

**EXPLORATIONS OF THE TREATMENT OF PAIN  
WITHIN IN AN INTEGRATIVE MEDICINE MODEL**

**by**

**Donnalee Ruth Forbes**

**A Thesis Presented in Partial Fulfillment  
of the Requirements for the Master Degree  
in Integrative Holistic Health  
Concentration: Biophysics**

**Energy Medicine University**

**October 2015**

**EXPLORATIONS OF THE TREATMENT OF PAIN  
WITHIN IN AN INTEGRATIVE MEDICINE MODEL**

by

Donnalee Ruth Forbes

October 2015

Approved:

Beverly Rubik, PhD., Committee Chair

James Oschman, PhD., Committee Member

Accepted and signed: \_\_\_\_\_  
Beverly Rubik, PhD. Date

Accepted and signed: \_\_\_\_\_  
James Oschman, PhD. Date

In presenting this thesis in partial fulfillment of the requirements for the Master Degree at Energy Medicine University, I agree that the Library shall make its copies freely available for inspection. I further agree that extensive copying of this dissertation is allowable only for scholarly purposes, consistent with “fair use” as specified in the U.S. Copyright Law. Requests for copying or reproduction of the dissertation may be referred to Energy Medicine University, Sausalito, California, 94965, USA, to whom the author has granted “the right to reproduce and sell (a) copies of the manuscript in electronic form and/or (b) printed copies of the manuscript made from the electronic form. The work reported in this dissertation is original and carried out solely by me, with the exception of assistance and direction gratefully received by professors and colleagues in order to produce the best end result.

Copyright by Donnalee Ruth Forbes, 2015

All Rights Reserved

## TABLE OF CONTENTS

### CHAPTER 1 – INTRODUCTION

<b>Introduction .....</b>	<b>1</b>
<b>Background .....</b>	<b>2</b>
<b>Definitions of pain in the United States.....</b>	<b>2</b>
<b>Demographics of pain in the United States .....</b>	<b>3</b>
<b>Economics of pain in the United States .....</b>	<b>4</b>
<b>Treatment options of chronic pain in the United States .....</b>	<b>5</b>
<b>Summary.....</b>	<b>6</b>

### CHAPTER 2 – LITERATURE REVIEW

<b>Introduction .....</b>	<b>12</b>
<b>Historical and Theoretical Overview of Integrative Medicine .....</b>	<b>12</b>
<b>Integrative Medicine in the Chronic Pain Population .....</b>	<b>19</b>
<b>Biomarker – Historical and Theoretical Overview of Heart Rate Variability. ....</b>	<b>23</b>
<b>Heart Rate Variability in the Chronic Pain Population.....</b>	<b>27</b>
<b>Biomarker – Historical and Theoretical Overview of Cortisol .....</b>	<b>34</b>
<b>Cortisol in the Chronic Pain Population .....</b>	<b>36</b>
<b>Modality – Historical and Theoretical Overview of Bowenwork® .....</b>	<b>41</b>
<b>Bowenwork in the Chronic Pain Population .....</b>	<b>44</b>
<b>Modality – Historical and Theoretical Overview of PEMF devices .....</b>	<b>47</b>
<b>Earth Pulse in the Chronic Pain Population .....</b>	<b>53</b>
<b>Modality - Historical and Theoretical Overview of Earthing .....</b>	<b>56</b>
<b>Earthing in the Chronic Pain Population .....</b>	<b>61</b>
<b>Summary .....</b>	<b>77</b>

**CHAPTER 3 – CRITIQUE**

**CHAPTER 4 - SUMMARY**

**REFERENCES**

**APPENDIX**

**Definitions**

## CHAPTER 1: INTRODUCTION

The Institute of Medicine (IOM) of the National Academy of Sciences identified pain as a primary healthcare problem in the United States in their 2011 publication *Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research* (Pizzo, 2011). Pain is an escalating problem affecting 100 million U.S. adults. The IOM report highlighted the growing problem of safe and effective short-term and long-term treatment options within this heterogeneous population. In America the use of Complementary and Alternative Medicine (CAM) modalities is increasing both within the general population and within the pain population. Despite the growing use of CAM modalities, research on CAM effectiveness for pain conditions is incomplete, and research remains controversial and underfunded (Pizzo, 2011).

As CAM modalities have gained popularity, the Integrative Medicine (IM) model has burgeoned. IM represents the merger of the conventional biomedical model and CAM modalities into a systems perspective with a focus on wellness, holistic treatment and *Patient-Centered Care*. This systems perspective focus approaches *stress*<sup>1</sup> as having detrimental effects on the body that can be seen in various physiological and biochemical markers. The term *allostatic load* was first coined by Bruce McEwen and Elliott Stellar in 1993. By definition allostatic load is “the long-term results of failed adaptation or allostasis, resulting in pathology and chronic illness” (McEwen & Stellar, 1993), or simply put the accumulative effects of stress. Allostatic load results in the dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, sympathetic nervous system and the immune system. Two such *biomarkers*<sup>2</sup> of stress are *heart*

---

<sup>1</sup> The definition of this word is found in the Appendix section Definitions

<sup>2</sup> The definition of this word is found in the Appendix section Definitions

*rate variability*<sup>3</sup> and circadian *cortisol*<sup>4</sup>. Heart rate variability provides a quantitative measurement evaluating the sympathetic nervous system. Circadian cortisol provides a quantitative measurement evaluating the HPA axis. Reviewing literature on chronic pain and treatment modalities through the lens of allostatic load, a systems perspective, is consistent with the philosophical shift in IM.

This chapter provides a brief description of attributes of the chronic pain syndrome in the United States, discussing the background, demographics and economics.

## **Background**

### **Definitions of pain in the United States**

In the introduction to *Relieving Pain in America* the authors provide the definition of pain from The International Association for the Study of Pain:

An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. . . . Pain is always subjective. . . . It is unquestionably a sensation in a part or parts of the body, but it is also always unpleasant and therefore also an emotional experience. (Pizzo, 2011, p. 25)

They state they used this definition as it diverged from the strictly physical and biological definition, and encompassed the critically significant emotional and psychosocial factors (Pizzo, 2011).

Chronic pain differentiated from generalized pain was further defined by the United States Army Surgeon General's Pain Management Task Force (PMTF) as:

---

<sup>3</sup> The definition of this word is found in the Appendix section Definitions

<sup>4</sup> The definition of this word is found in the Appendix section Definitions

Chronic pain continues beyond the normal time expected for healing and is associated with the onset of pathophysiologic changes in the *central nervous system*<sup>5</sup> that may adversely affect an individual's emotional and physical well-being, cognition, level of function and quality of life. Chronic pain serves no apparent useful purpose for the individual and may be diagnostically and therapeutically approached as a chronic disease process. It cuts across the boundaries of mind, brain and body, resulting in a common symptomatic and functional spectrum of physical, cognitive, psychological and behavioral effects. Chronic pain can be described as ongoing or recurrent pain, lasting beyond the usual course of acute illness or injury or more than 3 to 6 months, and which adversely affects the individual's well-being. A simpler definition for chronic or persistent pain is pain that continues when it should not. (Delgado, 2014, p. S11)

Patients who fail successful pain management with a primary care provider are often referred to secondary care pain centers. This can be due to complexities such as comorbidities, as well as patients considered high risk for addiction and suicide (Pizzo, 2011).

### **Demographics of pain in the United States**

The medical specialty of Pain Management has been experiencing rapid growth in recent years (Asher, 2013). In 2006 the Center for Disease Control and Prevention (CDC) published its annual Chartbook on Trends in the Health of Americans. Within this report was a special report on pain. It stated, "Pain affects physical and mental functioning, affects quality of life, reduces productivity, and is a major reason for health care utilization" (CDC, 2006, p. iii). The report detailed the percentage of increases in reported pain, the percentage of increase in the use of narcotics, and the increases in specific types of pain to include migraine or headaches, generalized muscular pain, low back pain and joint pains all within various ethnic and age

---

<sup>5</sup> The definition of this word is found in the Appendix section Definitions

groups. It states that between 1999 and 2002 more than a quarter of Americans reported having problems with pain (CDC, 2006, p. 13). Graphs and charts provided detailed information within age groups. In 2011 the IOM report updated this information stating that the number of Americans affected with pain was estimated to be 100 million, (Pizzo, 2011). As a point of reference the American Academy of Pain Medicine (AAPM) provided the number of patients during this same period under treatment for coronary disease was 16.3 million, cancer was 11.9 million and diabetes was 25.8 million (AAPM, 2013).

### **Economics of pain in the United States**

Two health economists at John Hopkins University (JHU) detailed the economic costs of pain in the 2012 publication “The economic costs of pain in the United States” (Gaskin & Richard, 2012). Using the 2008 Medical Expenditure Panel Survey the authors converted costs into the year 2010 equivalent dollars. Patients with moderate pain had an increase of \$4,516 and patients with severe pain had an increase of \$7,726 in healthcare costs when compared to someone with no pain (Gaskin, 2012). They found that “the total annual costs of pain ranged from \$560 to \$635 billion” (Gaskin, 2012, p. 723). The authors believed their figures were conservative as they did not include costs for individuals with pain in institutionalized settings to including nursing home residents, military personnel and incarcerated persons, nor did they include children (Gaskin, 2012). The JHU report found the cost of chronic pain exceeded the annual costs of heart disease (\$309b), cancer (\$243b) and diabetes (\$188b).

The economic costs above did not disclose the full costs of chronic pain to the society at large. These costs were illustrated in an AAPM report:

Millions suffer from acute or chronic pain every year and the effects of pain exact a tremendous cost on our country in health care costs, rehabilitation and lost worker

productivity, as well as the emotional and financial burden it places on patients and their families. The costs of unrelieved pain can result in longer hospital stays, increased rates of rehospitalization, increased outpatient visits, and decreased ability to function fully leading to lost income and insurance coverage. As such, patient's unrelieved chronic pain problems often result in an inability to work and maintain health insurance. (AAPM, 2013)

Further details of societal costs were also reported within *Relieving Pain in America*.

The findings of their report revealed:

Chronic pain is a significant public health problem that costs society at least \$560-\$635 billion annually, an amount equal to about \$2,000.00 for everyone living in the U.S. This includes the total incremental cost of health care due to pain ranging between \$261 to \$300 billion and \$297-\$336 billion due to lost productivity (based on days of work missed, hours of work lost, and lower wages. (Pizzo, 2011, p. 159)

### **Treatment options of chronic pain in the United States**

Treatment options for chronic pain patients were discussed in chapter three of *Relieving Pain in America* titled "Care of People with Pain" (Pizzo, 2011). Options included medications, anesthetic interventions, surgery, psychological therapies, rehabilitative or physical therapy, and Complementary and Alternative Medicine (CAM). Of note medication options for treatment include numerous classifications of medications from the simple aspirin to nonsteroidal anti-inflammatory medications, adjuvant nonsteroidal medications, and narcotics. Anesthetic intervention included epidural steroid blocks and medial branch blocks. The options of psychological, rehabilitative and CAM therapies were reported with mention being given to massage, chiropractic, acupuncture, magnets and yoga. Limitations of conventional treatment

included the lack of long-term gains with injection blocks, side effects of analgesics and abuse of opioid medications. The risks involved with opioid treatments was reviewed in “Systematic Review: Opioid Treatment for Chronic Back Pain” (Martel, et al., 2007). They stated,

Opioids are commonly prescribed for chronic pain and may be efficacious for short-term pain relief. Long-term efficacy is unclear. Substance use disorders are common in patients taking opioids for back pain, and aberrant medication-taking behaviors occur in up to 24% of the cases.... Prevalence rates of lifetime or current substance use disorders varied, with estimates up to 56%. (Martel, 2007, p. 123)

### **Summary**

The IOM report *Relieving Pain in America* references the National Center for Complementary and Alternative Medicine (NCCAM) survey that revealed pain is a “common complaint presented to CAM practitioners” (Pizzo, 2011, p. 134). The review article by Wells, et al. in 2010 references surveys that found 44% of patients with neurological pain sought assistance with CAM practitioners, CAM use is higher in patients with chronic conditions and it is used when conventional treatments fail (Wells, 2010). The results of a 2002 survey revealed 60% of back pain patients who sought care from CAM practitioners reported a *great deal* of relief (Kanodia, 2010). The chronic pain population is not a heterogenous group. This segment of the population tends to be of lower socioeconomic strata with limited to no discretionary income (CDC, 2006). Obstacles to receive complementary treatments include the lack of Medicaid, Medicare or other insurance reimbursement for CAM modalities. Existing limitations within CAM modalities include the lack of clarity as to efficacy of different treatments for differential diagnoses. This lack of clarity compounds the issue for the failed chronic pain patient. Additionally, CAM treatments’ nonlinear

dynamic systems responses or holistic responses are not addressed. This continues to fuel the debates of CAMs effectiveness.

The JHU and the AAPM reports both provided information regarding the socioeconomic impact of chronic pain in this country. The JHU figures revealed estimated healthcare costs in 2010 dollar equivalents were an increase of \$4,516 for patients with moderate pain and an increase of \$7,726 for patients with severe pain when compared to someone with no pain (Gaskin, 2012). The number of patients under treatment for chronic pain was estimated to be 100 million. During this same time period the AAPM figures revealed the number of patients under treatment for coronary disease was 16.3 million, cancer was 11.9 million and diabetes was 25.8 million (AAPM, 2013).

