ORIGINAL RESEARCH

Emotional Stress, Heart Rate Variability, Grounding, and Improved Autonomic Tone: Clinical Applications

Gaétan Chevalier, PhD; Stephen T. Sinatra, MD, FACC, FACN, CNS

Abstract

Over the last few years, the utilization of integrative biophysics for medical application has been increasing in popularity. Grounding or earthing is the oldest and most basic form of natural bioelectric potential that supports physiological and electrophysiological changes in the body. Since previous investigations have shown that grounding profoundly affects skin conductance within seconds, we hypothesized that grounding may also improve heart rate variability (HRV).

In this study of 27 final participants, grounded subjects had improvements in HRV that go beyond basic relaxation ($P<.01$). Since improved HRV has such a positive impact on cardiovascular status, it is suggested that simple grounding techniques be utilized as a basic integrative strategy in supporting the cardiovascular system, especially under situations of heightened autonomic tone (ie, when the sympathetic nervous system is more activated than the parasympathetic nervous system).

Gaétan Chevalier, PhD, has a doctorate in engineering physics from the University of Montréal, Montréal, Québec, Canada. After working 4 years at UCLA as a spectroscopist in the field of plasma physics, he worked 10 years as professor and director of research at the California Institute for Human Science (Encinitas, California) where his research focus was electrophysiology. He is currently a visiting scientist in the Developmental and Cell Biology Department, University of California at Irvine, and a scientific consultant for Earth FX Inc in Palm Springs, California. Dr Chevalier has published more than 40 papers in peer-reviewed journals.

Stephen T. Sinatra, MD, FACC, FACN, CNS, is an assistant clinical professor of medicine at the University of Connecticut School of Medicine. He is a cardiologist and author of more than a dozen books and 20 peer-review medical articles. Dr Sinatra also writes a national monthly newsletter entitled *Heart, Health and Nutrition*.

Grounding or *earthing* is defined as placing one's bare feet on the ground (especially when humid or wet), whether it be dirt, grass, sand, or concrete. It is known that the earth maintains a negative electrical potential on its surface.[1,2] When in direct contact with the ground (walking, sitting, or lying down on the earth's surface), the earth's electrons are conducted to the human body, bringing it to the same electrical potential as the earth.[3,4] Living in direct contact with the earth grounds the body, inducing favorable physiological and electrophysiological changes that promote optimum health.[5] Regulation of circadian rhythms and improved sleep and nighttime cortisol dynamics reflect a few changes associated with favorable autonomic nervous system (ANS) function that can come about with grounding.[5,6]

The many unpredictable sociological, economic, and political events of the 21st century have increased the stress of modern living as compared to earlier and simpler times. As a result, more and more people live day-to-day in unrelenting states of heightened physiological arousal. These physiological states involve chronic over-activation of the ANS.

Situations that balance the over-stressed sympathetic limb of the autonomic nervous system also support the parasympathetic nervous system (PNS) and result in a decrease in sympathetic tone and improved clinical outcomes for stress. Interventions such as exercise, supplementation with omega-3 essential fatty acids, and medicating with supportive pharmaceutical agents (eg, beta blockers and angiotension-converting enzyme [ACE] inhibitors) all support the ANS.[7] (ACE inhibitors impede activation of the renin-angiotensin system and indirectly reduce sympathetic tone.[7]) Hence, when choosing antihypertensive pharmaceutical therapy, it is important to consider the drug's action on the ANS.

Since the ANS is linked to the stress response, previous investigations have demonstrated that grounded subjects experience a reduction in stress and a normalization of the ANS function[6,8] with improvements in electroencephalography (EEG), electromyography (EMG), and blood volume pulse (BVP).

Heart rate variability (HRV) refers to beat-to-beat alterations in heart rate. During resting conditions, the electrocardiogram (ECG) in normal individuals demonstrates periodic variation in R-R intervals (the R peak is the most visually obvious peak of the ECG). Such HRV measurements provide reliable, noninvasive information on the autonomic nervous system, including its vagal and sympathetic components.[9] Measurements of HRV were explored by our investigative team as a method to measure the ANS response in grounded and nongrounded participants.

