THE ANS/HRV AND STRESS RELATIONSHIP

OCCUPATIONAL STRESS AND HRV

Utilizing HRV occupational stress research could integrate the strengths of understanding provided by the aforementioned research traditions to illuminate how workplace psychosocial stressors contribute to the development of chronic disease – through defined physiological pathways related to cardiac regulation by the autonomic nervous system.

Studies utilizing HRV measures for investigating the physiological impact of occupational stress in the work place are now very frequent. A variety of methods have been utilized to categorize occupational stress as well as to measure HRV.

DEPRESSION AND STRESS

Since 2000 there are many more reports in the literature on depression and HRV. This reflects the potential interest in this tool as a measure of the mind-body interaction and as a possible way of defining how mood state manifests its well-established effect on cardiovascular health (in particular stress, depression and anxiety). Nearly all the recent studies on depression and heart disease document increased cardiovascular morbidity and mortality in patients with depressive symptoms or major depression. This implicates depression as an independent risk factor in the pathophysiologic progression of cardiovascular disease, rather than merely a secondary emotional response to cardiovascular illness.

Studies have suggested that the relative risk of major depression with cardiovascular disease varies from 1.5 to 4.5. This seems to apply both to the development of cardiovascular disease and death after an index myocardial infarction. In patients with angiographic evidence of coronary artery disease, the presence of a major depressive disorder was the best single predictor of cardiac events during the 12 months following diagnosis. A decrease in HRV may mediate this effect.

Depression scores were established in healthy students. On the basis of their scores, students were categorised as being in a high or low depression group. Parasympathetic nervous system responses were measured by measuring high frequency HRV in response to an acute stress (a challenging speech task) and a forehead cold pressor test. Those in the high depression group had significantly greater reductions in HF during the speech task and smaller increases in HF during the forehead cold pressor task than those in the low depression mood group. Women were found to have significantly greater reductions in HF during the speech task and smaller increases in HF during the forehead cold pressor test than.

MOOD, PERSONALITY AND STRESS

Levels of hostility have been shown to affect HRV. Women with high hostility scores demonstrated less blood pressure and heart rate rises during confrontational discussions than women of low hostility scores. Greater blood pressure response was observed with positive than with negative feedback (as estimated on the hostility rating). Analysis of coping styles suggested that high hostility subjects may be less reactive due to withdrawal and lack of engagement during the task, while low hostility subjects may show greater engagement, especially when encouraged by positive feedback. Individuals with high hostility scores and patients with anxiety and depression have low HRV and may be at increased risk of death from coronary heart disease and arrhythmias.

HRV was investigated in eight Type A and eight Type B women during a 30minute psychomotor task. The results suggested that the sympathetic nervous system in Type A individuals was more stimulated during the task, and although there was no difference in task performance between the 2 groups, Type A subjects felt a greater subjective mental workload than did Type B individuals.

Both in laboratory conditions and in the workplace, techniques to engender positive thought processes in individuals have been demonstrated to produce a significant improvement in HRV. Emotions such as hostility and anger produce a sympathetically dominated HRV, whereas feelings of appreciation shift the HRV power spectrum in the opposite direction. It has been shown that people who express positive emotions show less life stress and are less likely to become ill.

WORK PERFORMANCE, PRODUCTIVITY AND STRESS

Stress results primarily from unmanaged emotions. Factors such as anxiety, worry or fear are disablers of performance.

States of peak performance have a measurable physiological correlate. A physiological state characterised by improved and coherent heart rhythm leads to measurable improvement in organizational performance, including heightened decision-making ability, quality of work, management and time efficiency.

A physiological state of entrainment, where HRV patterns, brain activity and respiration synchronize with each other, correlates with a state of peak performance. This same state is also associated with a reduction in stress-related symptoms, including tachycardia, tension and various aches and pains. These positive effects are best achieved during conditions of positive emotional management.

Various corporate-based studies have demonstrated that coherent heart rhythm with improved HRV profiles is associated with overall improvement in health and well-being (82%), reduced anger (62%), less worry (70%), less fatigue (87%) and feeling happier (68%). There was a 44% reduction in desire to leave the company and a 52% decrease in desire to quit the job. Listening skills improved 65%, decision-making ability increased 100%, efficiency increased 86% and creativity by 119% (Grove, 2000). These HRV-based studies report an increased capacity to recognize and manage stress and negative emotions, both in the workplace and outside it. Substantial reductions in items reflecting burnout and physical stress symptoms were also noted.

Recent scientific, medical and organizational research suggests that the turbulence of change and transformation and subsequent feelings of being overwhelmed, under-resourced, time pressured and stressed, substantially prevent individuals, teams and organizations from optimum performance. Research has also shown that a rise in physical symptoms is a leading indicator of productivity losses. For example, hypertension (high blood pressure) has been strongly linked with decreases in cognitive performance and memory loss.

