HeartQuest Professional: What it is and What the Research Says

Heart Rate Variability is Built into HQP

Heart Rate variability gives us a window into the autonomic nervous system. The autonomic nervous system is the automatic nervous system that controls the body's glands and organs without conscious thought. It is an automatic system. It is constantly changing and adapting to various stressors such as mental, emotional, environmental toxins, pathogens, etc. The autonomic nervous system is the master control system regulating all vital functions: blood pressure, respiratory rate, heart rate, immune system, endocrine system, digestive system. When the autonomic nervous system loses its ability to adapt and resist various stressors, health will decline. We see this in the HQP in various parameters that we will discuss indicating low heart rate variability. For in depth information on HRV go to fonters.org/articles 10.3389/pub.2017.00238/full.

How do we get the measurement that looks at the Autonomic Nervous System?

Time Domain

There are 2 parameters that give us the information on the autonomic nervous system. One is called the time domain. We perform an ECG looking at the electro cardio signal for 5 minutes. In the ECG there is something called the R wave which is a visual peak we see on the ECG when the heart contracts in systole. We measure the time in milliseconds between one R wave to the next. To understand why we measure this you have to understand that we have 2 parts to the autonomic nervous system. The Sympathetic nervous system also called the fight or flight system and the Parasympathetic nervous system also called the rest and digest nervous system.

The way to think about these 2 systems is that the Sympathetic nervous system speeds up the heart rate and the Parasympathetic slows down the heart rate and, like 2 Sumo wrestlers, the pushing back and forth of these 2 systems will elicit variability changes in milliseconds between one R wave to the next. This is what we want to see, hence heart rate variability. If the milliseconds are like a metronome and do not vary from one R wave to the next, we have decreased Heart Rate Variability and decreased adaptive capabilities of the autonomic nervous system to respond appropriately to whatever life throws at us.

Frequency Domain

The time domain is statistically viewed as SDNN, RMSSD, HRV Index and is well documented in the published medical literature. The second part of the measurements come from measuring the frequency domain. We take the Electro Cardio Signal and utilize something called Fast Fourier Transform and basically it is like shining a white line through a prism. On the other side of the prism, you get the frequencies representing red, blue, green, and orange.

On the HQP you get the frequency spectrum broken down into Low Frequency, High Frequency and Very Low Frequency. Low frequency is your Sympathetic nervous system and high frequency is the Parasympathetic nervous system, very low frequency is related to the Hypothalamic Pituitary Adrenal Axis also called the HPA axis. Now you have an explanation of the 2 parameters-- the Time domain and the Frequency domain found in a heart rate variability evaluation. Both Time domain measurements and the Frequency domain have an abundance of medical research behind them.

Balance is the key to health

Sympathetic Nervous System

The Sympathetic nervous system is what prepares the body for survival when under a real or perceived threat. It dilates your pupils so you can have enhanced far vision to see a predator coming to eat you. Additionally, the Sympathetic nervous system increases the heart rate to get more oxygen and nutrients to your muscles to fight or run; it also dilates the bronchi to get more air in the lungs, release glucose to increase blood sugar, increases blood pressure as well as releasing stress hormones from the adrenal glands. During this Fight or Flight response, the body will also shut down physiological functions not needed for survival such as reducing stomach and intestinal mobility and diverting blood flow away from the GI tract, and reduction of digestive enzyme secretions. This is why you do not want to eat when stressed out. When in the Sympathetic nervous system mode, digestion is shut down.

The point is that today many people are in this Sympathetic state for prolonged periods of time and it is usually perceived stress and not a Saber Tooth tiger chasing them. The other part of the nervous system called the Parasympathetic nervous system is designed to reset the physiology back to the state before the stress. In many cases this does not happen and the patient is stuck in Sympathetic nervous system dominance. The key is to bring down the Sympathetic nervous system and increase the Parasympathetic nervous system for balanced health. This can be accomplished using relaxation techniques, Vagal nerve stimulation and various herbs called adaptogens, CBD and others.

Parasympathetic Nervous System

The Parasympathetic nervous system is the opposite of the Sympathetic nervous system. The Parasympathetic response includes constricting the pupils of the eyes, decreasing heart rate, constricting the bronchi, decreasing blood flow to the skeletal muscles, increasing stomach and intestinal motility in addition to increasing blood flow to the GI tract as well.