Materials and Methods

Subjects

The health status of subjects was determined using the Health History Inventory (HHI).[10] The results presented in this paper are those of 28 relatively healthy subjects (48.11 ± 14.48; average age ± standard deviation [SD]). These subjects were equally divided among men and women: 14 men (45.43 ± 13.62, range 25-66), and 14 women (50.79 ± 15.32, range 26-78). Informed consent was obtained from all subjects prior to their participation. The Biomedical Research Institute of America provided Institutional Review Board supervision of the project (website: www.biomedirb.com).

Exclusion criteria were: 1) pregnancy; 2) age under 18 or over 80; 3) taking pain, antiinflammatory, sedative, or prescription sleeping medications (less than 5 days prior to testing); 4) taking psychotropic drugs or being diagnosed with mental disorder; 5) recent surgery (less than 1 year); 6) documented life-threatening disease (such as cancer, AIDS [acquired immune deficiency syndrome], etc); 7) consumption of alcohol within 48 hours of participation; and 8) use of recreational drugs. Past pilot projects suggested that the resulting relatively healthy subjects may be more responsive to short-term grounding.

Grounding System

Four transcutaneous electrical nerve stimulation (TENS) type adhesive electrode patches were placed on subjects, 1 on the sole of each foot and 1 on each palm. Wires from a standard electrostatic discharge ground system were snap-attached to the electrode patches and connected to a box (see Figure 1). The grounding system itself consisted of a 100-foot long (30.48 m) ground cord connected to the box on 1 end and attached to a 12-inch (30.48 cm) stainless steel rod planted in the earth outdoors at the other end.

Figure 1. Grounding system showing patches, wires, and box connecting to a ground rod planted outside through a switch (not shown) and a fuse (not shown). Similar patches and wires from the hands were also connected to the box to ground the hands.

Experimental Procedure and Study Design

After the consent form was signed and the HHI showed compliance with respect to the exclusion criteria, the subject was asked to sit in a comfortable reclining chair in the experiment room.

Participants served as their own controls. Each subject's data from a 2-hour session, of which 40 minutes were grounded, was compared with another 2-hour session when not grounded (nongrounded, conducted as a sham-grounded session). The sequence of grounding vs sham-grounding sessions was assigned randomly. This randomization process was designed to ascertain that the measured effects were due to grounding and not to artifacts produced by sitting in the same position for 2 hours.

Grounding session order for all subjects was determined prior to the beginning of testing. After a subject was seated in the reclining chair and electrode placement and equipment function was verified, the session was started. First a 40-minute segment was recorded with the switch not flipped. This baseline measurement was long enough to allow the signal to stabilize. Next the switch was flipped on, which resulted in the experimental subjects being grounded for 40 minutes. At the end of the 40 minutes of grounding, the switch was flipped off and the equipment continued to record for another 40 minutes, after which the session was ended (a total of 3 x 40 minutes = 120 minutes or 2 hours).

For all sessions (grounded and nongrounded) and for all subjects, the switch was flipped on and off at the same time (40 minutes after the start of the session for the "on" position and 40 minutes later for the "off" position). The assistant in charge of replacing the fuse was the only person during the entire experiment to know which session was the control and which was the grounding session for each subject.

Subjects were not allowed to leave the laboratory premises for the entire 2-hour experiment and lunch or a snack was provided. Subjects received instructions to relax and rest. Falling asleep was permitted but meditation was not allowed.

Results

The HRV parameters calculated from electrocardiogram recordings during the study were as follows:

