Autonomic Nervous System Physiology

Heart rate variability (**HRV**) power spectral analysis is one of many means of analyzing the electrocardiogram. Analysis of this kind can provide relative measures of the power or tone of various underlying physiologic influences on heart rate control, including hormonal and enzymatic, circadian, respiratory, and neural influences. Primary neural control of the heart is maintained by the **autonomic nervous system** (ANS).

The ANS influences every cell in the body through its two branches:

The sympathetic nervous system (sympathetic) and the parasympathetic nervous system (parasympathetic). In general, the sympathetic is responsible for mediating energy expenditure, while the parasympathetic is responsible for energy conservation and restoration. For example, the sympathetic mediates the "fight or flight" response and the body's response to stress, pain, and cold. Thus, the sympathetic causes higher heart rates and respiratory rates, shunting blood from the extremities to core organs and muscles (e.g., running or shivering), etc. The parasympathetic mediates resting states after meals and at night, digestion and nutrient storage, and recovery states by helping to coordinate immune responses and healing. Thus, the parasympathetic causes slower heart rates and respiratory rates, sleep, increased gastrointestinal track motility, increased peripheral vascular flow, blood flow to all cells, liver and kidneys, and venous return to the heart. The sympathetic and parasympathetic branches of the ANS work together to maintain homeostasis.

When the ANS affects a change in the body (e.g., heart rate or respiratory rate), it works only to cause the change. The ANS then returns to its baseline state. So, periodic excursions in one or the other branch from baseline are normal and expected as long as the ANS returns to baseline in a timely manner. Persistently elevated levels of tone in one or the other branch are not healthy. The general action of each of the branches of the ANS is to oppose the other. As one branch begins to work the other branch begins to return it to baseline. Consequently, persistently elevated tone in one branch can result in a persistently depressed tone in the other. This only serves to compound an unhealthy situation. **So, balance between the branches is as important as overall tone in each of the branches.**

It has been learned that the parasympathetic nervous system can change faster than the sympathetic nervous system. Thus, as the sympathetic starts to mediate a stress response the parasympathetic immediately begins to counter it. If the parasympathetic is not faster than the sympathetic, then any stress response could send the heart into tachycardia and onto ventricular fibrillation before the parasympathetic could act to prevent it. The parasympathetic, through the Vagus, is the main controlling influence on respiratory activity. Changes in respiration are influenced by changes in parasympathetic tone. Parasympathetic input to the heart is through fibers that synapse deep in the myocardium. Sympathetic influence on the heart is through surface synapses. Due to this arrangement the parasympathetic is more sensitive to heart damage (i.e.: infarct, ischemia, or cardiomyopathies). Since the parasympathetic is faster to respond, it is usually the branch that is first to indicate changes in health status anywhere in the body.