The IOM report *Relieving Pain in America* acknowledged pain is an endogenous mechanism that acts as a warning sign to protect an individual from further harm. Pain is part of the human condition. Chronic pain as defined by The United States Army Surgeon General's Pain Management Task Force is pain that "continues beyond the normal time expected for healing" and "serves no apparent useful purpose for the individual..." (Delgado, 2014, p. S11). The patients seen in secondary pain centers have failed treatment at the primary care level. As noted by H. Flor (1992), chronic back pain patients seen in secondary pain centers had an average of eighty-five months of unrelenting pain. The IOM committee was charged, "to increase the recognition of pain as a significant public health problem in the United States" (Pizzo, 2011, p. 2).

As patients failed to find relief within the biomedical model they sought treatment with CAM modalities, often without the knowledge of their primary providers. Surveys of patients receiving CAM treatment revealed 60% reported improvement in their symptoms (Kanodia,

2010). The IM shift in philosophy from treatment of disease to the promotion of wellness, to mitigate disease symptoms offers one option in the treatment of this failed population. This model offers transparency and integration of both allopathic and alternative medicine with a focus on the person as a whole.

The Literature Review of this paper provides the theoretical background in support of an IM philosophical shift, and the use of biomarkers to assess wellness changes and modalities that may provide support for patients on their journey towards wellness.

## CHAPTER 2: LITERATURE REVIEW

Although the field Integrative Medicine (IM) recently came to the fore, its roots can be traced to the discoveries and published works of physiologist Walter Cannon and endocrinologist Hans Selye in the early to mid-1900s. The foundation for these discoveries can be traced to the 1818 publication by German psychiatrist Johann Christian August Heinroth. Heinroth coined the term *psychosomatic* to describe interacting processes of the body (Steinberg, Herrmann-Lingen & Himmerich, 2013). The concept of interacting processes contrasted with the biomedical model; however, it was only within the context of the interdisciplinary discoveries and advancement of modern technology that the full breadth of the IM model formed. Like the history of IM the stress biomarkers of heart rate variability (HRV) and cortisol trace their roots back in history. In ancient times differences in pulse rates were noted by the Greek physician Herophilos circa 280 BCE. In the modern era heart rate variability was noted during the assessment of the pulse with the advent of the physician created second-hand stopwatch in 1707. The isolation and discovery of the *adrenal cortex*<sup>6</sup> hormone *cortisone*<sup>7</sup> dates back to the 1930s.

This chapter will trace the history and development of theory of the Integrative Medicine model, and the biomarkers HRV and circadian cortisol as they relate to the comorbidity of stress and chronic pain. Following this the history and theory of three complementary and alternative medicine modalities will be reviewed, as identified within the five categories of National Center for Complementary and Alternative Medicine (NCCAM). Included within each of the identified subsections above is application within the chronic pain population.

---

<sup>6</sup> The definition of this word is found in the Appendix section Definitions

<sup>7</sup> The definition of this word is found in the Appendix section Definitions

### **Historical and Theoretical Overview of Integrative Medicine**

The biomedical model followed the advancements in technologies, and the advancements in cellular pathology resulting from the work of biologist Rudolph Carl Virchow and microbiologist Louis Pasteur in the 1850s. The advancement of science in this era was influenced by philosopher and mathematician Rene Descartes (1596 – 1650). Descartes' theory of dualism proposed that the body and mind were separate. Additionally, the body was a “self-contained mechanistic system” and that “the locus of disease processes had physical etiologies that were to be resolved by chemical and mechanical interventions” (Heron, 1978 p.1) . This reductionist view continued to be shaped by John Locke (1632 – 1704) and David Hume (1711 – 1776) who both believed in reducing natural phenomena to greater simplicity in order to understand the larger whole (Rakel, 2013). For three hundred years the Cartesian paradigm dominated both scientific and philosophical views of the body. The body was conceptualized as a passive machine driven by mechanical causality, while the mind was the repository of intelligence, consciousness and motivation (Gold, 1985).

Unlike the developing Cartesian biomedical model German psychiatrist Johann Christian August Heinroth (1773 – 1843) believed there was an interaction between the body and the soul, and that the soul had primacy over the body. In 1818 he used the word psychosomatic to describe this concept. This term came to mean a physical illness or a condition aggravated by a mental factor of internal conflict, or what has come to be known as stress. The physiologist Walter Cannon (1871 – 1945) introduced the term *stress* in 1914 (Wisneski, 2009). Cannon used the term to define the phenomenon of an organism reaching a breaking point where homeostasis could not be maintained. Through his electrical stimulation studies he traced the epinephrine and norepinephrine roles during a stress reaction within the sympathetic nervous system. This

response pattern prepared the body for a strenuous activity which followed enabling a person to confront the stressor or run away from it. Cannon labeled this phenomenon the *fight or flight* response (Wisneski, 2009). He published the results of his research starting in 1914 (Wisneski, 2009).

In 1936 Selye first published his findings of a stress condition, which became known as the general adaptation syndrome (GAS) (Wisneski, 2009). Selye observed that patients in a hospital in Czechoslovakia in the 1920s had a fairly common set of symptoms despite their different diagnoses. When conducting experiments with rats in Montreal he observed the same phenomenon, what he called the *stress response* (Wisneski, 2009). He discovered this nonspecific response as being hormonally triggered by the hypothalamic-pituitary-adrenal axis (HPA). His work showed the relationship between glucocorticoids and the inflammatory response by determining that adrenocorticotrophic hormone (ACTH) and cortisol were related to the suppression of inflammation, and that an excess or deficiency of these and other hormones could suppress the normal adaptation response. Selye and Cannon were pioneers who provided information for future researchers on the chemical (Selye) and electrical (Cannon) pathways of the stress response (Wisneski, 2009).

The work by Cannon and Selye set the stage for George F. Solomon and Rudolf H. Moos (1964) to publish their article “Emotions, Immunity and Disease; a speculative theoretical integration” in the Archives of General Psychiatry. They began the article by stating:

Recent advances in immunology, clarification and the psychophysiology of stress, continued progress in the discovery of emotional factors in relation to physical disease, and the finding of apparent immunological disturbances in conjunction with mental illness lead to this attempt at a theoretical integration of the relation of stress, emotions,

immunological dysfunction (especially autoimmunity), and disease, both physical and mental. At this stage, far more questions will be raised than answered. (p. 657)

Then in the early 1970s the integration of psychological and physiological processes advanced with the serendipitous findings in a rat experiment conducted by psychologist Robert Ader (1932 – 2011) that involved an unexpected immune conditioned response when using a combination of the artificial sweetener saccharin and cyclophosphamide, an immunosuppressant drug used in chemotherapy (Wisneski, 2009). The experiment was created to understand conditioned behavioral responses to the saccharin. Ader then collaborated with immunologist Nicholas Cohen on the conditioned immune response based on his initial research. Ader first used the term *psychoneuroimmunology* (PNI) in his 1980 presidential address to the American Psychosomatic Society. He used the term to explain the premise of his findings, which he defined as an integrated process involving interactions among behavior, the nervous system, the endocrine system and the immune system (Hoolihan, 2013). An understanding of the integration of the nervous system with the immune and endocrine glands came with David L. Felten's discovery of a network of nerves leading to blood vessels, the thymus and the spleen terminating near clusters of cells, which helped control the immune system. These discoveries of interacting processes challenged the Cartesian model of autonomous separate neurological and physiological systems, creating a new paradigm with the central premise that homeostasis is an integrated process involving the interactions among behavior and three physiological systems – the neural, endocrine and immune systems. For this reason this emerging field was sometimes referred to as *psychoendoneuroimmunology* (PENI).

Knowledge of the relationships between the different systems of the body grew with research in a wide range of different disciplines including psychology, neurosciences,

immunology, pharmacology, psychiatry, behavioral medicine, infectious disease, endocrinology and rheumatology. A leader in this research was pharmacologist Candace Pert (1946 – 2013) who served as the Chief of the Section on Brain Biochemistry of the Clinical Neuroscience Branch at the National Institute of Mental Health. Her research extended the understanding of how the body/mind functions as a single psychosomatic network of information molecules, which controls physiology. Pert (1986) surveyed this research in the article “The wisdom of receptors; neuropeptides, the emotions and the bodymind”, in which she described a biomedical basis for emotion, and explained how feelings, emotions, and bodies are connected. In a 2004 lecture Pert further described her efforts over the previous two decades to actually decode the information molecules, such as peptides and their receptors, which regulate every aspect of human physiology. Her model was that of biochemicals, which flow and resonate. They distribute information to every cell in the body simultaneously. Cells contain receptor sites, similar to what Pert described as a key hole. The key is a natural or manmade substance (herbal or pharmaceutical) called a ligand.

Pert explained a more accurate description, of the process of ligands and receptor sites binding, was that of two voices striking the same note producing a vibration that rang a doorbell to open the doorway of the cell. The three types of ligands discovered during her research were 1) neurotransmitters (e.g. dopamine and serotonin), 2) steroids (e.g. sex hormones), and 3) peptides (e.g. the chemicals that regulate most of the processes of the body)(Pert 1986). It was this new understanding of neuropeptides that enabled the researchers to further delineate the effect of stress on the body (Schlitz, Amorok & Micozzi, 2004). Stress prevented the molecules from flowing freely where they were needed, the largely autonomic processes that regulates breathing, blood flow, immunity, digestion, and elimination.

In *The Scientific Basis of Integrative Medicine* Leonard Wisneski (2009) wrote:

Stress, therefore, is the absence of homeostasis or an imbalance in the harmonious workings of the organism, which results in the body's concerted effort to reestablish that balance. If that organism is incapable of re-establishing the homeostasis, the typical consequence is disease. In humans, activation of the chemical stress pathway (glucocorticoids) tends to be associated with depression, whereas activation of the electrical stress pathway (epinephrine) more frequently is correlated with anxiety. (p. 75)

Integrative Medicine (IM) evolved from an understanding of these system-wide responses, and the stress versus homeostasis responses of the body. Wisneski preferred to call PNI *integral physiology* defining IM "as the synthesis of conventional physiology and how our individual psyches (i.e. mind, emotions and spirituality) interact with the world around us to induce positive or detrimental changes in our bodies" (Wisneski, 2009, p. 75).

While the focus of most texts in psychoneuroimmunology addressed system integration and the effect of stress, Wisneski's text addresses the Relaxation System, his theoretical construct. If stress was the factor that created the cascade of dynamics disrupting homeostasis that led to disease, then relaxation would support homeostasis and health. The second section of Wisneski's book elucidated the research supporting a litany of CAM modalities, and how these modalities supported the body moving toward a state of wellness.

In addition to the shift in focus of systems integration and the implementation of CAM modalities, IM shifted the perspective of the patient-practitioner relationship. This shift has been termed *Patient-Centered Care*. The Cartesian model, which had incorporated the strides made in the pathophysiology of disease and the advancement of technology to combat its influence, failed to work well for chronic disease (Rakel, 2013). Surveys taken by NCCAM had revealed that

44% of chronic pain patients sought help from CAM practitioners, and many did so without the knowledge of their primary provider. Concomitantly, an over reliance of technology and the structure of medical treatment had fostered a divide in the patient-provider relationship. As dissatisfaction grew patients sought care from CAM practitioners (Passerelli, 2008 and Rakel, 2013).

During this era Andrew Weil offered the first fellowship in Integrative Medicine at the University of Arizona in 1997. The fellowship was created to provide physicians with an opportunity to learn therapies not included in their original training. In *Integrative Medicine* David Rakel and Andrew Weil offered the definition of a “healing-oriented medicine that takes account of the whole person (body, mind and spirit), including all aspects of lifestyle. It emphasizes the therapeutic relationship and makes use of all appropriate therapies, both conventional and alternative” (Rakel, 2013, p. 4). IM differs from the use of CAM modalities in an allopathic model, in that the focus is the transparent integration of both systems with a focus of wellness and Patient-Center Care.

The shift in focus to wellness and Patient-Centered Care were the topics of a 2001 Institute of Medicine (IOM) report and a 2006 American College of Physicians (ACP) report that addressed challenges within the American healthcare system. The IOM report noted that the public’s healthcare needs were changing, in part due to an aging population with prevalence of chronic disease. The ACP report proposed a restructuring of the health care system with a philosophical viewpoint similar to the philosophy of IM. Numerous authors have addressed the philosophical difference elucidating IM as not merely being the addition or utilization of CAM into traditional medicine (Bell et al., 2002, Maizes, Rakel & Niemiec, 2009, and Abrams et al., 2013). Rakel and Weil offered that IM was not created to fragment the medical culture further,

“but to encourage the incorporation of health and healing in a larger medical model. The culture of health care delivery is changing to adopt this philosophy, and the integration of nontraditional healing modalities will make this goal more successful” (Rakel, 2013, p.6). When Weil testified before the Committee on Health, Education, Labor, & Pensions for the United States Senate Integrative Medicine: A Vital Part of the New Health Care System hearing on February 26, 2009 he stated:

For practitioners of IM, preventing disease is not an afterthought, it is the cornerstone of our practice – the physician and patient form an ongoing partnership to maintain health, rather than fight illness, and IM practitioners are trained to be agents of lifestyle change. We treat illness promptly and aggressively when appropriate, but always seek to maximize the body’s innate capacity to stay healthy and resist disease and injury. (Weil, 2009, p. 1)

It should be noted that the formal birth of IM was in 1997 when the University of Arizona offered enrollment in the first IM fellowship. The Consortium of Academic Health Centers for Integrative Medicine currently lists fifty-seven programs within medical centers and institutions (Wilder, 2013). Additionally, the American Board of Physician Specialties slated accreditation for this specialty for May 2014 (Carbone, 2014).