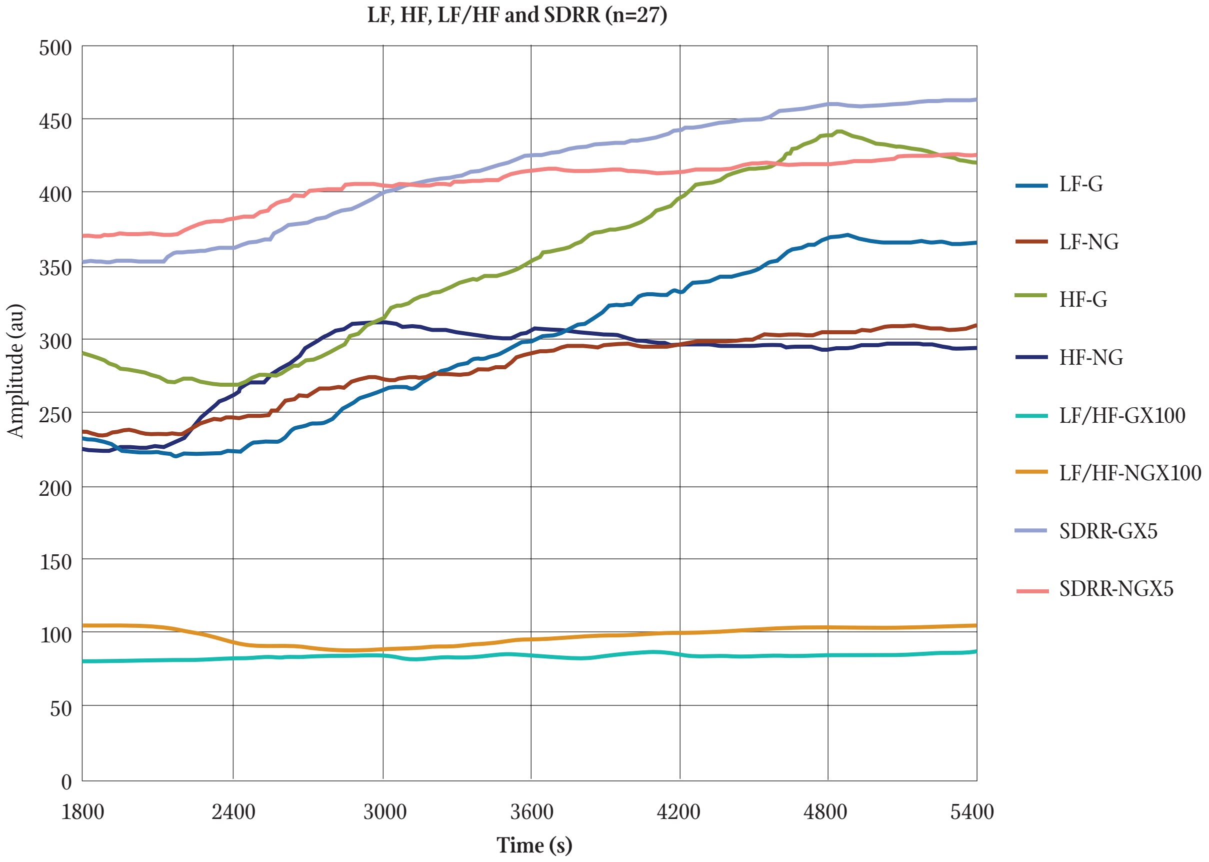
- the standard deviation of R-R intervals (SDRR, standard deviation of R peak to R peak intervals, also known as standard deviation of normal to normal intervals or SDNN);
- 3 spectral components of the power spectrum density (PSD, the square of the Fast Fourier Transform of the R-R intervals): low frequencies (LF), high frequencies (HF), and very low frequencies (VLF);
- the ratio LF/HF.

These parameters were automatically calculated according to the task force recommendations.[11]

Recordings of the average values and standard deviations for 27 subjects are shown in graphic representations in Figure 2 (1 subject could not be included because the grounded period lasted 55 minutes, 15 minutes longer than the other subjects). From this figure, it is clear that there is a change in slope at grounding and again at ungrounding for HF, LF, and SDRR averages values (even though less pronounced for SDRR) that is not seen in the corresponding recordings when the subjects served as controls (nongrounded). This pattern is also seen for standard deviations, but these results are not shown in Figure 2 for clarity of presentation. At grounding, the slope changes from negative to positive and the opposite happens at ungrounding.

Since PNS activity is the major contributor to the HF component of HRV,[11] a decrease in PNS function is seen in Figure 2 before grounding (HF-G, green line), which reverses and starts to increase after grounding. This increase continues for the entire 40 minutes of the grounding period and reverses back to pregrounding condition after ungrounding.