What is really important is something called the Vagus nerve and it is part of the Parasympathetic nervous system. It is important because it has the ability to reduce inflammatory chemicals found in most chronic diseases such as Rheumatoid arthritis, Systemic Lupus, Crohn's disease as well as the inflammatory storm found in viral infections etc. This reflex is the *cholinergic anti-inflammatory reflex* and the HQP gives a good indication

when the Parasympathetic nervous system tone is low and we need to stimulate the Vagus nerve using a non-invasive electrical stimulator below the ear. Most of the research comes from Dr. Kevin Tracey where he discovered this important pathway. There are many reasons for the Vagus nerve to be weak. Most of the time people are habituated in Sympathetic dominance or flight or fight mode and over time this can chronically weaken this nerve. Neck injuries like a whiplash can traumatize the Vagus nerve and any brain inflammation can cause decrease firing to the Vagus nerve. There is an array of symptoms associated with decreased Vagal nerve tone listed on the HQP. All of this information is listed in Pub Med under the cholinergic anti-inflammatory pathway and in the most respected publication, Nature. When we see increased Parasympathetic dominance in a young person or athlete it is a good thing and indicates a robust and dynamic autonomic nervous system and the ability to quickly recover after exercise. If we see Parasympathetic nervous system dominance with decreased Total Power this can represent an exhausted state.

Very Low Frequency

(The text in red is an interpretation of the research from the article referenced at the beginning).

The Very Low Frequency indication requires a recording of 5 minutes to obtain which is the case in the HQP. VLF power is more strongly associated with all-cause mortality than LF or HF power. The VLF power may be fundamental to health. I have gone a little more in depth with VLF since we see this with most chronic health issues. We need the VLF band but too much or too little is associated imbalances in health. Low VLF power has been shown to be associated with arrhythmic death and PTSD and in this case VLF % would be low and HF would be high, (Low VLF power should not to be confused with VLF%). Low power in this band has been associated with inflammation in several studies. (With inflammation you would have a high % of VLF and low total power). Finally low VLF power has been correlated with low levels of testosterone. (On HeartQuest Professional this would be associated with High% of VLF and low total power and imbalance in the kidney meridian and low DHEA on the HQP). DHEA is a precursor of testosterone.

Observations with VLF indicate that it can sometimes give indications of metabolic syndrome or insulin resistance which is a cardiovascular risk factor. When the VLF% is high it could be a strong indicator of blood sugar handling problems and diet and life style needs to be addressed. In a young population it could be a psychoemotional issue. The literature talks about the Renin-Angiotensin system and its involvement in the regulation of blood pressure, fluid, and electrolytes. It has been observed that a high percentage of VLF can possibly contribute to elevated blood pressure. High VLF is a slower regulation system and requires lots of energy to run versus the autonomic nervous system that is a fast speed regulation system. One is fast speed internet the other snail mail. It has been observed that as we age VLF goes up. Another important aspect of VLF is that it is a backup system to LF. LF initiates its response from the ANS directly as the nerves exit the spine to the target organs and glands

including the adrenal glands to deal with the stress response. The VLF is also part of the sympathetic nervous system but works thru neurohormonal regulation. Here we are talking about the Hypothalamic Pituitary Adrenal Axis (HPA axis). With stress we end up making the stress hormone cortisol but when chronic and high and can create HPA axis distortion. Looking at the stress questionnaires on the HQP can give clues if HPA is under responsive or over responsive.

Total Power

Total Power is a common parameter in HRV that is the total frequency power spectrum of LF, HF and VLF and gives us information on the total energy available to perform work. When low it affects all the frequency bands such as LF, HF, VLF on the HQP and the patient may need an outside source to bring this up such as nutrition and life style, adaptogenic herbs and energy modalities such as light, sound, electrochemical modalities performed in moderation.

Novel Parameters on HQP Unique to this Evaluation

Inflammatory Index

The Inflammatory Index on HQP gives a possible indication of inflammation and can be backed up by research articles from Pub Med titled *Heart Rate Variability, and Inflammatory Biomarkers Among Healthy Young and Healthy Adults*. (See Ann Med. Feb. 2017). The conclusion of this paper is that inflammation increased heart rate and decreased HRV and the inflammatory marker High-sensitivity C-reactive protein was inversely associated with HRV. Another pub med article noted is titled *Heart Rate Variability and Circulating Inflammatory Markers in Midlife*. (See Pub Med article from NIH, 2021). Results are consistent with the cholinergic anti-inflammatory pathway and suggest the Parasympathetic modulator of inflammation through the Vagus nerve may act on specific inflammatory molecules more than others. In this article statistical analysis revealed robust inverse relations between HF-HRV and IL6.