### **Integrative Medicine in the Chronic Pain Population**

The authors of the Institute of Medicine (IOM) report *Relieving Pain in America* noted that they were charged with the request to “assess the state of science regarding pain research, care and education and to make recommendations to advance the field...” (Pizzo, 2011, p.2). In response they provided “a blueprint for transforming the way pain is understood, assessed, treated, and prevented” (Pizzo, 2001, p. 2). The Committee addressed the idea of the IM model

only once throughout the 364 page report stating, “In general, an integrative approach to persistent and severe pain is beneficial, but even an integrative approach may fail a large number of patients. In addition, the history of pain care suggests that it may be wise to temper enthusiasm for any single approach” (Pizzo, 2011, p. 126). An alternative to an IM specialist is the use of CAM practitioners within an allopathic treatment approach. Within this model the Committee noted barriers existed. They stated, “Should primary care practitioners want to engage other types of clinicians, including physical therapists, psychologists, or CAM practitioners, it may not be easy for them to identify which specific practitioners are skilled at treating chronic pain” (Pizzo, 2011, p. 46). But as noted above IM is not allopathic medicine with the addition of CAM modalities. The philosophical difference between IM and conventional medicine that is aware of the use of CAM modalities within a treatment plan was not addressed by the Committee.

While the IOM committee may not have acknowledged the tenants of IM within their report, the subject of chronic pain within the IM literature is scattered throughout both text and journal articles with diversity and specificity. The focus of the literature covered in this paper is pain management within the practice of IM, but reference sources do include CAM research projects within the chronic pain population.

An exhaustive search of Google Scholar and PubMed in July 2015 for the string “Integrative Medicine and chronic pain” as inclusion criteria yielded 338 articles. After screening of the abstracts thirteen articles were deemed to meet the criteria of the subject matter. Of the thirteen articles listed two were published in 2015, eight in 2014, one in 2012, one in 2011 and one in 2006. The eight articles published in 2014 are part of an April supplemental special issue in the periodical *Pain Medicine*. Two of the articles were research by the Bravewell

Collaborative, published in 2013 and 2015. In reviewing IM text, three books were obtained. They were *Integrative Medicine* by David Rakel published in 2013, *The Scientific Basis of Integrative Medicine* by Leonard Wisneski published in 2009, and *Health and Healing: The Philosophy of Integrative Medicine and Optimum Health* by Andrew Weil published in 2004.

The 2015 article identified above from the Bravewell Collaborative was titled, “Integrative Medicine patients have high stress, pain and psychological symptoms.” It was a large cross-sectional study, stated to be the first of its kind. It documented the psychosocial profiles of 4182 patients at nine research sites that are a part of the BraveNet Practice-Based Research Network. The article documented the population studied “reported higher levels of perceived stress, pain, depressive symptoms and lower quality of life when compared with national norms.” (Wolever et al., 2015, pg 302). This study appears to be an expansion of the earlier study published in 2013 titled “The BraveNet prospective observational study on integrative medicine treatment approaches for pain.” The competing interest disclosure revealed that one of the fifteen authors was a consultant for the Collaborative. The background information within the article reflected the philosophical information as elucidated above. The authors stated the study was “the first practice-based research network in the field...the project was to characterize 4182 patients seeking care at nine clinical sites in a systematic fashion...” (Abrams et al., 2013, p. 2). The study enrolled 409 patients and took place over six months. It was a non-randomized observational design. In keeping with the principles of IM the data gathered reflected multiple aspects of health and well-being. The battery consisted of standardized evaluations for pain scores, fatigue, stress, quality of life, work productivity, hs-CRP and vitamin D. The intervention period did not consist of a standardized treatment for all participants, but rather each patient/provider devised a plan. Additionally, the patients did not

receive remuneration for participation, and services not covered through insurance were the responsibility of the patient. At the conclusion of the study 66% of the participants completed the exiting battery. The authors noted this retention rate fell within the normal range of 50% to 80% for the chronic pain population. The article concluded with the individual test results within the battery; 1) reduction in overall pain ( $P < 0.0001$ ), 2) reduction in depression, stress and fatigue ( $P < 0.001$ ), 3) improvement in quality of life ( $P < 0.001$ ), 4) improved work productivity ( $P < 0.001$ ), and 5) improvement in the inflammatory marker hs-CRP and vitamin D levels (Abrams et al., 2013). The limitations of the study included no control group and an inability to document the motivational forces for those who completed versus those who did not complete the study.

The origin of the research reviewed in articles in the April 2014 *Pain Medicine* supplement, co-written by a group of authors, was the U. S. Army Medical Research Center, Samueli Institute. Utilizing the resources of the Samueli Institute and the definition of chronic pain, as defined by the Office of the Army Surgeon General Pain Management Task Force, the authors reviewed multiple aspects of published literature on the IM model within the chronic pain population. None of the articles reviewed were the result of research projects. Thematic throughout the reports was the acknowledgement of chronic pain as “a common problem today that presents considerable challenges to the healthcare system because of its complex etiology and poor responses to current treatment strategies” (Crawford, et al. 2014, p. A86). They noted that despite advances in conventional medicine there is a deficiency in efficacy. The authors viewed IM as offering the possibility of a more efficient and comprehensive pain management system with the collaboration of practitioner and patient (Crawford, 2014). In general, they found integrative relaxation-based approaches to be more effective than single CAM approaches and more effective than controls of conventional care (Lee et al., 2014). Additionally, the

authors felt there were few high quality studies that provided “robust answers to clinical questions about efficacy, effectiveness, and safety” (Crawford, et al., 2014, p. S94). Outcomes, research gaps and deficits in research were discussed (Delgado, et al., 2014; Lee et al., 2014).

The three text books of Rakel (2013), Wisneski (2009) and Weil (2004) were the result of IM fellowships of clinical professors in medical schools. David Rakel taught at University of Wisconsin School of Medicine, Leonard Wisneski at George Washington University Medical Center, and Andrew Weil at University of Arizona Center for Integrative Medicine. The focus of each of their books differed greatly, related to their objectives and intended audience. The focus of Wisneski’s book was theory and current research, Rakel’s book was provider application, and Weil’s book was provider and layperson application. Wisneski’s text begins with the physiology of stress, and his theoretical construct of the Relaxation System. The text documents the current research findings on a litany of CAM modalities in support of his theoretical construct. In keeping with the IM principles, the modalities overall did not specifically address any diagnosis. Instead the reader was provided information on how these modalities provide support for a state of wellness, where disease was mitigated. The two references for pain were the listing of a conventional electrotherapy using alternating high frequency, and biostimulation lasers potentially affecting C nerve fibers. In contrast to text by Wisneski (2009), Rakel (2013) and Weil (2004) discussed pain syndromes in more detail, but all of their discussions were congruent with the IM principle of treating the whole person. For the provider they reviewed imaging, laboratory results and interview information, and described potential treatment interventions that wove allopathic and CAM modalities.

### **Biomarkers - Historical and Theoretical Overview of Heart Rate Variability**

Thematic within the chronic pain research above is the comorbidity of stress and chronic pain. One mechanism for evaluating the effects of stress on the body is through heart rate variability (HRV). HRV, or SDNN – Standard Deviation of the NN interval, is defined as the fluctuation in the length of intervals between heart beats (Task Force, 1996). The advent of HRV in the modern era began with the invention of a portable clock with a sweep secondhand by English physician John Floyer (1649 – 1734). He recorded both the pulse and respiration under a variety of conditions, publishing his findings in 1707 and 1710 (Billman, 2011). In 1733 Stephen Hales (1677 – 1761) first documented HRV when he observed a respiratory pattern in the blood pressure and pulse of a horse (Bernston, et al., 1997). The Dutch physiologist Willem Einthoven (1860 – 1927) was credited with inventing the first electrocardiogram in 1902 (Billman, 2011). These were the first accurate continuous recordings of the electrical activity of the heart from which HRV was observed. As technology developed in the ensuing years it became possible for clinicians to evaluate the beat-to-beat changes in the cardiac rhythm. However, for years controversy existed as to the origin and meaning of HRV (Bernston, et al., 1997). Theories investigated included input from the central neural respiratory neurons, reflex activation of afferent fibers from the lungs, cyclic activation of arterial baroreceptors, thermoregulatory control, and angiotensin system contributions. Ironically, despite more than ninety years of investigations, the physiological basis underlying HRV remains a mystery (Billman, 2011).

While the physiological basis of HRV remained a mystery what did become apparent was that HRV is the result of activation of the vagus nerve during respiration (Billman, 2011). In 1910 Heinrich E. Hering (1866 – 1948) demonstrated the lowering of heart rate with breathing, associating it as a function of the vagi. This feat was documented in a range of mammalian

species from cats and dogs to horses and humans. As technology advanced so did the sophistication of studies resulting in the current knowledge base:

The rhythmic changes in the heart rate at any given moment reflect the complex interactions between parasympathetic nerve fibers (activation decreases heart rate), sympathetic nerve fibers (activation increases heart rate), mechanical and other factors on the cells located in the sinoatrial node. (Billman, 2011, p. 5)

It was here within the interplay of the sympathetic and parasympathetic nervous system the idea that HRV was more than an index of heart function took form (Thayer, Ahs, Fredrikson, Sollers & Wager, 2012).

Current clinical interest in HRV emerged in 1965 when E. H. Hon and S. T. Lee noted that fetal distress was marked by heart beat-to-beat fluctuations prior to a change in the heart rate that preceded fetal demise (Task Force, 1996). Since Hon and Lee published their first article more than one million references have contributed to the listing in Google Scholar, and approximately 17,000 articles are currently listed within PubMed.com. With the advent of technological advancements HRV has become a simple and noninvasive technique that correlates with significant changes in many disease processes. Clinical application of HRV has been diversely applied to the area of diabetes, physical/sports medicine, renal failure, cardiology (myocardial infarction, cardiomyopathy, coronary artery disease, and arterial hypertension), chronic obstructive pulmonary disease, leukemia, Alzheimer's disease, and epilepsy (Vanderlei, Pastre, Hoshi, Carvalho & Godoy, 2009). Research has shown that individuals with a greater variability have a greater degree of health, and a higher HRV indicates a healthy balance between the sympathetic and parasympathetic systems (Vanderlei, 2009).

Numerous research projects published in peer-reviewed journals reference the 1996 article “Heart Rate Variability; Standards of measurement, physiological interpretation and clinical use” published by the Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology. The article acknowledges HRV testing as:

a seemingly simple tool for both research and clinical studies. 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. (Task Force, 1996, p. 354)

The goals of the 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” (Task Force, 1996, p. 354). After a brief review of the background of HRV the report acknowledged the then new availability of technologies including digital and 24 hour monitoring equipment, which had the potential to provide valuable insight into physiology and enhance risk stratification.

A major portion of the report reviewed the various definitions historically used in HRV tests, including an explanation of the time-domain and frequency-domain analysis reporting. Recommendations included recording requirements along with standardization of commercial equipment. Short recordings were defined at five minutes and long recordings were computed from 24-hour Holter monitoring readings. Time-domain indices were defined as “the heart rate at any point in time or the intervals between successive normal complexes” (Task Force, 1996, p. 355). The report defined the common time-domain index as SDNN, the standard deviation of the normal-to-normal (NN or RR) intervals (Task Force, 1996). Frequency-domain indices were

described as “Power spectral density (PSD) analysis provides the basic information of how power (i.e. variance) distributes as a function of frequency” (Task Force, 1996, p. 356). These are obtained through mathematical algorithms which includes Fast Fourier Transform. The frequency-domain indices include very low frequency (VLF), low frequency (LF) and high frequency (HF), along with Total Power. Research has demonstrated VLF to correlate with the sympathetic tone, the LF with sympathetic/parasympathetic tone and HF with parasympathetic tone of the autonomic nervous system (Task Force, 1996).

Additionally, the Task Force acknowledged that little was known about the effects of the environment, i.e. the influence of physical activity or emotional circumstances, on the recording. They suggested experimental design variables be controlled, the character of the environment be described, and that the recording environment of subjects be similar. Pharmacological responses and physiological phenomena were acknowledged.

It was years after the Task Force published its standardizations that research into the effects of stress on HRV indices emerged within the literature. In “A meta-analysis of heart rate variability and neuro-imaging studies; implications for heart rate variability as a marker of stress and health” the authors noted, “The search for biomarkers of stress and health remain a challenging task...” (Thayer, Ahs, Fredrikson, Sollers & Wager, 2012, p. 747). They also noted there is a “lack of consensus on the meaning and operationalization of the concept of stress” and “there is a lack of a comprehensive framework to investigate an organism within changing environments (Thayer, 2012, p.747). The authors proposed a model they termed *Neurovisceral Integration*, a flexible neural network structure linking psychological and physiological processes that could be indexed by HRV. They conclude their article by suggesting that “HRV may index important organism functions associated with adaptability and health” and the article

“highlights the importance of HRV as a potential marker of stress and health, and provides evidence for neural correlates that serve to underpin this relationship” (Thayer 2012, p. 754).

### **Heart Rate Variability in the Chronic Pain Population**

An exhaustive search of Google Scholar and PubMed in May 2014 for the string “heart rate variability and chronic pain” as inclusion criteria yielded nineteen articles. Half of the articles were published between 2014 and 2011, with the balance dating back to 1983, reflecting recent attention to the chronic pain population. In reviewing HRV two text books were obtained: *Heart Rate Variability* by Gernot Ernst published in 2014 and *Heart Rate Variability Signal Analysis, clinical applications* by Markad V. Kamath, Mari A Watanabe and Adrian R.M. Upton published in 2013.

