on the app or through our website and upload sessions to the private and secure MySweetBeat database. If you wish, you may create separate accounts for each client. The other option is to “tag” the sessions as the client’s name or email.

When you visit the calendar, you can view session details by clicking on the session to open a pop-up window. At the bottom of this window, you will find a link to your session graph.

**Figure 6.** Track through the MySweetBeat Portal, <http://www.sweetwaterhrv.com>



Source: SweetWater Health, LLC

If patients wish to purchase their own heart rate monitors and apps, they can run their own sessions and upload to the same or separate accounts than their chiropractic account.

With the SweetBeat app and the secure MySweetBeat portal, you will be able to:

- Measure a particular client's HRV before and after the chiropractic session.
- Recommend SweetBeat to your patients to measure HRV between chiropractic sessions, encouraging them to keep an eye on stress throughout the week.
- Measure their HRV during a chiropractic session to measure efficacy.
- Upload individual client HRV sessions to MySweetBeat for tracking and review.
- E-mail your patients their session summaries from previous sessions.

## CPT Codes for ANS Monitoring

When SweetBeat is approved by the FDA, CPT codes will be available to use with insured patients. At the moment, two reimbursable CPT codes allow practitioners to be paid for autonomic nervous system monitoring. The reason for two CPT codes is simple: to get a complete look at autonomic nervous system functioning, you must read both of its branches (sympathetic and parasympathetic) independently. CPT code 95921 is for parasympathetic nervous system monitoring, and CPT code 95922 is for sympathetic nervous system monitoring. Patients whose healthcare plans reimburse for chiropractic will be pleased that the new service is covered by insurance.

## Kubios

If you are interested in using the data received from SweetBeat to analyze the data even further, we recommend the freeware, Kubios. You may obtain more information on HRV analysis by visiting the Kubios website at <http://kubios.uku.fi>. (Please note that SweetWater Health has no connection to the developer of this program.)

## Coming Soon

We are working on providing you with an easy-to-use system for interpretation of the data from SweetBeat. First of all, we will be syncing a list of the R-R Intervals to the session summaries that are now available on the MySweetBeat calendar. To get here you will follow these steps:

1. Go to the website <http://beathealthy.com>
2. Click on MySweetBeat at the top of the page
3. Log in using your email and password
4. Scroll down until you see the large calendar with your sessions on it
5. Select the session you wish to see R-R Intervals for and scroll to the bottom
6. Click on the link that will say R-R Intervals

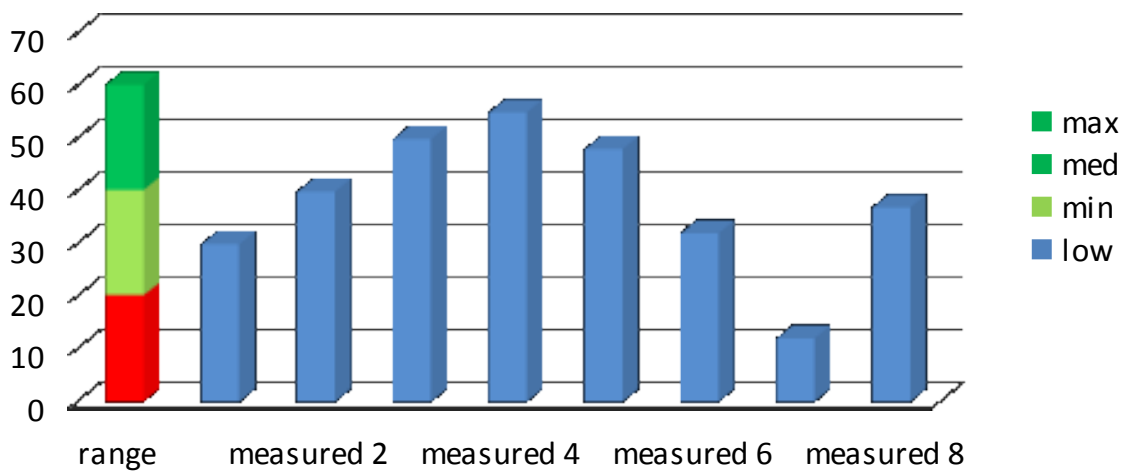
Using this spreadsheet of R-R Intervals, you will be able to fully utilize the Kubios freeware.