Thyroid Functional Index (TFi)

The Thyroid Functional Index gives a good indication of thyroid function based on a study out of Russia with a population base of 77 Graves' disease subjects where heart rate variability was recorded before radiation treatment of the thyroid and 1 month, 3 months and 6 months after. The scientists came up with an algorithm that diagnostic sensitivity was 71% and the specificity was 79% and gives a good indication in what direction the thyroid is going. This can be confirmed with a full thyroid panel.

Performance Wellness Score

Performance Wellness Score is a scoring system from the famous Russian scientist Baevsky who developed an algorithm to track the wellness of the cosmonauts on the International

Space Station. It was based on various HRV parameters combined. Gives a good indication of overall health.

Five Stages of Stress

The 5 Stages of Stress was developed by Dr. Karimov of the HeartQuest LLC team and based on several parameters on the HQP. The scale runs from 1-5 and 5 being the highest level of stress.

Chinese Medicine

This section is looking at the interconnection of all systems of the body from a Chinese medicine perspective. In Chinese medicine they look at the body as being connected to the whole via the meridian highway vital currents. As the seasons change so do the vital currents or meridians that interact with various organ systems. This is now showing up in main stream science that between summer and winter the same biochemical pathways have an opposite function like yin and yang and everything has 2 poles. Depending on the season we get different signaling in the body. On the HQP from the frequency spectrum we get LF (Low Frequency) and within this band we have the frequencies that represent the Small Intestine meridian and Heart meridian and when we divide the LF (Low Frequency) further it gives us the frequencies of Liver and Gall Bladder meridians. We have broken down HF (High Frequency) the same way and VLF (Very Low Frequency) the same way. We have performed traditional acupuncture and cold laser and light gem therapy on specific meridians according to what showed up on the HQP and the changes on the post test matched what we predicted should change in the vital currents of the meridians.

Ayurvedic Medicine

Ayurvedic medicine has a 5000-year-old history with valuable insights into a patient's tendencies and weaknesses as well as strengths unique to that patient. Like Chinese medicine this information comes from the frequency spectrum. We have 3 different functional states in Ayurvedic medicine. LF or low frequency represents a Pitta constitution, HF or high frequency represents the Kappa constitution, and VLF represents the Vata constitution. Each one has a specific symptom when out of balance. Once you see the imbalance on the HQP in the Solutions tab under Vata, Pitta, Kapha you can see what each of these 3 functional states governs, possible symptoms, areas to support, life style options, solutions and there is a section for the specific diet for that functional state in Ayurvedic medicine that is most prominent.

Brain Power

Brain Power is derived from the electro cardo signal from the ECG and not directly measuring the EEG of the brain and is extrapolated from the electro cardio signals. The heart's electromagnetic field is the most powerful electromagnetic field produced by the human body. This field envelopes every cell in the human body and extends out in all directions into

the space around us. The cardiac field can be measured several feet away from the body. Research conducted at IHM (Institute of Heart Math) suggests that the heart's field is an important carrier of information. The heart is about 100,000 times stronger electrically and 500,000 times stronger magnetically than the brain. The heart has more neurological connections to the brain than the other way around. The heart has 40,000 neural connections and the heart can sense, learn and remember. The messages from the heart have profound effects on brain function. It is no surprise that we can ascertain information from the heart about the brain. From the mathematical algorithm we can extrapolate the spectrum of the brain frequencies and give us information about the brain power. This is based on the ECG and the brain connection. We calculate the brain frequencies from the power spectrum which gives us information about the brain's activities and power.

Questionnaires

Each meridian controls a specific mineral, hormone and neurotransmitter and gives us an idea what is going on at multiple levels. This is also for research and education but can be confirmed with labs and symptoms. In the HQP we have several questionnaires that track symptoms over time. The Stress Questionnaire, the Nutritional Metabolic Questionnaire and the Neurotransmitter Questionnaire are all included within the HeartQuest software. We have run a hormone test to check the validity of the Cortisol and DHEA and the HQP matched what we found. We did the same with the neurotransmitters and it was also matching the lab test. The neurotransmitters can also be validated with the Neurotransmitter questionnaires.