The nongrounded group HF average values recording presents a small increase after the 2200th second from the beginning of the session, stabilizing about 10 minutes after that (at 2800



Key: LF=low frequencies, HF=high frequencies, SDRR=standard deviation of R-to-R peak intervals, G=grounded, NG=not grounded, X100=values multiplied by 100, X5=values multiplied by 5, (s)=seconds

Figure 2. Grounded and non-grounded group results (n=27 subjects). Average amplitudes and standard deviations of LF, HF, LF/HF, and SDRR for a 1-hour window of the 2-hour session, starting 30 minutes (1800 s) after the beginning of the session, ending 1 hour later (at 5400 s). Grounding (or sham-grounding for the control group) occurred 40 minutes (2400 s) and ungrounding (or sham ungrounding for the control session) 80 minutes (4800 s) after the start of the session.

seconds). This can be interpreted as an increase in relaxation, which remained relatively steady for the rest of the session. This increase in HF is small compared to that of the grounded group.

At the end of both 40-minute periods, HF increased by 33% for the nongrounded group compared to an increase by 63% for the grounded group—about double the increase of the nongrounded group. The increase in HF standard deviation during the grounding period (not shown, but which shows a similar pattern as HF) suggests an increase in vagal variability that started to reverse after ungrounding.

The meaning of LF is less clear. The general consensus is that both the sympathetic nervous system (SNS) and the PNS contribute to LF.[11] However, according to Perini,[12] LF could be used as a marker of SNS function while monitoring the change from supine position (predominantly dominated by PNS) to sitting position (predominantly dominated by SNS) for healthy people in normal conditions. Since our subjects were healthy and in supine position, we presume that LF in our case is also predominantly related to the PNS. This hypothesis is confirmed by the fact that the LF graph in Figure 2 (LF-G, the cornflower blue line) shows similar tendencies as HF (HF-G, green line). At the end of the 40-minute periods, LF increased by 28% for the nongrounded group (LF-NG, red line) and by 68% for the grounded group—a little more than double the nongrounded group increase.

SDRR is recognized as a parameter representing total power; ie, it includes contributions from all frequencies present in the recording.[11] As such, it contains contributions from both SNS and PNS. However, because for short recordings HF and LF are the major components of SDRR (the other, smaller component being VLF) and the fact that they mainly represent the PNS for healthy subjects in supine position, a similar conclusion as for HF and LF can be drawn, namely that the most important contribution to SDRR comes from the PNS. At the end of the 40-minute periods, SDRR increased by 20% for the nongrounded group and by 50% for the grounded group.

The LF/HF ratio in Figure 2 reveals that the changes in LF and HF during grounding were virtually the same so that there was no change in their ratio. In fact that line for the grounded group is even more flat than it is for the nongrounded group. The fact that LF/HF is so perfectly flat during grounding supports our presumption that the change in LF was due to the same cause as for HF, namely dominance of the PNS over the SNS.

Statistical tests were performed to determine differences in means and in variances before and after grounding (or sham-grounding for control sessions) and between the grounded and nongrounded sessions. In order to retain the normality of our data, periods selected for statistical tests were:

- the last 10 seconds before grounding (or sham-grounding for control sessions)
- the last 10 seconds at the end of the 40-minute grounding period (or sham-grounding period for control sessions).

To compare difference in means, *t*-tests were used, while F-tests were used to compare difference in variances. Since there were statistically significant differences before grounding between the groups we repeated the statistical tests after normalizing the data so that the means before grounding were the same for both groups. Sixteen means and their standard deviations were computed (4 parameters: SSDR, LF, HF, and LF/HF, before and after grounding for the grounded and sham-grounded groups) and used to perform a total of 40 *t*-tests (5 *t*-tests per parameter repeated for normalized groups) and 40 F-tests. All *t*-tests comparisons were significant at $P< .01$ or better.

These results mean, for example, that the mean amplitude for the last 10 seconds of grounding was statistically larger compared to the last 10 seconds of sham-grounding. This difference was true also for F-tests and for all parameters tested (LF, HF, SDRR, and LF/HF). The only exception was the F-test comparing LF/HF variances before and during grounding for the grounded session, which was not significant, meaning the variance of LF/HF did not change during grounding.

The conclusion of these statistical tests is that for LF, HF, SDRR, and LF/HF, the means and variances before and during grounding (or sham-grounding for control sessions) were significantly different (with 1 exception) and that was also true for comparisons between sessions. We conclude that there were real effects changing both the means and variances over time. For the sham-grounded group, this effect was primary relaxation, while for the grounded group, an additional effect on the PNS due to grounding was observed. It is worth noting that this additional effect due to grounding was at least as important as the effect due to relaxation alone.