In addition to this, we will offer a set of graphs that will help you interpret your data over time. We will provide you with a system of comparing your clients' scores to the desired HRV, total power, and sympathovagal balance values. By simply entering the LF, HF,

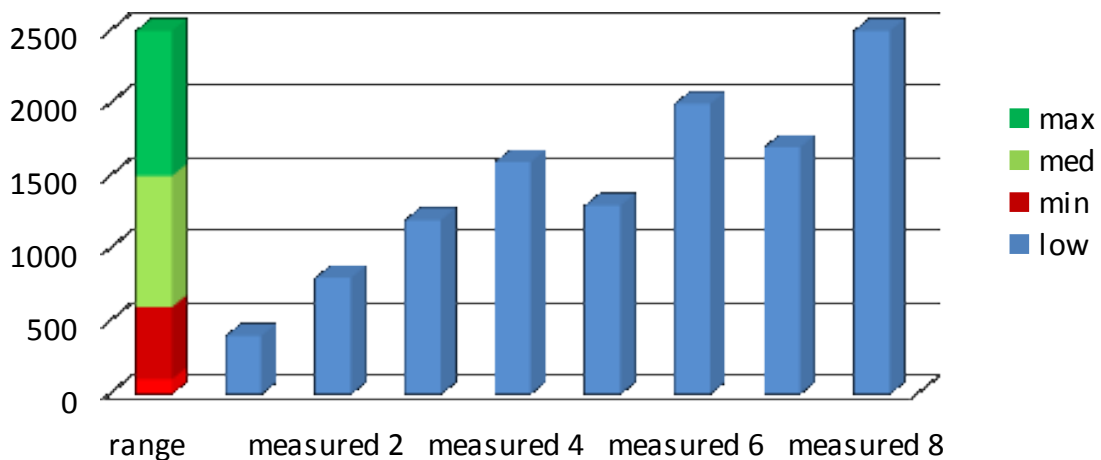
and rMSSD from a session summary, you will be able to view readable charts like the ones you see below. We have made it easy to find this data from each session. When you stop a session, you just go to the main screen on the app. The EKG part of the screen can be flipped by touching the button on the bottom right corner of that space. You can then record the LF, HF, and rMSSD to see a return of data on the graphs. This will give you and your client a visualization of the work that needs to be done or has been done through your care.

**Figures 7, 8, 9, 10.** These are examples of the charts you will receive from simply entering your LF, HF and rMSSD information from a session summary.

## HRV (rMSSD)



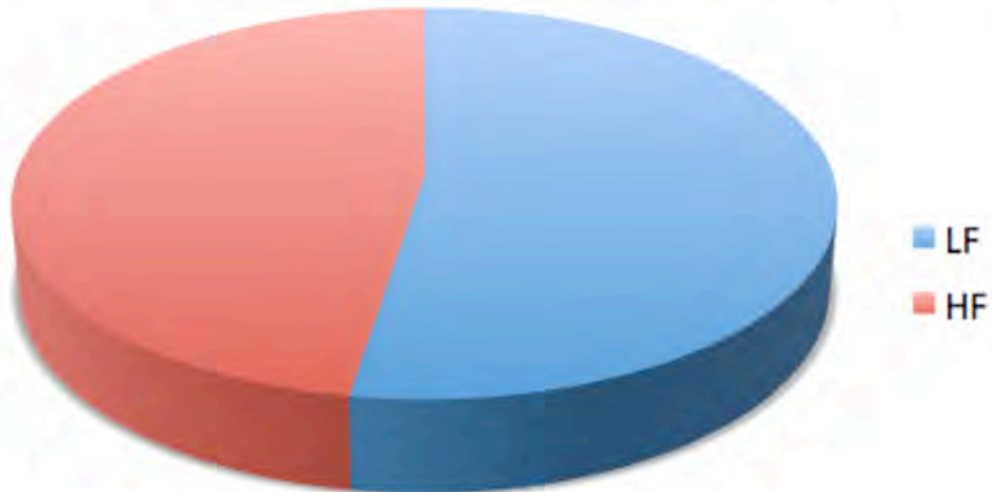
## ANS Total Power



## Measured Sympathetic/Parasympathetic Balance



## Desired Sympathetic/Parasympathetic Balance



Source: SweetWater Health, LLC

## References

- <sup>1</sup>Welch, A., and R. Boone. "Sympathetic and Parasympathetic Responses to Specific Diversified Adjustments to Chiropractic Vertebral Subluxations of the Cervical and Thoracic Spine." *Journal of Chiropractic Medicine*. U.S. National Library of Medicine, 7 Sept. 2008. Web. 06 Apr. 2012. <http://www.ncbi.nlm.nih.gov/pubmed/19646369>
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- <sup>3</sup>"The Analysis of Mental Stress Using Time-Frequency Distribution of Heart Rate Variability Signal," H.M. Seong; J.S. Lee; T.M. Shin; W.S. Kim; Y.R. Yoon; Y.R. Yoon; Proceedings of the 26th Annual International conference of the IEEE EMBS, September 2004.
- <sup>4</sup>Zhang, J., Dean, D. "Effect of short term chiropractic care on pain and heart rate variability in a multisite clinical study." International Research and Philosophy Symposium: Abstracts. Sherman College of Straight Chiropractic, Spartanburg, SC. October 9,10, 2004. <http://www.ncbi.nlm.nih.gov/pubmed/16690380>
- <sup>5</sup>Roy, R. A., J. P. Boucher, and A. S. Comtois. "Heart Rate Variability Modulation after Manipulation in Pain-free Patients vs Patients in Pain.," National Center for Biotechnology Information. U.S. National Library of Medicine, May 2009. Web. 06 Apr. 2012. <http://www.ncbi.nlm.nih.gov/pubmed/19447264>