Research Parameters in the HQP

SDNN

SDNN stands for "standard deviation of all RR intervals measured between consecutive sinus beats." This reflects your ability to respond quickly, dynamically, and effectively to a crisis. Normal range is 49-70. The higher the range, the better. This number is increased by proper physical activity, decreased toxicity, stress reduction and balanced fatty acids. SDNN is the most widely used and researched number in Heart Rate Variability. The SDNN parameter is a reflection of how well your ANS can respond to an emergency. In the medical literature there are research papers showing that SDNN is a good prognosticator in many conditions.

RMSSD

RMSSD is strongly backed by research and is considered the most relevant and accurate measure of the autonomic nervous system activity over the short-term. It represents the strength of your ANS specifically your Parasympathetic nervous system.

LF-HF Ratio

LF-HF Ratio represents the balance between the Sympathetic nervous system (Low Frequency) and the Parasympathetic nervous system (High Frequency) and the normal range is between 1-3. Less than 1 is Parasympathetic dominance and over 3 is Sympathetic dominance. This can give the illusion of balance between both systems. Both these systems can look good but the VLF (Very Low Frequency, Neuro Hormonal, Hypothalamic Pituitary, Adrenal system) can be the dominant system and that has associated imbalances that may be attached to a high % of VLF as mentioned in the VLF section above.

Total Power

Total Power is the sum of all the frequencies measured such as LF, HF, VLF from the spectral analysis of the ECG. This reading is about the total energy produced in these frequency bands. When low energy the patient's ability to adapt to stress may be affected. It takes energy for any changes to take place in the body. From a HQP perspective looking at Chinese medicine we are talking about *Chi* or movement of energy to supply vital currents to the organs. Any improvement in this reading is a good indication that health is moving in the correct direction.

AMO%

AMO% is the percentage of cardiac cycles with the most frequent duration. The % ranges can be seen in the HQP and give us information on the physiologic state of the ANS and CNS. An example is 30-50%- This is an Indication of a balanced ANS. Within this range we find a dynamic and energy efficient ANS with a greater ability to adapt to stress. In this state, the body's utilization of energy is balanced between conserving and spending energy.

Stress Index

The Stress Index gives us an indication of how the body uses energy to correct for changes in the environment, (physical, mental, emotional, toxins). With higher ranges in the Stress Index the body will use more energy to correct for changing stress conditions and the normal range is 10-100.

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Guidelines

Heart rate variability

Standards of measurement, physiological interpretation, and clinical use

Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology (Membership of the Task Force listed in the Appendix)

Introduction

The last two decades have witnessed the recognition of a significant relationship between the autonomic nervous system and cardiovascular mortality, including sudden cardiac death[1–4]. Experimental evidence for an association between a propensity for lethal arrhythmias and signs of either increased sympathetic or reduced vagal activity has encouraged the development of quantitative markers of autonomic activity.

Heart rate variability (HRV) represents one of the most promising such markers. The apparently easy derivation of this measure has popularized its use. As many commercial devices now provide automated measurement of HRV, the cardiologist has been provided with a seemingly simple tool for both research and clinical studies[5]. However, the significance and meaning of the many different measures of HRV are more complex than generally appreciated and there is a potential for incorrect conclusions and for excessive or unfounded extrapolations.

Recognition of these problems led the European Society of Cardiology and the North American Society of Pacing and Electrophysiology to constitute a Task Force charged with the responsibility of developing appropriate standards. The specific goals of this Task Force were to: standardize nomenclature and develop definitions of terms; specify standard methods of measurement; define physiological and pathophysiological correlates; describe currently appropriate clinical applications, and identify areas for future research.

In order to achieve these goals, the members of the Task Force were drawn from the fields of mathematics, engineering, physiology, and clinical medicine. The standards and proposals offered in this text should not limit further development but, rather, should allow appropriate comparisons, promote circumspect interpretations, and lead to further progress in the field.

The phenomenon that is the focus of this report is the oscillation in the interval between consecutive heart beats as well as the oscillations between consecutive instantaneous heart rates. 'Heart Rate Variability' has become the conventionally accepted term to describe variations of both instantaneous heart rate and RR intervals. In order to describe oscillation in consecutive cardiac cycles, other terms have been used in the literature, for example cycle length variability, heart period variability, RR variability and RR interval tachogram, and they more appropriately emphasize the fact that it is the interval between consecutive beats that is being analysed rather than the heart rate per se. However, these terms have not gained as wide acceptance as HRV, thus we will use the term HRV in this document.