The focus of all nineteen articles was the demonstrated abnormalities of the various HRV indices and patterns. “Induction of chronic non-inflammatory widespread pain increases cardiac sympathetic modulation in rats” (Oliveira L. et al., 2012) was the only article not on human subjects. The authors investigated the HRV response to an agent known to cause chronic non-inflammatory widespread pain, an acidic saline at 4.0 pH. Chronic non-inflammatory widespread pain was consistent with the definition of *fibromyalgia*<sup>8</sup>. The study included a control and treatment group. The results of the study demonstrated the rats in the treatment group had changes in their HRV indices that corroborated the findings in patients with fibromyalgia; a shift of balance between sympathetic and parasympathetic tone to an increased sympathetic predominance, or what was termed *autonomic imbalance* (Oliveira, 2012).

The abnormality of autonomic imbalance was discussed in “Heart rate variability as a biomarker for autonomic nervous system response differences between children and chronic pain and healthy control children” (Evans, et al., 2013). The authors reported the study of low HRV

---

<sup>8</sup> The definition of this word is found in the Appendix section Definitions

within the pediatric chronic pain population was limited with conflicting information confounded by small sample-size studies. Their study included 152 children, 104 healthy controls and 48 chronic pain children. The focus of the study was to compare changes in HRV indices in both groups when subjected to laboratory pain tasks. While low HRV has been linked to anxiety and emotional disorders in children in previous research the authors stated that HRV response to pain-related stressors had not been researched (Evans 2013). The first objective was to document resting HRV in both groups capturing frequency and ratio indices.

Each of the 152 children underwent the laboratory pain tasks which included an evoked pressure task, a cold pressor task and a conditioned modulation task (Evans 2013). Using *t*-tests, Chi-square tests and ANOVA the authors reported the results. The study revealed the chronic pain group had reduced HRV frequency indices with a dominant sympathetic balance and a static HRV response to the laboratory pain tasks. The control group had an appropriate stress response. The heart rate of each group remained constant. The authors noted “These differences could not be explained by different subjective emotional experiences because both groups rated the laboratory pain tasks as similarly anxiety-provoking” (Evans 2013, p.454). They concluded by stating:

Our findings suggest that the relationship between low HRV and compromised health appears relatively early in life. Children with chronic pain demonstrated not only lowered resting HRV relative to their healthy counterparts, but their autonomic nervous system response was also blunted following laboratory pain induction. This autonomic balance, if not addressed, may lead to further stress on the body and a cascade of protracted health problems (Evans, 2013, p. 456).

The results of their study indicated HRV abnormalities were trait-based within the child chronic pain population. Numerous articles on HRV within adult populations shared this view (Cain, Jarrett, Burr, Hertig, & Heitkemper, 2007; Gavi et al., 2014; Heitmann, Huebner, Schroeder, Perz & Voss, 2011; Thayer & Strenberg, 2006). In “Heart rate variability in assessment of autonomic dysfunction in patients with chronic prostatitis/chronic pelvic pain syndrome” Cho et al. (2011) found this group of fifty-nine men to have reduced resting HRV frequency indices as compared to ninety-four healthy controls. While the ratio between the LF and HF was not significantly different between groups, the authors concluded that the reduction of indices might be a factor that aggravates this diagnosis. These findings were inconsistent with an earlier study of this population. In comparison the authors of “Autonomic nervous system changes in men with chronic pelvic pain syndrome” (Yilmaz, Liu, Berger & Yang 2006) reported no difference in resting HRV frequency indices between groups, albeit the number of participants was less with twenty-two experimental and twenty control participants. However, the results did reveal the HRV responses in opposing directions when taken from a supine to standing position, which could possibly have influenced the maintenance of this disorder (Yilmaz 2006).

The idea that the abnormal HRV frequency indices are related to the maintenance of a disorder was thematic throughout the Functional Somatic Disorder (FSD) literature, specifically fibromyalgia. Rheumatologist Dr. Frederick Wolfe first coined the phrase *fibromyalgia* in 1984 to describe a constellation of symptoms observed predominantly in women (Powell, 2014). The constellation of symptoms was first described by the physician Sir William Osler (1849 – 1919) in 1892 (Powell, 2014). Despite its long history there is no laboratory test or imaging technique for definitive diagnosis of fibromyalgia. The idea that HRV could be used as a biomarker for

this population was the subject of several articles. In “Nocturnal heart rate variability parameters as potential fibromyalgia biomarker: correlation with symptoms severity,” the authors noted that the lack of an objective marker had “hampered recognition and research” (Lerma et al., 2011). This sentiment was acknowledged throughout other studies that were reviewed. Seven of these articles acknowledged dysfunctional HRV frequency indices and or patterns. Lerma et al. (2011) discussed dysfunctional HRV indices’ patterns during sleep within this population.

In “Heart rate variability as a biomarker of fibromyalgia,” Staud (2008) further elucidated the dysfunction by highlighting the finding of autonomic imbalance which was “persistent hyperactivity at rest and hyporeactivity during stress” (p. 5). Fibromyalgia patients have a constellation of symptoms that include fatigue, widespread pain, sleep-disturbances, gastrointestinal complaints and psychological symptoms (Mostoufi S, Niloofar A, Ahumada S, Reis V. & Wetherell, 2012). In “Health and distress predictors of heart rate variability in fibromyalgia and other forms of chronic pain” the authors examined the possible role HRV plays in the “development and maintenance of chronic pain,” (Mostoufi, 2012). They found that their participants reported “poorer physical health functioning and more depression .... and exhibit more severe clinical symptoms and lower quality of health-related quality of life compared to those with chronic benign pain conditions” (Mostoufi, 2012). The study referenced previous studies in which patients with higher levels of depression and reported psychological distress correlated with increased physical symptoms and dysfunction (Mostoufi, 2012). All of these factors were predictors of HRV abnormalities.

Movement in the opposite direction - the reduction of symptoms and improvement of HRV indices - was addressed in the article by Staud (2008). He referenced three studies that demonstrated an improvement of HRV indices within the FSD population when engaged in an

exercise training program. The reduction of pain perception correlated with an improvement in the HRV results.

The relationship of pain perception correlating with changes in HRV indices was the focus of three articles reviewed. The etiology of pain within each population was different, as was the outcome of the study. In “Relief of chronic pain may be accompanied by an increase in a measure of heart rate variability” authors Storella et al. (1999) examined patients with low back pain resulting from nerve root compression secondary to a herniated disc. Unlike other studies this study used a point correlation dimension (PD2) “that is an estimate of the number of independent variables needed to describe a system” (Storella, 1999). The PD2 created a series of vectors within the time-domain data. This was a small study of sixteen patients with either moderate or severe levels of pain. Both groups received caudal epidural steroid injections. In the discussion the authors shared that it was the patients with severe levels of pain who had an improvement in the PD2, supporting their hypothesis that the “effects of chronic pain can be reversed by acute pain relief” (Storella, 1999).

Concomitant with pain perception is the perception of disability. In “Disability in patients with chronic neck pain; heart rate variability analysis and cluster analysis” authors Kang, Chen, Chen, and Jaw (2012) reported on their study of 121 patients. Several questionnaires of pain and quality of life were compared to resting HRV indices in both the time and frequency domains. They noted that chronic neck pain could be difficult to treat. The experimental group was divided by age, sex and severity of pain. In the conclusion they reported “reduced heart rate variability was associated with subjective disability in these patients” (Kang 2012). The group with the highest perceived disability and pain intensity was also found to have disordered sleep,

Kang (2012) noting that “sleep disorder and poor mental health lead to the development of disability” (p. 801).

The relationship of disability, pain and HRV indices was echoed in “Perceived disability but not pain is connected with autonomic nervous function among patients with chronic low back pain” by authors Gockel, Lindholm, Niemisto and Hurri (1999). Their study included thirty-nine patients who completed an *Oswestry Disability Index*<sup>9</sup> and an analog pain scale. Resting HRV indices were obtained and analyzed in relationship to the two survey questionnaires. The article reported “Perceived disability, but not pain, was combined with HRV, suggesting that perceived pain causes different levels of distress among patients with low back pain” (Gockel, Lindholm, Niemisto & Hurri 1999).

These articles illustrated abnormal HRV indices within the chronic pain population. Subject to subpopulations and research-design is the manifestation and interpretation of these abnormalities. With the exception of one article, the consistently demonstrated findings throughout research are lower HF/parasympathetic frequency, lower Total Power and poor variability when compared to healthy controls.

Two text books by Ernst (2014) and Kamath (2013) reviewed research and were written for clinicians. Each briefly reviewed the history of HRV and concluded with varying clinical applications. In addition the text by Ernst (2014) reviewed the theoretical and pathophysiological background of HRV, including methodology. The text by Kamath (2013) reviewed techniques. As mentioned, HRV has been utilized in diverse disciplines of medicine. While the clinical application of both writers differed, both reviewed recent research in cardiology. For the purposes of this paper the clinical chapters reviewed are “General Mortality”, “Pain”, and “Psychiatric; depression and stress” by Ernst (2014), and “Sleep” and

---

<sup>9</sup> The definition of this word is found in the Appendix section Definitions

“Depression” by Kamath (2013) The topics of depression and sleep were reviewed, as these are frequent concomitant diagnoses within the chronic pain population, where poor sleep architecture and depression are viewed as secondary to the pain syndrome (Jungquist C. et al., 2010; Korff & Simon, 1996; Mostoufi, 2012; Smith & Haythornthwaite, 2004; Staud, 2008).

As discussed poor HRV is a representation of poor health. In the chapter “General Mortality” Ernst (2014) reviewed large longitudinal studies; i.e. 347 to 900 participants in four-year to twelve-year studies, which attempted to stratify risk. Concluding this chapter Ernst (2014) stated “HRV does not have a high predictive value”; however, he also stated, “There is quite clear evidence that preventive measures result in increasing HRV, which can motivate patients” and “HRV can be a worthwhile addition for medical staff working preventively” (p. 154). (This comment can be viewed as congruous with Weil’s testimony before the Senate Committee, contained within the history of Integrative Medicine section of this paper.) In the chapters on depression and sleep both Ernst and Kamath reviewed recent research on the endogenous stress system, its relationship to depression and anxiety, and this influence on dysfunctional sleep patterns. HRV patterns within sleep stages were reviewed, with normal and abnormal patterns elucidated. Missing in the HRV articles, but documented within both books, were the results of studies showing antidepressant medication enhancement of cardiac dysregulation (Ernest, 2014; Kamath, 2013).

In the chapter on pain Ernest (2014) acknowledges that pain has become a major medical problem asking “Can we understand? Can we identify patient subgroups?” and “Do HRV parameters correlate with outcome and can they be used for prognosis?” (p. 245). He reviewed the research on chronic pain syndromes as defined above. He acknowledged that “pain causes distress, which is sufficient to cause changes in HRV” (Ernest, 2014, p. 245). However, he noted

this was not observed in all studies as the chronic pain population is a heterogeneous group with varying research results (Ernst, 2014). The chapter concluded by posing a question for researchers: Can specific constellations of HRV predict pain treatment results?

As identified above chronic pain correlates with high levels of allostatic load. Allostatic load is the dysregulation of the parasympathetic as represented by HRV, and the dysregulation of the HPA axis as represented by the hormone cortisol to be discussed next.

### **Biomarkers - Historical and Theoretical Overview of Cortisol**

Cortisol was first identified in 1929 by a group of physiologists working at the University of Buffalo and Princeton University. Through the research efforts of a few physiologists twenty-eight different steroid compounds were identified from the adrenal cortex. These compounds were designated letters of the alphabet. Eventually the physiologist discovered two subgroups; one group affected electrolytes, and another group affected carbohydrates and proteins. Through their research they discovered that some of the compounds had the ability to restore muscle function in the animals that had been adrenalectomized (Kendall, 1950). In 1941, a request came from the U.S. Army and Navy for the release of these hormones, which had the potential to mitigate the ravages of World War II. Eventually in an effort to shift possible confusion of one of the compounds from a vitamin, compound E was given the name *cortisone*. Cortisone is the inactive precursor compound to cortisol (Dorland's, 1974). In 1950 Edward Calvin Kendall (1886 – 1972), Phillip Hench (1896 – 1965) and Tadeus Reichstein (1897 – 1996) shared the Nobel Prize for Physiology/Medicine for their research on the biological effects and preparation for production of these compounds. By definition cortisol is a hormone released by the adrenal gland. Specifically:

Cortisol and corticosterone break down proteins and convert them to glucose. They ensure that glucose in the blood stream is adequate to meet the needs of the brain, and during stress they reduce glucose delivery to parts of the body with the brain always being supplied first. They also break down fat that can be used for energy. The effect of these hormones is long lasting, as they are removed slowly from body tissue. (Wisneski, 2009, p. 27)

The concept of cortisol as part of a system-generated stress response was the result of research by endocrinologist Hans Hugo Bruno Selye (1907 – 1982). In 1936 he identified a stress response that became known as the general adaptation syndrome (GAS) (Wisneski, 2009). The GAS was viewed as an adaptive mechanism to “protect the organism and restore homeostasis” (Bomholt, Harbuz, Blackburn-Munro & Blackburn-Munro, 2004, p. 1). Selye’s research laid the ground work for further research on the biological functions of a class of hormones called glucocorticoids. These hormones bind to glucocorticoid receptor sites, which are present within human cells (Baulieu & Kelly, 1990). They are part of the communication network described by Candace Pert in her research (Schlitz, Amorok & Micozzi, 2004). The compound cortisol is classified as a glucocorticoid. Selye’s research into the GAS led to the discovery of the hypothalamic-pituitary-adrenal axis, or the HPA axis. This axis is the chemical highway that conveys information. When an emotional or physically stressful situation is perceived by the brain’s cerebral cortex and limbic system a neural message is sent to the hypothalamus. The hypothalamus releases an informational hormone received by the pituitary gland and a neural message to the brain stem. In response to the hormonal message the pituitary gland releases the adrenocorticotrophic hormone (ACTH) “which causes to the *adrenal cortex*<sup>10</sup> to release corticosteroids, primarily cortisol” (Wisneski, 2009, p.31). This suppresses the immune

---

<sup>10</sup> Definition of this word is found in the Appendix section on Definitions

system, inhibits the sexual/growth system and begins conversion of fats and proteins into energy (Wisneski, 2009). In response to the neural message the brain stem stimulates the *adrenal medulla*<sup>11</sup>, which cascades catecholamines. Catecholamines are neurotransmitters that include dopamine, norepinephrine and epinephrine (Dorland's, 1974). These compounds create a sympathetic response in the system (Wisneski, 2009). Researchers discovered that it was during periods of extended chronic stress that the system fails to turn off the endogenous reactions, and as a result the immune system can become compromised and dysfunctional. Additionally, the prolonged excess can lead to what has been termed *adrenal fatigue* (Wilson, 2001). Various studies have shown a correlation between chronic pain syndromes producing stress and a preponderance of chronic pain syndromes in patients with physical and emotional stressors (Pizzo, 2011).