There is now increasing evidence that the physical symptoms of stress are linked negatively to workplace effectiveness. Techniques that improve HRV in individuals have been shown to benefit organizations by increasing productivity, reducing health care costs, lowering absenteeism and improving retention. Pilot studies have shown that executives with stage 1 and 2 hypertension have been able to restore their blood pressure to normal without medication, by learning techniques that regulate their HRV.

It would seem that the heart is more powerful in improving one's ability to succeed than the mind. The heart as a source of electromagnetic energy is 40 to 60 times greater than the brain and carries intricate messages that affect people's emotions, physical health and quality of life. These can be measured up to 18 inches away from the body. Furthermore, the heart is an intelligent system that profoundly affects brain processing. This two-way communication between the heart and the brain directly affects perception, reaction speeds and decision-making ability.

We know that when people are off balance emotionally they often have impaired brain functions. Engendering appreciative thoughts and positive emotions not only has a beneficial impact on the sympathetic and parasympathetic nervous system balance, measured by Dantest® as ANS/HRV, but also provides the foundation to dramatically boost performance, without burning out in the process. Positive feelings, such as appreciation, progressively increase heart-brain synchronization and therefore create a healthier HRV profile. Workplaces known for caring, appreciative climates are more productive, encouraging greater retention and innovation. Whilst an attitude of frustration and anger is known to inhibit cortical function, and to produce incoherent heart rhythm signals, appreciative or caring attitudes are proved to enhance cortical function and produce ordered and coherent signals from the heart. There is an associated shift away from stress patterns to those that are more calm and balanced.

WORK STRESS

Work stress has been repeatedly associated with an increase in cardiovascular disease and especially where there is a lack of individual control.

Vagal tone was assessed as a possible determinant of work stress effects comparing HRV and model of work stress. High imbalance represents a combination of high effort and low reward at work. High over commitment on the other hand represents an exhaustive work-related coping style indexing the inability to unwind. Findings were adjusted for differences in posture and physical activity between the 2 work stress groups. High imbalance was associated with a higher heart rate during work, a higher systolic blood pressure during both work and leisure time and a lower vagal tone on all 3 days of measurement. Over-commitment was not associated with an unfavorable ambulatory profile. The study suggested that the detrimental effects of work stress are partly mediated by increased heart rate reactivity to a stressful day, an increase in systolic blood pressure, and lower vagal tone.

The effects of positive mood, negative mood, demand, satisfaction, demand-satisfaction ratio and time of day were correlated with HRV throughout the working day. Need for control had a negative effect on HF HRV after controlling for time of day effects i.e. subjects with a high need for control have lower vagal control of the heart. In the long run these subjects may be considered at increased health risk due to a reduction in the protective effects of vagal tone.

An increased risk of coronary heart disease has been described in shift workers. The exact mechanisms behind this increased risk are not well understood but it is possible that the unphysiological timing of physical activity and food intake in relation to circadian rhythms may be important. Lower values of HRV were present when a job task was performed at night compared with values obtained when the work was performed in the morning and evening. They suggested that the continuous weekly changes of time of maximum and minimum in the cardiac sympathetic and vagal autonomic control might play a role in the excessive rate of cardiovascular disease that has been described. Shift workers were also found to display significantly reduced standard deviations of HRV during sleep compared with those of daytime workers.

Competitiveness, as in sport (golf), suppresses HRV and this suppression was still evident 3 hours after competition. It may be that competitiveness at work may also reduce HRV, though there do not appear to be studies at this time that have addressed this possibility.

Workers reporting a high noise level at work compared with a low work noise level also displayed an elevated adjusted mean %LF during work.

HRV TRENDS IN PHYSICAL ILLNESS

Loss of normal autonomic nervous system control of heart rate and rhythm is now recognized to be an important risk factor for adverse cardiovascular events.

Significant high frequency decreases in HRV occurred from 60 minutes before ischemic events in male patients with stable coronary heart disease who had ambulatory ECG recording. Low frequency decreases began at 4 minutes before the ischemic event. It was also observed that ischemic events occurring at high mental activities were preceded by depressed high frequency HRV levels compared with events at low mental activity. It was concluded that autonomic changes consistent with vagal withdrawal can act as a precipitating factor for daily life ischemia and particularly in episodes triggered by mental activities.

On the basis of HRV studies it has been suggested that atrial fibrillation can be preceded by autonomic imbalances affecting either the sympathetic or parasympathetic divisions of the autonomic nervous system. Increased sympathetic activity is associated with lower ventricular fibrillation threshold and an increased risk of ventricular fibrillation, in contrast to increased parasympathetic activity, which protects the heart.

Migraine sufferers were divided into those with and those without disabling headaches. Disabled migraine cases had significantly reduced HRV compared with non-disabled migraine cases and controls ($p<0.01$). Whilst this apparent autonomic dysfunction may play a causal role the authors rightly concluded that this dysfunction could also be a consequence of frequent disabling headaches.