In summary, the PNS function increased about twice as much in the grounded group as compared to the nongrounded group at the end of the 40-minute grounding or sham-grounding periods. Also, there was a continuous increase in their SDs that was not present (or small) for the nongrounded group, which points to an increase in the vagal nerve variability. Combined, these results indicate that grounding produced an improvement in HRV that is beyond simple relaxation.

Discussion

Heart Rate Variability

The characteristics of a healthy ANS include intact HRV as well as normal baroreflex sensitivity (reflex-mediated changes in heart rate that respond to fluctuations in venous return such as those noted upon supine and standing conditions).[7] Altered cardiac autonomic tone determined by HRV represents one of the most interesting explanations of sympathico-vagal imbalance due to an excessive cardiac sympathetic situation and/or inadequate cardiac parasympathetic tone.

Excessive sympathetic stimulation and/or diminished vagal tone are markers of a stressed cardiovascular system. There are multiple situations that contribute to sympathetic activities including physical, emotional, behavioral, and pharmaceutical factors (see Table 1). Chronic sympathetic hyperactivity increases cardiovascular hemodynamics and predisposes to endothelial dysfunction, coronary spasm, left ventricular hypertrophy, and cardiac arrhythmia.[13]

Table 1. **Factors Contributing to Chronic Sympathetic Activation**

Environmental conditions
Air pollution: Ambient particulate matter <10 micron (PM (10))

Health conditions
- Obesity
- Insulin resistance, diabetes, or metabolic syndrome
- Hypertension
- Depression, anxiety
- Congestive heart failure
- Sleep apnea

Psychosocial and behavioral conditions
- Chronic stress
- Social isolation and loneliness
- Hostility, anger, or rage
- Smoking
- Sleep deprivation
- Sugar-laden diet
- Sedentary lifestyle
- Abuse of stimulants

Pharmaceutical drugs
- Short-acting calcium channel blockers
- B-agonist bronchodilators
- Peripheral alpha blockers

Increased vagal tone exerts a protective effect in a setting of ischemia and arrhythmia.[14] Predictive associations between reduced HRV and increased mortality after an acute myocardial infarction have been documented,[15-17] HRV represents one of the most promising evaluation tools for risk stratification of cardiac patients. Reduced HRV and an increase in the incidence of coronary heart disease and subsequent cardiovascular events have often been determined in community-based populations.[18] HRV imbalance reflecting autonomic dysfunction and the severity of progression of coronary artery disease has been repeatedly demonstrated in clinical investigations.[18,19]

For decades, the relationship between ANS dysfunction and sudden cardiac death (SCD) resulting from lethal cardiac arrhythmias has spurred considerable interest in terms of determining the degree of parasympathetic tone and/or reduced vagal activity.[11,20] Thus, HRV has become a reliable clinical tool in investigating not only survival after myocardial infarction but also in predicting sudden death in patients with myocardial infarction independent of other prognostic indicators such as left ventricular dysfunction.

A recent statement by the American College of Cardiology on risk-stratification techniques for identifying patients at risk for SCD acknowledges that limited data exists to link diminished short-term HRV to SCD and is less reproducible in patients with congestive heart failure.[20,21] Nonetheless, short-term HRV has reproducibility in normal subjects and therefore has important clinical applications.[21] HRV studies will improve our understanding of physiological situations involving the actions of medications and disease mechanisms[11] as well as yield valuable information in population studies.[22]

Since reduced HRV appears to be a marker of cardiovascular disease, it makes sense not only to understand its clinical applications but also to utilize interventions to support or improve HRV, which will help reduce the likelihood of cardiac events. An outstanding review of autonomic tone as a cardiovascular risk factor was reported by Curtis and O'Keefe, Jr, in the Mayo Proceedings.[7] In their conclusion, they urged clinicians to develop an increased awareness of the effect of various therapies on autonomic function and to carefully consider the risks involved before prescribing medications with sympathomametic effects such as short-acting calcium channel blockers and beta-agonist bronchodilators.