### **Cortisol in the Chronic Pain Population**

A search in Google Scholar and PubMed in May 2014 for the string “HPA axis dysfunction and chronic pain” as inclusion criteria yielded twelve articles. Many of the abstracts in this search focused on medication responses, treatment responses, chronic fatigue syndrome and depression. As both emotional and physical stressors ignite HPA axis dysfunction concomitant diagnoses were discussed in all of the articles. The articles chosen for review were those where the primary focus was a chronic pain syndrome versus chronic pain as adjunct to other diagnoses.

Of the articles reviewed three were on animal models, two were reports on the results of an experiment, while the third was a review of literature. All three of the articles described experiments using rodents. Both of the experimental reports acknowledged HPA dysfunction within chronic pain syndromes along with hyperalgesia and allodynia. The focus of “Stress-

---

<sup>11</sup> Definition of this word is found in the Appendix section on Definitions

induced hyperalgesia: Animal models in putative mechanisms,” by Imbe, Iwai-Liao and Senba (2006) described how a variety of stress-producing conditions contributed to and enhanced nociceptive behaviors in the rodents. The authors concluded this report by stating “The unraveling of mechanisms underlying stress-induced hyperalgesia may provide a more rational basis for drug therapies in a variety of pain syndromes” (Imbe, 2006). The focus of “Plasma corticosterone levels in mouse models of pain,” by Benedetti et al. (2012) was a time-dependent response variable. This experiment “monitored circulating corticosterone under different pain models” with results that “indicate that HPA axis activation in acute and chronic pain models is time dependent and may be dissociated from evoked hyperalgesia” (Benedetti et al., 2012, p. 803). The authors suggested that the results of this study indicated the need for this variable to be considered in research design. The review article “Involvement and role of the hypothalamo-pituitary-adrenal (HPA) stress axis in animal models of chronic pain and inflammation” by Bomholt, Blackburn-Munro and Blackburn-Munro (2004) spanned research on chronic pain in conjunction with rheumatoid arthritis and multiple sclerosis. Chronic inflammatory processes are not seen in all chronic pain syndromes, but were prevalent. They concluded their article by noting inconsistent findings in the “severity and progression of chronic inflammation and HPA stress axis dysfunction” (Bomholt, 2004, p. 10). They suggested that future research correlate HPA axis function with continued differential chronic pain patterns.

“Sex differences in hypothalamic-pituitary-adrenal axis function in patients with chronic pain syndrome” (Turner-Bobb, Osborn, DaSilva, Kegoh & Jessop, 2010) was the only article that addressed the difference in HPA axis responses between sexes. The authors noted that inconsistent data had been reported for HPA axis function in normal healthy controls of males and females. Their study compared diurnal salivary cortisol samples in male and female patients

diagnosed with refractory chronic pain, duration more than one year. Excluded from the study were those persons diagnosed with chronic fatigue or fibromyalgia. The study consisted of thirty-seven experimental subjects (eighteen males and nineteen females) and forty-seven healthy control subjects (seventeen males and thirty females). Consistent with literature the experimental group had altered HPA axis function as compared to healthy controls.

Additionally, the experiment demonstrated differences in the pattern of diurnal cortisol between males and females. The researchers did not find a correlation of the diurnal patterns and self-report of depression/anxiety in either sex. The results revealed salivary cortisol levels were higher in the experimental female versus the male subjects, and it was theorized this was the result of the females being more accustomed to coping with pain than the male subjects (Turner-Bobb, 2010). Weaknesses acknowledged within the study included the exclusion of body mass index and the women's current stage of menstruation as variables, even though literature has reported these had an effect on basal cortisol levels (Turner-Bobb, 2010). Recommendations for future research included longitudinal studies to stratify risk in pain-free healthy subjects to determine if hypocortisolemia predisposes persons to develop chronic pain syndromes.

An investigation into genetic predisposition of HPA axis function was the subject of an article by Holliday et al. (2010) titled "Genetic variation in the hypothalamic-pituitary-adrenal stress axis influences susceptibility to musculoskeletal pain: Results from the EPIFUND study." The authors cited two previous studies that "estimated that genetics explains 50% of the variance in pain syndromes" (Holliday et. al., 2010). They noted prior studies investigating the genetic component of pain were "limited and problematic in design" and "lacked sufficient samples size..." (Holliday et. al., 2010). Contrary to previous limitations this four-year longitudinal study focused on 164 experimental subjects and 172 control subjects within a study of 994 subjects.

The study identified and analyzed seventy-five single nucleotide polymorphisms (SNP) or gene expressions contained within seven genes. The study included participants diagnosed with both fibromyalgia and chronic widespread pain syndrome. At the conclusion of the study the researchers found a modest “genetic variation in HPA axis genes was associated with musculoskeletal pain; however, some of the associations were explained by comorbidities” (Holliday et. al., 2010, p. 556). The comorbidities included psychosocial factors such as depression and anxiety in addition to poor sleep architecture.

The concept of comorbidities within the chronic pain population was thematic throughout the remainder of the research reviewed. Most prevalent in the articles was the relationship between various psychosocial stressors and chronic pain (Blackburn-Munro, 2004; McBeth et al., 2005; Mutsuura et al., 2009; Riva, Mork, Westgaard & Lundberg, 2012). Numerous studies tracked the relationship between psychosocial stressors, depression and chronic pain (Blackburn-Munro & Blackburn-Munro, 2001; Martin, 2013; Mutsuura, et al., 2009; Tak et. al, 2011; Wingenfeld, et al., 2009). The role of depression within the chronic pain population was the focus of “Chronic pain, chronic stress and depression: Coincidence or consequence?” by G. Blackburn-Munro and R.E. Blackburn-Munro (2001). Their findings represented evidence from both experimental and clinical studies. They outlined the involvement of the HPA axis in both chronic pain and depression arguing that they share a common etiology. They cited studies that revealed patients with fibromyalgia had dysfunctional HPA axis response, in addition to hypothalamic response. From the studies reviewed, they suggested that “HPA axis dysfunction may be a common underlying factor in chronic pain and depression comorbidity” (Blackburn-Munro, 2011, p. 1016).

The diagnosis of fibromyalgia was contained within the class of chronic pain disorders referred to as functional somatic disorders (FSD). The role of depression within this subcategory was included in the review article by L. M. Tak et al. (2011) titled “Meta-analysis and meta-regression of hypothalamic-pituitary-adrenal axis activity in functional somatic disorders.” The authors noted that FSD was a group of chronic pain syndromes “without known underlying conventional organic pathology” (Tak, 2011). It included fibromyalgia (FM), chronic fatigue syndrome (CFS) and *irritable bowel syndrome*<sup>12</sup> (IBS). The authors of this article conducted their meta-analysis on eighty-five studies. Inclusion criteria listed were basal hypocortisolism by serum, saliva or urine. Their findings revealed that FSD was not a heterogenous group, and hypocortisolism was significant only when the three diagnoses were evaluated separately in addition to evaluation by sex. *Comorbid depressive disorder*<sup>13</sup> was a moderator. Within the limitations discussed at the conclusion, the authors acknowledged the “research field lacks a gold standard how best to study the HPA axis” (Tak, 2011, p. 190). Additionally, they acknowledged that acute and chronic stressors has been documented to have an impact on cortisol levels; however, not included within their study were variables of psychosocial moderators, and there were limited studies on HPA axis resiliency due to challenge tests.

“Chronic pain therapy and hypothalamic-pituitary-adrenal axis impairment” was the only study to evaluate the effects of common chronic pain medication protocols of opiates and nonsteroidal anti-inflammatory drugs (NSAIDS) on HPA axis function through the indices of corticotrophin-releasing hormone (CRH), adrenocorticotrophin hormone (ACTH), cortisol, dehydroepiandrosterone (DHEA) and dehydroepiandrosterone sulfate (DHEAS) in blood levels. Over a period of ten months the study evaluated 126 patients with a diagnosis of non-cancer

---

<sup>12</sup> The definition of this word is found in the Appendix section Definitions

<sup>13</sup> The definition of this word is found in the Appendix section Definitions

chronic pain and age-matched controls who did not carry a diagnosis of chronic pain. Blood levels were drawn during routine visits, and patients filled out a battery of standardized questionnaires for depression, quality of life and pain levels. The researchers reported that the blood levels of hormones tested “were significantly decreased in the subjects taking opiates or NSAIDS to treat pain, moreover these hormones appeared to be correlated with psychological features of these subjects (Aloisi et al., 2011, p. 1037). Citing previously published research on suppression and reversal of cortisol production with opioid compounds the authors postulated the correlation between the lower levels in these blood markers with depression and quality of life in addition to the known effects of physiological functions (Aloisi et al., 2011).

The IM model focus of wellness identifies stress as having a detrimental systemic effect on the body. As discussed above both HRV and cortisol are biomarkers of stress. The next section of the Literature Review discusses three modalities, their historical and theoretical constructs, and their application within the chronic pain population.

### **Modality - Historical and Theoretical Overview of Bowenwork®**

The National Center for Complementary and Alternative Medicine (NCCAM) category manipulative and body-based practices is defined as “...modalities which are based on manipulation and/or movement of one or more parts of the body...the focus is primarily on the structures and systems of the body including the bones and joints, the soft tissues and the circulatory and lymphatic systems” (NCCAM, 2007). Modalities included within the NCCAM list were chiropractic and osteopathic manipulation, massage therapy, and various practices used in massage therapy such as *Tui Na*, *Trager bodywork*, *rolfing*, *Feldenkrais*<sup>14</sup> and Bowenwork. It should be noted Bowenwork® is used by physicians, physical therapists, occupational therapists, nurses and massage therapists in the United States and around the world. While NCCAM listed

---

<sup>14</sup> The definitions of these words are found in the Appendix section Definitions

Bowenwork in this category and massage therapists incorporated this modality into their practices, the technique was excluded from numerous state massage legislations. Additionally, as receiving Bowenwork® and massage therapy concurrently is contraindicated the theories behind massage therapy will not be reviewed for this paper.

Bowenwork®, also referred to as Bowtech®, Bowen therapy, Bowen technique or just Bowen, was developed by Thomas Ambrose Bowen (1916 -1982) in Gheelong, Victoria, Australia. Bowen became interested in ways to alleviate human suffering and noticed certain moves on the body had particular effects. He developed the technique through trial and error, stating it was a gift from God. Eventually he opened a clinic to treat the public in the late 1950s. In 1975 the Victorian Government of Australia published the *Report of the Committee of Inquiry into Chiropractic, Osteopathy, Homeopathy, and Naturopathy*, which verified Bowen treated an estimated 13,000 patients per year. The report also revealed a greater than 80% success rate in symptoms that were associated with a wide range of conditions from chronic ailments to acute injuries including pain reduction (Hansen, 2010). Oswald (Ossie) Rentsch, a student of Bowen continued this work following Bowen's death establishing the Bowen Therapy Academy of Australia (BTAA) in 1987. Subsequently, the modality became part of an Australian nationally accredited two-year vocational program, and it is currently taught in six languages in twenty countries around the world. In 1993 it was accepted into the British Complementary Medicine Association, and has been recognized by the Canadian Naturopathic Association.

In a 2010 interview Ossie Rentsch referred to Bowenwork® “as a soft tissue technique that resets the body to allow it to heal itself” (Rentsch, 2010). The technique involves a series of what are described as moves. With a client lying on a massage table a typical move involves the practitioner placing his/her thumbs or index fingers at prescribed locations, drawing the skin and

subcutaneous tissue to the side of a muscle belly and then rolling through the muscle during exhalation. An integral part of the technique is referred to as the waits. Between each prescribed set of moves the client is allowed to rest for a period of 2+ minutes while there is believed to be an integration of information and responses between the nervous system and the body. In “What is Bowenwork®; A Systematic Review” authors Christine Hansen and Ruth Taylor-Pillae (2010) noted:

To date, the theory of how Bowenwork® actually works is based on clinical observations. It is postulated that Bowenwork® is closely linked to the autonomic nervous system (ANS) and involves stimulation of stretch receptors in muscles that include the Golgi tendons and spindle cells. The activated fibers of the proprioceptive system, an internal awareness of sensory stimulation, initiates a brain response, which in turn sends nervous system messages back to the fascia to normalize the resting rate of the tissues. As the tension level is normalized, fluid movements of lymph and blood are increased in the area, which enhances tissue repair in injury sites (p.1002).