Background

The clinical relevance of heart rate variability was first appreciated in 1965 when Hon and Lee[6] noted that fetal distress was preceded by alterations in interbeat intervals before any appreciable change occurred in the heart rate itself. Twenty years ago, Sayers and others focused attention on the existence of physiological rhythms imbedded in the beat-to-beat heart rate signal[7–10].

Key Words: Heart rate, electrocardiography, computers, autonomic nervous system, risk factors.

The Task Force was established by the Board of the European Society of Cardiology and co-sponsored by the North American Society of Pacing and Electrophysiology. It was organised jointly by the Working Groups on Arrhythmias and on Computers of Cardiology of the European Society of Cardiology. After exchanges of written views on the subject, the main meeting of a writing core of the Task Force took place on May 8–10, 1994, on Necker Island. Following external reviews, the text of this report was approved by the Board of the European Society of Cardiology on August 19, 1995, and by the Board of the North American Society of Pacing and Electrophysiology on October 3, 1995.

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Table 4 Summary of selected studies investigating the clinical value of HRV in cardiological diseases other than myocardial infarction

Disease state	Author of study	Population (no. of patients)	Investigation parameter	Clinical finding	Potential value
Hypertension	Guzzetti 1991[149]	49 hypertensive 30 normals	Spectral AR	↑ LF found in hypertensives as compared to normals with blunting of circadian patters	Hypertension is characterized by a depressed circadian rhythmicity of LF
	Langewitz 1994[150]	41 borderline hypertensive 34 hypertensive 54 normals	Spectral FFT	Reduced parasympathetic in hypertensive patients	Support the use of non-pathological therapy of hypertension that ↑ vagal tone (e.g. exercise)
Congestive heart failure	Saul 1988[155]	25 chronic CHF NYHA III, IV 21 normals	Spectral Blackman–Turkey 15 min acquisition	↓ spectral power all frequencies, especially >0·04 Hz in CHF patients	In CHF, there is ↓ vagal, but relatively preserved sympathetic modulation of HR
	Casolo 1989[102]	20 CHF NYHA II, III, IV 20 normals	Time–domain RR interval histogram with 24 h-Holter	Low HRV	Reduced vagal activity in CHF patients
	Binkley 1991[152]	10 dilated cardiomyopathy (EF 14 to 40%) 10 normals	Spectral FFT 4 min supine acquisition	↓ in high frequency power (>0·1 Hz) in CHF ↑ LF/HF	Withdrawal of parasympathetic tone observed in CHF CHF has imbalance of autonomic tone with ↓ parasympathetic and a predominance of sympathetic tone
	Kienzle 1992[104]	23 CHF NYHA II, III, IV	Spectral FFT Time-domain 24–48 h-Holter	Alterations of HRV not tightly linked to severity of CHF ↓ HRV was related to sympathetic excitation	
	Townend 1992[153]	12 CHF NYHA III, IV	Time domain 24 h-Holter	HRV ↑ during ACE inhibitor treatment	
	Binkley 1993[154]	13 CHF NYHA II, III	Spectral FFT 4 min supine acquisition	12 weeks of ACE inhibitor treatment ↑ high frequency HRV	A significant augmentation of parasympathetic tone was associated with ACE inhibitor therapy
	Woo 1994[155]	21 CHF NYHA III	Poincaré plots Time-domain 24 h-Holter	Complex plots are associated with ↑ norepinephrine levels and greater sympathetic activation	Poincaré plots may assist analysis of sympathetic influences
Heart transplantation	Alexopoulos 1988[156]	19 transplant 10 normals	Time–domain 24 h-Holter	Reduced HRV in denervated donor hearts; recipient innervated hearts had more HRV	
	Sands 1989[100]	17 transplant 6 normals	Spectral FFT 15 min supine acquisition	HRV from 0·02 to 1·0 Hz — 90% reduced	Patients with rejection documented biopsy show significantly more variability
Chronic mitral regurgitation	Stein 1993[157]	38 chronic mitral regurgitation	Spectral FFT Time-domain 24 h-Holter	HR and measures of ultralow frequency by SDANN correlated with ventricular performance and predicted clinical events	May be prognostic indicator of atrial fibrillation, mortality, and progression to valve surgery
Mitral valve prolapse	Marangoni 1993[158]	39 female mitral valve prolapse 24 female controls	Spectral AR 10 min supine acquisition	MVP patients had ↓ high frequency	MVP patients had low vagal tone

Continued