They suggest placing greater emphasis on interventions that support autonomic function such as regular, moderate-intensity exercise, beta blockers, and ACE inhibitors, all of which have been shown to improve autonomic function and outcomes in patients with cardiovascular disease.[7]

Omega-3 fatty acids also demonstrate a reduction in the risk of SDC and improved clinical outcomes for the same patients with higher intake either from their diet[23] or supplements.[24]

Among the host of interventions to improve autonomic function (see Table 2), we would like to add grounding as a simple, cost-effective, and noninvasive intervention.

Table 2. Interventions to Improve Autonomic Function

Modalities
Grounding to the earth
Lifestyle modifications
Exercise
Social support
Religiosity or faith
Meditation, yoga, tai chi, and/or qi gong
Restoration of normal sleep
Weight loss
Smoking cessation
Stress reduction, biofeedback
Medications
Beta-blockers
Angiotensin-converting enzyme inhibitors
Omega-3 fatty acids

Conclusion

When one grounds to the electron-enriched earth, an improved balance of the sympathetic and parasympathetic nervous system occurs. Previous investigations reported a marked change in biological parameters after about 20 to 30 minutes, others in several days, and a few others show a drastic change immediately at grounding (<2 sec). Skin conductance and electroencephalographic and electromyographic recordings showed the most immediate and profound changes.[6,8] This study showed a positive trend in HRV that kept improving all the way to the end of the 40-minute period of grounding, suggesting a greater benefit with time.

In patients who experience anxiety, emotional stress, panic, fear, and/or symptoms of autonomic dystonia, including headaches, cardiac palpitations, and dizziness, grounding could be a very realistic therapy. These patients may see positive effects most likely within 20 to 30 minutes and in almost all cases in 40 minutes.

Negative emotions such as panic,[25] depression,[26] anxiety,[27] and hostility[28] have all demonstrated reduced HRV. Grounding has the potential to help support HRV, reduce excessive sympathetic overdrive, balance the ANS, and, thus, attenuate the stress response. This has important prognostic considerations especially because an association between depression and increased risk of cardiovascular events has been repeatedly observed in both the healthy population and patients with established cardiovascular disease.[26]

Future studies are warranted in utilizing grounding to help assuage the chronically over-stimulated sympathetic nervous system in patients with cardiovascular disorders. Such prospective studies should also include subjective measurements of perception of anxiety, depression, obsessive ruminations related to distressors, and perceived levels of stress.

In the setting of acute or chronic sympathetic overdrive, grounding the body to nature, as well as employing conventional medical care when appropriate, is a logical and ethical integrative intervention that will help to support positive clinical response and possibly outcome as well.

References

1. Anisimov SV, Mareev EA, Bakastov SS. On the generation and evolution of aeroelectric structures in the surface layer. *J Geophys Res*. 1999;104(D12):14,359-14,367.
2. Williams E.R., Boccippio D.J., Susskind J., Anyamba E., Sentman D.D., Bold R. What lightning type dominates the excitation of Schumann resonances. IUGG XXI General Assembly. Boulder, Colorado: July 1995.
3. Callahan PS, Kornberg H, inventors; Photonic ionic cloth radio amplifier. United States Patent 5,247,933. September 28, 1993.
4. Feynman RP, Leighton RB, Sands ML. *The Feynman Lectures on Physics*. Reading, MA: AddisonWesley Publishing Co; 1963.
5. Ghaly M., Teplitz D. The biological effects of grounding the human body during sleep, as measured by cortisol levels and subjective reporting of sleep, pain, and stress. *J Altern Complement Med*. 2004;10(5): 767-776.
6. Chevalier G, Mori K, Oschman JL. The effect of earthing (grounding) on human physiology. *Eur Biol Magn.* 2006;2(1):600-621.
7. Curtis BM, O'Keefe JH Jr. Autonomic tone as a cardiovascular risk factor: the dangers of chronic fight or flight. *Mayo Clin Proc*. 2002;77(1):45-54.
8. Chevalier G. Changes in pulse rate, respiratory rate, blood oxygenation, perfusion index, skin conductance and their variability induced during and after grounding human subjects for forty minutes. *J Altern Complement Med*. 2010;16(1):81-87.
9. Kleiger RE, Bigger JT, Bosner MS, et al. Stability over time of variables measuring heart rate variability in normal subjects. *Am J Cardiol*. 1991;68(6):626-630.
10. American Council on Exercise. Health History Inventory Form. ACE Fitness. http://www.acefitness.org/acestore/p-369-health-history-inventory-form.aspx. Accessed May 11, 2011.