This is the way Bowenwork® linked to the ANS was described by one practitioner:

Tom Bowen developed a combination of moves that under normal circumstances will reset the resting length of muscles. This in turn can remove restrictions in the fascial system, re-hydrate connective tissue, promote efficient visceral function, and balance the autonomic nervous system through an increase in parasympathetic function. (Claude, 2012)

The autonomic nervous system, divided into the two complementary systems previously described as the sympathetic and parasympathetic systems, regulates the autonomic vital functions of the body. They are respectively referred to as the fight/flight or rest/digest

responses. It is during activation of the parasympathetic nervous system's rest/digest that the body coordinates regeneration or healing (Wisneski, 2010; Thayer & Sternberg 2006). An integral part of the parasympathetic activation is the information received by the vagus nerve. The vagus nerve, or cranial nerve X, originates in the brain stem, contains both sensory and motor branches, and innervates the ears, tongue, pharynx, lungs, heart, stomach and intestines. Numerous Bowen moves are performed in areas of vagus nerve innervation. The "reset" effect that Rentsch refers to may be due to the body's response to the information communicated by the vagus nerve as evidenced in shifts of the ANS, in addition to information received from the muscles involved with the moves (Whitaker, Gilliam & Seba, 1997; Whitaker, Gilliam & Seba, 1998; Shapiro, 2004; Pakozkdi, 2014).

Hansen and Taylor-Pillae compiled a systematic review of the literature published in English on Bowenwork® since 1985. They stated the theories behind Bowenwork® were based on clinical observation (Hansen, 2011, p. 1002). They found a total of 309 articles with a total of fifteen meeting their inclusion criteria of original Bowenwork®, health-related outcomes and quantitative or qualitative data reported. They found eight research studies published between 2001 and 2008, with seven case studies reported between 1999 and 2008. Since Hansen published her dissertation findings on breast cancer survivor lymphedema in 2011 three studies were published on musculoskeletal conditions. Of the eight studies Hansen found five utilized standard measurement tools to assess the health-related outcomes such as range of motion in joints. They noted the most common application of Bowenwork was for pain and mobility issues associated with musculoskeletal problems; however, what was not well documented was the improvement of symptoms following Bowenwork® among persons with chronic illness.

It should be noted that Bowen did not formally teach his technique. Throughout his life several physicians interested in his technique observed him while he worked. Rentsch was the last of Bowen's students. The Bowen Therapy Academy of Australia (BTAA) does not represent the interpretation of all of Bowen's students, and fragmentation exists within the modality (Pennington, 2012). Hansen's inclusion criteria of original Bowenwork® excluded publications by persons outside of the BTAA.

### **Bowenwork in the Chronic Pain Population**

NCCAM surveys revealed that pain is one of the primary reasons patients seek CAM therapies. This phenomenon is not limited to the United States. In 2001 the Department of Complementary Medicine School of Postgraduate Medicine and Health Sciences University of Exeter in the United Kingdom (U.K.) published the results of their survey titled "Which complementary and alternative therapies benefit which conditions? A survey of the opinions of 223 professional organizations." The article reflects similar findings as reported in the U.S. with pain as one of the top five reasons patients sought care with CAM therapies (Long, Huntley & Ernst, 2001). While the authors recommended Bowenwork for pain, they qualified the recommendation based on scant research.

In Hansen's survey of publications eleven of the articles and case studies she reviewed addressed the issue of pain. Pain syndromes included acute and chronic low back pain, frozen shoulder pain, pain as a result of work injury, migraine headaches, sacroiliac joint pain, fibromyalgia and temporomandibular joint pain. The reported results involved a pre- and post-practitioner assessment of range of motion and patient analog pain scale rating per questionnaire.

Articles found outside of Hansen's review included two articles co-authored by JoAnne Whitaker (1927 – 2008). Whitaker<sup>15</sup>, a medical doctor, was associated with the American College of Rheumatology (Shapiro, 2004) where she conducted research on the results of Bowenwork with fibromyalgia patients. She presented her findings at two separate conferences in 1997 and 1998. The results of her small study (eleven control and seven fibromyalgia patients) revealed shifts in the ANS via HRV testing before and after a treatment, which correlated with patient self-report reduction in pain symptoms on analog pain scale (Whitaker, 1997). Additionally in 1998 Amy Norman presented her findings of a study at the University of North Carolina Department of Physical Education, Exercise and Sport Science. Norman's survey of clients revealed they reported between a 75% to 85% positive response for back pain, stress/tension, fibromyalgia, temporomandibular joint pain, hip pain and other pain (Pakozdi, 2014). Janie Godfrey (2001) writing in the periodical N2N (Nurse to Nurse) recounted several case histories in the article titled "The Bowen Technique – gentle and effective antidote to pain." These case studies reported improvement in various pain syndromes per analog pain scale questionnaire. Not present in any of the articles reviewed above is pain from Parkinson's disease. Australian naturopathic physician John. C. Coleman (2009) self-published the book *Stop Parkin' and Start Livin'*. The book chronicled his recovery from Parkinson's disease. Coleman described the relief he received from Bowen treatments, and his theory on the efficacy for Parkinson's disease. He went on to treat patients in his clinic with Bowenwork, claiming his patients who "persisted with this therapy have made great steps forward in returning to health" (Coleman, 2009).

Numerous case studies document this minimalistic approach is inconsistent with patient responses. These responses are more consistent with the NCCAM category of Energy Medicine

---

<sup>15</sup> It should be noted Whitaker's laboratory testing of Lyme disease was discredited.

where a mechanical vibration produces an affect. The modality discussed next falls into the category of Energy Medicine with the use of unconventional use of electromagnetic fields.

### **Modality - Historical and Theoretical Overview of PEMF devices**

The National Center for Complementary and Alternative Medicine (NCCAM) defines Energy Medicine as therapies that “involve the use of energy fields. They are of two types: Biofield therapy intended to affect energy fields...and Bioelectromagnetic-Based therapies that involve the unconventional use of electromagnetic fields such as pulsed fields, magnetic fields or alternating-current or direct-current fields” (NCCAM, 2007). The category of bioelectromagnetic-based therapies includes pulsed fields, magnetic fields, alternating-current fields or direct-current fields (NCCAM, 2007). Earth Pulse is a bioelectromagnetic device that emits pulsed electromagnetic frequencies designed to enhance health.

The history of bioelectromagnetics therapy can be traced back to circa 300 BCE in Western civilization and 2000 BCE in China. In ancient civilization, Aristotle wrote of the healing powers of magnets. The origin of the word magnet is from the Greek *magnes lithos*, meaning the stones from Magnesia where magnetized ore was obtained (Entomology, 2013). The Chinese Medicine classic *The Yellow Emperor’s Book of Internal Medicine* included writings on the use of magnetic stones in assisting the practitioner to correct health imbalances. In the modern era Robert O. Becker pioneered much of the initial research at the Veteran’s Administration Hospital in Syracuse, New York. This facility was closely affiliated with the State University Medical School. As chief of orthopedic research he researched the relationship between electrical currents and the ability of salamanders to regenerate limbs. In his book *Cross currents; the perils of electropollution, the promise of electromedicine* Becker (2004) wrote that medical science underwent a revolution which began following the death of the physician

Paracelsus (1493 – 1541) when the surgeon Andreas Versalius (1514 - 1564) published the first accurate anatomical text. Becker noted that following this publication science developed two distinct branches; biology and physics, the science of living organisms versus the science of matter, motion and energy. During this period, electricity and magnetism were still a part of medical practice. The field of medicine was then influenced by the writings of Descartes (1596 – 1650) and then Newton (1642 -1727).

It was during this period that a divide developed which became known as the *vitalists* versus the *mechanists*<sup>16</sup>. During the 20<sup>th</sup> century as Western Medicine progressed in the United States, the schism became known as the vitalist versus biomedicine or conventional medicine. Conventional medicine disregarded any therapy that did not have a foundation in the biochemistry model. During the mid-1900s remarkable achievements were made in the area of medical biochemistry saving millions of lives with the discovery of penicillin, the subsequent development of antibiotics, the creation of vaccines such as polio and measles, and the unlocking of the cell nucleus' DNA. It was also during this period that physics made leaps and bounds in understanding the microscopic world with the birth and development of quantum physics and subsequent major advancements in technology. With the mechanist view of the body technological advancements progressed disregarding any potential hazards (Becker, 1977). Electromagnetism became common-place changing communications and the environment (Becker, 1977). The reduction of human life to a chemical machine and the advancements of technology collided, creating another revolution, one that bridged biology and physics. Becker stated, “The new scientific revolution has shown that the whole of the body is more than the sum of its parts, that the ability of living things to heal themselves is far greater than the mechanists

---

<sup>16</sup> The definitions of these words are found in the Appendix section Definitions

thought, and that electricity and magnetism are at the very basis of life” (Becker, 2004, p. 25).

Physics and biology were re-merged to create a new paradigm.

The concept of this emerging paradigm is thematic in the book *Magnetic Resonance Stimulation*. Author Joel Carmichael stated, “The modern clinical application of electro-biology in North America began in 1971 when Zachary Friedenbergs described their success in the healing of a nonunion fracture with 10 micro amps of direct current delivered with stainless steel electrodes” (Carmichael, 2009). Following this Andrew Bassett used biphasic low frequency electromagnetic signals for treatment of non-healing fractures. During this period in time public awareness grew regarding the enhancement of race horses’ speed and endurance after receiving electromagnetic field therapy. Although the use of these devices was widespread in Western Europe it was not until 1979 that the Food and Drug Administration (FDA) approved the use of applied electromagnetic fields for non-union or delayed union fractures. Subsequently a decade later FDA approved the use of pulsed electromagnetic field (PEMF) therapy for the treatment of edema of the superficial soft tissue and pain. Additionally, the Center for Medicare Services acknowledged PEMF as a plausible therapeutic modality for application of healing chronic wounds, such as pressure sores and diabetic leg and foot ulcers (Markov, 2006).

Non-ionized electromagnetic fields (EMF) are electrical and magnetic forces that are a type of natural or manmade radiation in the form of waves. Included within EMF is a band of frequencies referred to as ELF or extremely low frequency, where the waves are below 300 Hz. A subset within ELF is pulsed electromagnetic fields (PEMF) which range from 6 Hz up to 500 Hz that are “asymmetric, biphasic, and quasi-rectangular or quasi-triangular in shape” (Shupak, 2003, p. 9). PEMF characteristics also include high rates of change. These high rates of change, pulsating or time-varying fields “easily produce cell induction through lower levels without

producing cell fatigue... cells do not habituate or fatigue to the stimulus” (Carmichael, 2009, p. 41).

The understanding of how EMF influence cellular function correlates with the theory of *biological windows* by S. M. Bawin and R. W. Adey developed in the 1970s (Carmichael, 2009). Bawin and Adey’s research demonstrated calcium output in brain cells was triggered with low magnetic field frequencies (Bawin & Adey, 1976). The theory of biological window states that a range of the band of EMF is information accepted by cells and converted into physiological responses (Bawin, 1976). Examples of these physiological responses include increased oxygen uptake, promotion of circulation, increased production of adenosine triphosphate (ATP), membrane permeability and cellular metabolism, improved communication between cells and promotion of ionic transfer in cells (Sarkar, 2014).

The biological effects of these frequencies were delineated in the article “Insights into electromagnetic interaction mechanisms” by Reba Goodman and Martin Blank (2002). The results of their research showed EMF influenced the cell membranes, and also the DNA synthesis by changing the velocity of electrons within the double helix. This suggested that EMF could be used pre-surgically for enhancement of tissue regeneration (Goodman & Blank, 2002). They began their article stating:

It is now well established that low frequency fields induce biological changes that include effects ranging from increased enzyme reaction rates to increased transcript levels for specific genes. The induction of stress gene HS70 expression by exposure to EM fields provides insight into how EM fields interact with cells and tissues.... Based on published evidence of the electron transport/charge flow in DNA, it is likely that EMF interact directly with electrons in DNA to stimulate biosynthesis. (Goodman, 2002, p. 16)

These concepts were further clarified in “Why are living things sensitive to weak magnetic fields?” by Abraham R. Liboff (2013). The article acknowledged there had been numerous well-documented experiments reporting that living things were sensitive to “weakly intense, extremely low-frequency magnetic fields”, and this had puzzled researchers as they were “well below levels that might conceivably result in meaningful Faraday induction or Joule heating” (Liboff, 2013). Theoretical constructs to explain this phenomenon included ion cyclotron resonance (the movement of ions in magnetic fields), parametric resonance (superharmonic resonance) and quantum electrodynamic formation of ion-free water (quantum coherent water effects on biological organisms) (Liboff, 2013). The article questioned whether these theories made biological sense. In reviewing the literature on geomagnetic fields (GMF) and the navigation of insects, reptiles and avialae, Liboff noted there were differences and similarities between magnetostatic fields and time-varying fields. GMF did have oscillations, but they existed over a 24-hour period. Additionally, they were affected by solar flares. Both of these produced daily fluctuations in ultraviolet radiation and tidal-induced flow of electrons, which “may act as a surrogate for biological clock activities” (Liboff, 2013, p. 3). Liboff citing articles by Bernard and Gertrude Dull (1935), H. Friedman, R.O. Becker and C. H. Bachman (1963), M. Berk, S. Dodd and M. Henry (2006), and James Close (2012), showed there was a seventy-five year correlation between geomagnetic perturbations and the manifestation of various medical problems. His article concluded by stating that though the diurnal changes in the GMF may help explain ELF bio-interactions, they do not provide an answer as to the exact mechanism (Liboff, 2013). He acknowledges all of these frequencies and fluctuations existed as organisms evolved on the planet.