Patients with irritable bowel syndrome (IBS) and healthy controls were studied with HRV. In the supine position, the VLF (very low frequency) component of HRV was significantly higher. On changing from supine to standing normal subjects showed a raised VLF and LF, indicating raised sympathetic tone, whereas HF remained unchanged. Similarly IBS patients showed an increase in VLF and LF on standing up but the HF was also raised. On deep breathing normal subjects had a significant increase in HF with significant reduction in VLF and insignificant reductions in LF. In IBS subjects, HF remained constant while LF and VLF were reduced. In IBS the median sympatho-vagal outflow ratio was significantly lower in the standing position and higher in the deep breathing mode. In summary it would appear that IBS patients have reduced sympathetic influence on HRV in response to orthostatic stress and reduced parasympathetic modulation during deep breathing.

INTERVENTIONS SHOWN TO IMPROVE STRESS

Lifestyle rehabilitation (particularly smoking cessation and regular exercise) after myocardial infarction for 3 months has been shown to improve sympatho-vagal balance favourably with a shift towards higher parasympathetic tone. Furthermore, this favourable effect persisted after one year.

In older people greater physical fitness is associated with significantly higher total power and HF component of HRV measured at rest.

Emotional self-management skills and in particular emotional competence skills designed to intercept stressful responses and during emotionally challenging situations. Behavioral outcomes were assessed using the Achievement Inventory Measure. Following the program students exhibited significant improvements in stress and anger management, work management and focus, and relationships with family, peers and teachers.

These improvements were sustained over the ensuing 6 months. As compared to the control group, trained students demonstrated significantly increased HRV and more rhythmic sine-wave heart rhythm patterns during recovery. On the basis of this and other work the authors state that this physiological response pattern was due to increased parasympathetic activity and that this heart rhythm coherence is associated with improved cognitive performance, emotional balance, mental clarity and several positive health outcomes.

Relaxation states, as achieved by myofascial trigger point massage therapy to the head and neck was able to significantly increase the parasympathetic component of HRV. Controlled breathing, particularly that associated with abdominal breathing, has been demonstrated to increase HF power of HRV. Meditation reduces sympathetic and increases parasympathetic components of HRV. Immediately and one hour after listening to relaxing music for 20 minutes HF HRV was significantly increased and heart rate and respiratory rate were significantly decreased in patients who were hospitalized after acute myocardial infarction.

In summary, it is likely that an ability to control HRV could well alleviate negative mood states in people seeking assistance for inadequate stress responses, anxiety or depression. Since there is a clear association between negative mood states and heart disease the efficacy of any psychological intervention to reduce the risk of heart disease would be improved if it focused directly on improving autonomic nervous system imbalance characterized by SNS dominance and low HRV. Furthermore, since an increasing number of physical ailments appear to be associated with autonomic nervous system imbalance the potential application of HRV to monitor this balance is enormous.

DRUGS AND STRESS

Candesartan, the angiotensin II receptor antagonist, was found to have no effect on HRV after 4 weeks of treatment of patients with heart failure, at which time it did however have a significant blood pressure lowering effect (Vaile et al, 2001).

Tricyclic anti-depressants have been shown to reduce HRV, whereas the selective serotonin inhibitor, paroxetine, has been shown to normalise HRV (Gorman & Sloan, 2000).

In patients with decompensated heart failure (New York Heart Association functional class III and IV) beta-blockers significantly improved the HF component of HRV by 41% (Aronson & Burger, 2001).

Allopurinol at doses which are known to reduce oxidative stress, appeared to have no significant effect on resting autonomic tone, as indicated by time domain HRV or on dysrhythmia count in stable heart failure patients (Shehab et al, 2001).

The use of clozapine in schizophrenic patients is associated with significantly higher heart rate, lower HRV, higher LF and lower HF components of HRV compared with patients taking olanzapine or haloperidol (Cohen et al, 2001)

CONCLUSIONS

Taking all this research together we can make the following conclusions:

Stress, anxiety and depression are associated with reduced HRV, with sympathetic dominance and loss of vagal tone appearing to be the trend. This trend, with a loss of protective vagal tone, would explain the increased vulnerability to cardiovascular disease and sudden cardiac death that has been documented in these psychological states.

An increasing number of physical illnesses also appear to be associated with sympathetic dominance, reduced vagal tone and reduced HRV. This pattern does not seem to be a reaction to disease symptoms, but may be a contributing or predisposing factor to the underlying disease process. Vagal tone and the physiological processes that determine its efficiency clearly have a lot more do with vulnerability to disease than has previously been contemplated. It is likely that further study of the various frequency components of HRV will lead to much fruitful information on subtle physiological regulatory mechanisms that maintain health and on how the compromise of these regulatory processes may lead to disease processes.

The role of mood, emotions and thought processes (positivity and negativity) are often ignored or placed in the background when addressing an individual's well-being and recovery process. But more recent research, particularly involving HRV, is demonstrating the profound potential gain that can be achieved on the basic physiological regulatory processes that govern health by addressing an individual's emotional response and employing simple techniques to alter the negative thought processes that often accompany and color our responses to challenge and stress. Of course, we have always acknowledged the close interplay between mind and body, but HRV may yet prove to be the "simple" tool by which we can examine the interface and coherence between mind and body.