11. No authors listed. 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. *Circulation*. 1996;93(5):1043-1065.
12. Perini R, Veicsteinas A. Heart rate variability and autonomic activity at rest and during exercise in various physiological conditions. *Eur J Appl Physiol*. 2003;90(3-4):317-325.
13. Metra M, Nodari S, D'Aloia A, Bontempi L, Boldi E, Cas LD. A rationale for the use of β-blockers as standard treatment for heart failure. *Am Heart J*. 2000;139(3):511-521.
14. Iellamo F, Legramante JM, Massaro M, Raimondi G, Galante A. Effects of residential exercise training on baroreflex sensitivity and heart rate variability in patients with coronary artery disease: a randomized, controlled study. *Circulation*. 2000;102(21):2588-2592.
15. Kleiger RE, Miller JP, Bigger JT, et al. Decreased heart rate variability and its association with increased mortality after acute myocardial infarction. *Am J Cardiol*. 1987;59(4):256-262.
16. Ewing DJ. Heart rate variability: an important new risk factor in patients following myocardial infarction. *Clin Cardiol*. 1991;14(8):683-685.
17. Bigger JT, Fleiss JL, Rolnitzky LM, Steinman RC. The ability of several short-term measures of RR variability to predict mortality after myocardial infarction. *Circulation*. 1993;88(3):927-934.
18. Kupari M, Virolainen J, Koskinen P, Tikkanen MJ. Short term heart rate variability and factors modifying the risk of coronary artery disease in a population sample. *Am J Cardiol*. 1993;72(12):897-903.
19. Huikuri HV, Jokinen V, Syvanne M, et al. Heart rate variability and progression of coronary atherosclerosis. *Arterioscler Thromb Vasc Biol*. 1999;19(8):1979-1985.
20. Goldberger JJ, Cain ME, Hohnloser SH, et al. American Heart Association/ American College of Cardiology Foundation/ Heart Rhythm Society Scientific Statement on Noninvasive Risk Stratification Techniques for Identifying Patients at Risk for Sudden Cardiac Death: A Scientific Statement From the American Heart Association Council on Clinical Cardiology Committee on Electrocardiography and Arrhythmias and Council on Epidemiology and Prevention. *J Am Coll Cardiol*. 2008;52(14):1179-1199.
21. Sandercock GR, Bromley PD, Brodie DA. The reliability of short-term measurements of heart rate variability. *Int J Cardiol*. 2005;103(3):238-247.
22. Sinnreich R, Kark JD, Friedlander Y, Sapoznikov D, Luria MH. Five minute recordings of heart rate variability for population studies: repeatability and age-sex characteristics. *Heart*. 1998;80(2):156-162.
23. Sellmayer A, Witzgall H, Lorenz RL, Weber PC. Effects of dietary fish oil on ventricular premature complexes. *Am J Cardiol*. 1995;76(12):974-977.
24. No authors listed. Dietary supplementation with n-3 polyunsaturated fatty acids and vitamin E after myocardial infarction: results of the GISSI-Prevenzione trial. *Lancet*. 1999;354(9177):447-455.
25. Yeragani VK, Pohl R, Berger R. Decreased heart rate variability in panic disorder patients: a study of power-spectral analysis of heart rate. *Psychiatry Res*. 1993;46(1):89-103.
26. Carney RM, Freedland KE. Depression and heart rate variability in patients with coronary heart disease. *Cleve Clin J Med*. 2009;76(Suppl 2):S13-S17.
27. Kawachi I, Colditz GA, Ascherio A, et al. Prospective study of phobic anxiety and risk of coronary heart disease in men. *Circulation*. 1994;89(5):1992-1997.
28. Sloan RP, Shapiro PA, Bigger JT Jr, Bagiella E, Steinman RC, Gorman JM. Cardiac autonomic control and hostility in healthy subjects. *Am J Cardiol*. 1994;74(3):298-300.