The importance of these frequencies was the subject of a study during early space exploration. Although not found in peer-review journals or books, numerous Internet sites refer to the first cosmonaut and astronaut flights into space causing weakness of an unknown origin, presumed to be gravitationally related. In “Shielding, but not zeroing of the ambient magnetic field reduces stress-induced analgesia in mice” the authors mimicked space beyond Earth’s gravitational field in an experiment with mice. Their study revealed that the lack of ELF magnetic fields for a period of two hours was sufficient time to result in decreased cellular function (Choleris et al., 2002). The reduction of magnetic fields was the subject of research by Kyoichi Nakagawa. Nakagawa (1976) researched the effect of magnetism on human illness syndromes. He felt the origin of a constellation of symptoms, mitigated by the application of magnetism, was due to what he termed *magnetic field deficiency*. As a result of his research he concluded this deficiency was based on the natural historical weakening in the Earth’s field (Nakagawa, 1976). Carmichael explained the overarching impact of these findings when he wrote:

Magnetic resonance stimulation within the biological window can have a profoundly positive impact on health. Stimulation at frequencies and amplitudes outside the biological window will produce little or no positive health benefit...Magnetic fields pass through the body virtually without encountering any resistance...The resonance effect restores disrupted or abnormal cellular and/or cell receptor oscillations that are vital for metabolic processes, circulation, cell regeneration and the immune system. (Carmichael, 2009, p. 35)

An additional use of PEMF is for restoring healthy sleep patterns. In “Impulse magnetic-field therapy for insomnia; a double-blind, placebo-controlled study” (Pelka, Jaenicke &

Gruenwald) the authors randomly assigned 101 patients to a treatment or placebo group. The findings revealed seventy percent of the treatment group reported a great deal of improvement in their symptoms while only two percent of the control group reported a great deal of improvement.

### **Earth Pulse a PEMF device in the Chronic Pain Population**

The use of pulsed electromagnetic frequency (PEMF) devices in this country has been limited. Following extensive research by Becker in 1979, the FDA did approve EMF devices for bone regeneration of nonhealing unions. Over-the-counter devices that use PEMF use one type of low-frequency signals (Markov, 2007). In “Expanding the use of pulsed electromagnetic field therapies” the author explains;

PEMF devices are usually low-frequency fields with very specific shapes and amplitudes. The large variety of commercially available PEMF devices makes it difficult to compare their physical and engineering characteristics, presenting a major obstacle when attempting to analyze the putative biological and clinical effects obtained when different devices are used. (Markov, 2007)

The Earth Pulse is an over-the-counter device. When purchasing the device the buyer must accept the disclaimer that it is not intended to be used to diagnose, treat, cure or prevent any disease (Becker, 2014). As described by Markov (2007), this type of device emits low-frequency fields with specific shapes and amplitudes. The schematic of this output is included in Appendix A. The device is the size of a hockey puck. It was designed to be placed under a

mattress and deliver PEMF during sleep with four settings for up to eight hour cycles of varying pulse sequences. The device is promoted to help with relaxation and sleep.

A search in Google Scholar and PubMed in May 2014 for the string “Earth Pulse and chronic pain” as inclusion criteria yielded no articles. An additional search for the string “PEMF and chronic pain” yielded eight articles. Of the eight articles reviewed three were on fibromyalgia, rheumatoid arthritis and generalized nonmalignant pain. The remaining five articles were on neck pain.

The review article “Neck Pain” delineating multiple differential diagnoses within this single diagnosis. It reviewed treatment modalities for each subtype to include whip lash and nonspecific neck pain (Binder, 2008). Two review articles were from the Cochrane Collaboration. Both of these articles reported findings that were limited, and the evidence for the use of PEMF devices could not be determined (Kroeling, Gross & Goldsmith, 2005; Kroeling, Gross & Goldsmith, 2005). The remaining two articles on neck pain reported conflicting findings, although in design they were not comparable. One study was a randomized six-month study with criteria of neck pain for more than three months which compared PEMF ( $n=42$ ) to spa therapy ( $n=44$ ). Utilizing the Copenhagen scale score and the MOS SF-36 survey the researchers reported the PEMF treatment was superior to the spa therapy (Forestier, 2007). The second study’s criterion was mechanical neck pain. They compared two levels of weight training with PEMF, reporting that PEMF was not found to have a significant effect (Giombini, 2013). One additional article was found on cervical osteoarthritis. In this study thirty-four patients were included in a randomized and double-blinded trial with a treatment and sham treatment group (PEMF  $n=17$  and sham  $n=15$ ). They reported improvement in pain within the PEMF group correlating with previous studies of improvement in pain in studies involving

osteoarthritis of the knees. In reviewing literature on the effects of PEMF on osteoblast cultures they postulated that the PEMF may have stimulated enhancement of cellular differentiation allowing cartilage to absorb more stress-reducing transmission of stress to bone (Sutbeyaz, 2006).

The three articles found on musculoskeletal pain syndromes included fibromyalgia with other syndromes of nonmalignant chronic pain and rheumatoid arthritis. All three studies were double-blinded placebo-controlled studies. The study “Exposure to a specific pulsed low-frequency magnetic field; a double-blinded placebo-controlled study of effects of pain ratings in rheumatoid arthritis and fibromyalgia” consisted of thirty-one participants with an inclusion criteria of physician referral (Shupak, 2006). Thirteen participants carried the diagnosis of rheumatoid arthritis and eighteen carried the diagnosis of fibromyalgia. Listed within the article were the details of multiple standardized questionnaires. Participants received a single thirty-minute treatment or sham treatment utilizing a headset as the source of the PEMF. The sham group received an identical head set that had been altered. In the conclusion of the study the authors reported PEMF appeared to have some analgesic properties for the rheumatoid arthritis subjects, but the results for the fibromyalgia subjects were mixed (Shupak, 2006).

The study reported in “Low-frequency pulsed electromagnetic field therapy in fibromyalgia; a randomized, double-blinded, sham-controlled clinical study” consisted of fifty-six participants with an inclusion criteria of chronic pain greater than three months (Sutbeyaz, Sezer, Koseoglu & Kibar, 2009). The duration of the diagnosed fibromyalgia ranged from two years to six-and-half years. Listed within the article were the details of multiple standardized questionnaires. Each participant received two thirty-minute self-administered treatments per day for a total of three weeks. The sham group received an identical mat that had been altered.

Assessments were taken at baseline, at the end of therapy and at twelve weeks. At twelve weeks forty-five participants completed the study protocol. The results reported by the authors' revealed significant improvements at the end of therapy when compared to baseline, with maintenance of improvement at twelve weeks in pain perception but not on Beck Depression Inventory scores.

The study "A randomized, double-blind, placebo-controlled clinical trial using a low-frequency magnetic field in the treatment of musculoskeletal chronic pain" consisted of fifty patients with an inclusion criteria of specialist diagnosed chronic pain for a duration of more than six months. Twenty-seven of the patients were diagnosed with fibromyalgia. Listed within the article were the details of multiple standardized questionnaires. Each participant received two forty-minute self-administered treatments utilizing a headset as the source of the PEMF. The sham group received an identical head set that had been altered. Thirty-two participants completed the study protocol. The study took place over four weeks, but treatment was limited to seven days. At seven days there was a documented drop in levels of pain reported by the treatment versus sham group, but it did not reach statistical difference. Evaluation following the washout period revealed a steady rise in pain levels in the treatment group.

PEMF as described above is part of the NCCAM category of Energy Medicine. It is the unconventional use of electromagnetism. The next modality to be discussed is also listed under the NCCAM category of Energy Medicine, but it utilizes a form of direct current through the movement of free mobile electrons.

### **Modality - Historical and Theoretical Overview of Earthing**

The National Center for Complementary and Alternative Medicine (NCCAM) defined Energy Medicine as therapies that "involve the use of energy fields. They are of two types:

Biofield therapy intended to affect energy fields...and Bioelectromagnetic-Based therapies which involve the unconventional use of electromagnetic fields such as pulsed fields, magnetic fields or alternating-current or direct-current fields” (NCCAM, 2007). Earthing is a new modality based on health benefits achieved through reconnecting with the earth’s free mobile electrons. It is not contained within the list by NCCAM, but by definition is part of this category.

The definition of Energy Medicine above includes the unconventional use of electricity. The term electricity is defined as “a form of energy resulting from the existence of charged particles such as electrons or protons” (Oxford, 2014). The discovery of electrons dates back to 1897 when J. J. Thomson (1856 – 1940) and a team of British physicists performed experiments with cathode rays. Their experiments indicated the rays were unique particles, rather than waves or atoms as previously believed. The name electron was then proposed by the Irish physicist George F. Fitzgerald (1851 – 1901) for these particles. It was theorized that electrons were components of atoms. This was later clarified through the research of physicist Henri Becquerel (1852 – 1908) and Ernest Rutherford (1871 – 1937) in 1900. During the previous century Ben Franklin (1706 – 1790) used the nomenclature of negative and positive when referring to electricity during his experiments. Subsequently, the atom’s electron charge was described as negative and the proton’s charge positive. The atom evolved from the Greek atomos, which means *indivisible particle*. The atom consisted of protons, neutrons and electrons, with the electrons being the smallest in weight and mass (Schumaker, 2009). The movement and flow of discrete electrons was referred to as *current* (Holzner, 2006).

In the book *Energy Medicine* James Oschman (2000) used the term *living matrix* to describe the body-wide energetic system, a latent whole-body high-speed communication

network capable of free-flowing discrete electrons. Nobel laureate Albert Szent-Gyorgyi (1893 – 1986) theorized the existence of such a high-speed communication system based on his research of the subatomic properties of the protein fabric within mammals, rapid reflex responses within the human eye and a kitten's rapid reaction which was quicker than the speed of nerve action (Oschman, 2003). Oschman noted Szent-Gyorgyi's observation that the extracellular protein fabric of connective tissue had the properties of being semiconductive. It was this matrix that allowed the rapid passage of electrons, which could be the means of a whole organism communication network. In 1941 Szent-Gyorgyi published two papers on this subject explaining how collagen, the main component of connective tissue, created a “lattice structure bonded by electrons, which are actually mobile, as they are not fixed nor do they belong to any particular atom, molecule or bond” (Oschman, 2003, p. 59). Oschman wrote, “Szent-Gyorgyi's 1941 statement refers to electrons belonging not to single atoms, but to the whole system. In other words, certain electrons within a crystalline substance are free to migrate from atom to atom or molecule to molecule, thereby conveying energy and information from place to place through the continuum” (Oschman, 2003, p. 92). In electronics it was the advancement of semiconductors that propelled Western society into the Information Technology (IT) age, and it was the semiconductive properties of the entire body's connective tissue that provided the human body with this proposed high-tech system. It was the free movement of electrons that was at the heart of the latent body-wide energetic and communication network (Oschman, 2008). It is the movement of the free mobile electrons within this lattice structure that can aid the body as antioxidant in the healing of inflammatory processes.

In the past, Western medical advancements were successful in the areas of infectious disease and surgery, but it remained challenged in the areas of autoimmune related and chronic diseases. At

the core of many chronic disease syndromes is inflammation. Chronic inflammation is associated with the painful symptoms such as seen in lupus, enteritis, and arthritis. The origin of the medical terminology suffix *itis* is from the Greek *pertaining to* and evolved to mean *inflammation of* (Inflammation, 2014). In an acute setting the body initiates “a protective complex biological response by having the white blood cells “release free radicals, called an oxidative burst” (Ober, Sinatra & Zucker, 2010, p. 59). The natural process of free radicals is to aid in the destruction of invading micro-organisms and damaged tissue. These positive-charged molecules are looking for a free electron in either a pathogen or the damaged tissue. Metabolically, a chronic inflammatory process begins with the same protocol as the acute process; however, it progresses to an electron obtained from healthy tissue (Oschman, 2007). This in turn increases the number of free radicals and the circular loop process repeats itself. When the body’s defense mechanism turns on itself this chronic low grade inflammatory process can be a silent or occult medical condition leading to more serious disease processes (Oschman, 2007).

While the chronic inflammation process was known to be at the core in diseases like arthritis and regional enteritis (Crohn’s disease), it was not until the mid-1980s that it came to the forefront with a different perspective. Australian researchers Barry Marshall and Robin Warren reported chronic inflammation caused by *Helicobacter pylori* bacteria was the origin of stomach ulcers, and not stress, spicy foods and too much acid (Marshall, 1995). Then in 2000, the Harvard cardiologist and lead researcher Paul Ridker, M.D. published the results of his three-year longitudinal study of 28,263 post-menopausal women. In an interview for the American Association for Clinical Chemistry Ridker stated, “We now teach the Harvard Medical School students right at the beginning, atherosclerosis, yes, is a disease of lipid accumulation; but it’s a disease of inflammation fundamentally, the same way we teach the students rheumatoid arthritis

is a disease of inflammation. That shift in our thinking is what this is really all about, and I think that shift is what will drive the research for the future” (Barrett, 2012).

## **Earthing**

The theoretical foundations of Earthing are based in the theory of electrons, their movement within the human body and the effect of free mobile electrons as described above. In the book *Earthing* Clinton Ober (2010) chronicled his exploration of the health effects of the human connection and interaction with the earth’s electrical field including electrons. Ober noted that the Earth's surface was covered with negatively charged free electrons. Ober had worked in the cable industry, where he trained his employees to take precautions in electromagnetic generated fields using a procedure called *grounding*. The act of grounding connected a person to the Earth through a conductive or semiconductive material, avoiding the buildup of negatively and positively charged particles, and instead allows the free movement of electrons from one object to another, to create a harmless homeostatic state (Ober, 2010). The Earth's surface maintains a negative electron charge, which occurs via a global electrical circuit (Chevalier, Mori & Oschman, 2006). Physicist Gaetan Chevalier noted humanity evolved over the past 26,000 years with direct or unimpeded contact to this environment (Chevalier, 2006). When the Earth's surface, with all of the free negative electrons, comes in contact with the human body, electrons move towards the body to create a homeostatic state with the same electrical potential as the earth (Chevalier, 2006).

Electrical engineer Roger Applewhite (2005) investigated the electrical impedance and capacitance of grounding a body reporting his results in “The effectiveness of a conductive patch and a conductive bed pad in reducing human body voltage via the application of earth ground.” Electrical impedance is the resistance or opposition of an electrical current and electrical capacitance is the ability of the system to store an electric charge. Applewhite designed

electrostatic discharge systems for the electronics industry. In his study Applewhite (2005) explained the interactions of the human body with electromagnetic fields. For the purposes of understanding the effect of grounding, although the scenario is actually more complex, the two parameters of impedance and capacitance are “widely accepted as a reasonable approximation of a real body's electrical response, as long as the spectral content of interest is not of too high a frequency” (Applewhite, 2005, p. 4). The goal of his study was to determine the body surface voltage changes without unwanted influences from the environment. The report detailed the equipment chosen, justification for the chosen equipment and the steps taken to avoid contamination of the data. Although Applewhite's design for grounding and equipment were more sophisticated than equipment originally used by Ober, it contained the basic element of a human body being placed on an item made with conductive material which was connected to the Earth through circuitry. The details of his findings graphed out the surface voltage of a body before and after being on a grounding item (a bed pad and a patch designed by Ober). Readings were taken from three areas of the body, "The purpose of the study was to verify a voltage drop across the impedance to an earth ground that represented the current into the body's capacitance" (Applewhite, 2005, p. 13). Graphs demonstrated the reduction in 60 Hz voltage, the electromagnetic field that increases concentrations of free radicals, lengthens their lifespan and enhances the probability that they can do damage to the body (Ober, 2010).

Applewhite's study demonstrated that the body's electrical potential when exposed to the earth changed before and after grounding. He reported:

Body voltage is reduced, even though relatively high impedance. This is consistent with our estimate of the small capacitive link between mains voltage and the body. In addition, the voltage drop waveform is of primarily the same shape as the

original body voltage. The waveforms were moved along the time axis so as to make their peaks coincide, as a phase shift would be expected from impedance analysis. This is consistent with the current we expect to be entering the body capacitance from earth ground. (Applewhite, 2005, p. 14)

The study demonstrated free electrons moved into the body and reduced the electromagnetic fields of the body. The hypothesis of how this affected the body had been the subject of ongoing and continued research.

### **Earthing in the Pain Population**

Due to the recent discovery of Earthing, the literature on this modality is scant. Differential diagnoses of chronic pain syndromes versus generalized pain were not utilized for this section. A total of four references of Earthing in the pain population were found. One reference was part of Ober's initial investigations, one was a more formalized investigation by Ober, one was a research study conducted by a medical doctor and the fourth were reports of case studies at a conference.

Following a personal revelation, Clint Ober started his investigations into the effects of grounding on health in 1999. It was during that period in his life that he referred to himself as an amateur scientist. After conducting an extensive review of literature he could not find any information on the effects of grounding and health, either positive or negative. Following this he recruited friends to use a rudimentary device he fashioned. This small circle of subjects shared a similar experience of just feeling good, with decreased generalized pain and improved sleep (Ober, 2010). Ober continued to investigate his theory eventually recruiting sixty volunteers. This blinded study had twenty-two males and twenty-eight females who were randomly assigned

an active or sham device. Ober tracked the changes in electrical potential along with self-reports of generalized pain and sleep, in addition to other ailments (Ober, 2010). The findings revealed positive results when he compared the experimental and control group.

Ober eventually was able to interest retired medical doctor Maurice Ghaly, in assisting him in conducting additional investigations. In 2004 Ghaly and Dale Teplitz published “The biological effects of grounding the human body during sleep as measured by cortisol levels and subjective reporting of sleep, pain and stress.” Twelve subjects were recruited for an eight week study. Ghaley added salivary circadian cortisol to the testing profile, to test the subject’s stress levels (Ghaly, 2004). The study reported the changes in electrical potential, in addition to the changes in six-sample 24-hour cortisol levels. Both the electrical potential and cortisol levels trended towards normalization in the majority of the participants. At the conclusion of the study eleven subjects reported, “it took less time to fall asleep...awoke fewer times during the night..., nine reported improvement in fatigue... and ten reported decreased pain” (Ghaly, 2004, p. 771). Review of the narratives provided by the subjects revealed self-reported improvement in gastrointestinal symptoms, temporomandibular symptoms, headaches, and female hormonal symptoms.

On November 12, 2003 in Budapest, Hungary, Ober and environmental biologist Roger W. Coghill made a presentation at the European Bioelectromagnetics Association annual meeting. A copy of the presentation titled, “Does grounding the human body to Earth reduce chronic inflammation and related chronic pain?” reviewed the theories behind Earthing, the study by Ghaly and Teplitz, and case history information obtained by Ober. Case histories documented improvement of swelling and pain associated with diabetic peripheral vascular disease and non-healing foot ulcers, with maintenance of improvements after three months.

It should be noted a total of nine articles on Earthing were used for this report. Earthing is a product invented and produced by Clint Ober. The research branch of this company is Earth FX, Inc. The authors from these articles were interdisciplinary with backgrounds in electrical engineering, engineering physics, biophysics, biology, cardiology, and neurology. Three of the authors have worked as independent contractors or consultants for Earth FX, Inc. A declaration of interest was declared in each article as appropriate. In addition funding support by Earth Tether International of the research projects was included in disclosure declarations within the articles as appropriate.

### **Summary**

The U.S. Army Surgeon General's Task Force defined chronic pain as a condition that does not serve a useful purpose, and it is accompanied by pathophysiological changes in the central nervous system that may adversely affect a patient's physical well-being and quality of life (Delgado, 2014). This population often experience failure of treatment at the primary care level, and move on to treatment in a secondary pain center. Patients with a diagnosis of chronic pain are not in a heterogenous population, as the etiology of the pain syndromes has multiple origins.

The Institute of Medicine 2011 report *Relieving Pain in America* identified chronic pain as an escalating public health concern (Pizzo, 2011). Underlying principles of the report identified the need for interdisciplinary approaches and the need for research. Research challenges included the gap between knowledge and the implementation of this knowledge into safe and effective therapies. The report clearly identified the reciprocating effect of pain and psychosocial stressors. Not identified within the report was the emerging IM model. IM is not the introduction and use of CAM modalities within an allopathic model, but rather it has a focus

of wellness and Patient-Centered Care. In *The Scientific Basis of Integrative Medicine* Wisneski (2009) provides evidence for his proposed Relaxation System. Thematic throughout this paper is the role of stress and relaxation towards the goal of wellness.

The Bravewell Collaborative implemented the IM model within their chronic pain population with positive results. Not included within the Bravewell study, but scattered throughout the literature, was the identification of abnormal stress markers of HRV (Cain, 2007; Ernest, 2014; Gavi et al., 2014; Heitmann, 2011; Kamath, 2013; Lerma, 2011; Thayer, 2006;) and circadian cortisol levels (Blackburn-Munro, 2004; Bombolt, 2004; Holliday, 2010; Mutsuura, 2009; Turner-Bobb, 2010) in the chronic pain population.

The theoretical foundation for the three modalities of Bowenwork, Earth Pulse and Earthing are based on supporting the body towards states of wellness. The modality Bowenwork promotes wellness through the theoretical construct of autonomic nervous system rebalancing, rehydration of tissues, and the reset of tissue tension (Coleman, 2009; Hansen, 2010; Whitaker, 1997). The modality Earth Pulse promotes wellness through the theoretical construct of improved cellular metabolism and sleep architecture (Bawin, 1976; Carmichael, 2009; Sutbeyaz, 2006; Liboff, 2013). The modality of Earthing promotes wellness through the theoretical construct of system-wide response to the correction of electrical potential (Chevalier, 2012; Ghaley, 2004; Ober, 2010; Oschman, 2007). Based on the theories developed in PNI, movement towards wellness in one system will affect the whole system.

Further review of this IM model is offered in Chapter 3 Critic.

### **CHAPTER 3: CRITIC**

Integrative Medicine (IM) is a new model of care in the United States. Its roots are based in the recent interdisciplinary discoveries within biology, chemistry, endocrinology,

immunology, psychology and physics. IM philosophy represents a shift in focus from treatment of a disease state to enhancement of wellness with a holistic approach that utilizes CAM modalities with an emphasis in body, mind and spirit. Research on chronic pain has correlated the reciprocating effects of stress in this population, where chronic pain is a stressor and stress enhances chronic pain symptoms. Beginning in the 1990s, the research by Candace Pert (Schlitz, Amorok & Micozzi, 2004) began to unravel how stress prevents information molecules from flowing freely in the largely autonomic processes that regulate the body. Utilizing stress biomarkers to evaluate chronic pain and CAM modalities represents a deviation from the Cartesian model to a systems perspective consistent with the definition of biophysics.

Biophysics is the branch of science that uses “mathematics, physics, chemistry and biology to study how living organisms work” (Scarлата, 2002). Based on biophysics life can be viewed as:

Living systems are regarded as complex, nonlinear, dynamic, self-organizing systems at a global or holistic level according to the principles of nonequilibrium thermodynamics of open systems and chaos theory. Living systems are constantly exchanging energy-with-information at multiple levels of organization with their surroundings in order to maintain themselves. They also possess emergent properties such as higher order relationships dependent on context and meaning that have effects on health, disease, and healing. This biophysical view of life provides the rudiments of a scientific foundation for CAM modalities involving the transfer of bioinformation carried by a small energy signal. This goes beyond the usual molecular concepts of bioinformation. (Rubik, 2002)

This definition of biophysics provides a theoretical foundation for the effect of the three modalities being examined within the IM model discussed within this paper. The two

biomarkers (HRV and cortisol) explored above can represent the system's response to stress. The three modalities explored above may stimulate global regulatory processes resulting in systemic-wide bioinformation.

The IOM report acknowledged that patients seen in secondary pain centers traditionally have failed treatment with primary care practitioners, and often have severe and recalcitrant levels of pain. According to the report by Flor et al. (1992) patients with chronic back pain seen in pain management centers had on an average eighty-five months of unrelenting pain. The study conducted by the Bravewell Collaborative adhered to the principles of the IM model; however, it was not conducted in a secondary pain center. In 2010 B. K. Lind and colleagues published the findings of healthcare costs in patients utilizing CAM modalities within the State of Washington insurance program. The study found a reduction of \$367 to \$1420 in CAM users based on disease burden (Lind, Lafferty, Tyree & Diehr, 2010). The Bravewell Collaborative utilized the IM model with a pain population served in primary care, reporting positive results (Abrams, et al., 2013).

The continued controversy between allopathic and alternative medicine is in the nature, meaning and validity of corroborating research. This issue was formally addressed in "The Vanguard Faculty Program; research training for complementary and alternative medicine faculty" by Connelly, et al. (2010). The goal of the Vanguard project was to educate the educators, teaching CAM practitioners, details of evidenced-based medicine methodology and research, in an effort to increase and improve communication between healthcare professionals. The scope of pilot projects includes problem solving of processes and refinement of research instruments.

Currently, there does not appear to be published research of the application of the principles identified above within a secondary pain center that crosses into a more complex patient population. Future research utilizing this model could add to the IM knowledge base, and provide useful information in a burgeoning disenfranchised segment of the population. Utilizing HRV and cortisol as stress biomarkers within an IM model offers an opportunity to add to the current body of knowledge, and perhaps begin the foundation for stratification of success in subgroups within this heterogenous population. The exploration of treatment stratification in this population addresses a primary deficit identified by the writers of the articles from the Samueli Institute in the April 2014 supplement of *Pain Medicine*.

## CHAPTER 4 SUMMARY

The relationship between wellness, stress and pain has been the subject of ongoing research in multiple subspecialties of medicine, as well as in the domain of public health. In *Relieving Pain in America* the authors discussed the correlation between the stressors of socioeconomic status and levels of pain as found in numerous research studies (Pizzo, 2011). These studies documented how the concept of allostatic load contributed to the chronic pain patients' experience, citing "population-based studies have consistently shown that chronic pain occurrences are inversely related to socioeconomic status" (Pizzo, 2011, p. 74). Additionally, they noted studies have documented surgical care patient outcomes correlated with "inadequately controlled pain and circulation of stress-related hormones" whereby patients were more prone to developing chronic pain (Pizzo, 2011, p. 84).

The focus of the IOM literature reviewed demonstrated the stress-related predictive factors contributing to the prevalence and degrees of chronic pain. IOM treatment recommendations included a biopsychosocial approach. Examples of this approach were given in the section on psychological therapies. In reviewing the literature the IOM reported meta-analysis found positive results in overall function, but they also cited studies which showed conflicting long-term benefit. Included within this section of the IOM report were examples of studies specifically demonstrating a correlation between the reduction of stress and improvement in pain syndromes. From general literature, examples of this approach included a ten-week stress reduction program of ninety chronic pain patients who were trained in the mindfulness meditation technique. The authors of this study reported the stress reducing technique resulted in improvement of present-moment pain and multiple psychosocial factors, and decreased medication use in this heterogenous population (Kabat-Zinn, Lipworth & Burney, 1985).

Similar findings were found in studies within the field of pulmonological, gastroenterological and gynecological surgery. Authors G. B. Diette, et al. (2003) conducted a randomized controlled trial (RCT) of patients receiving a bronchoscopic procedure. This study surrounded patients with the known stress reducing effect of nature sounds and murals before, during and after a flexible bronchoscopy. The results reported included a significant reduction in post procedure pain of the treatment group when compared to the control group (Diette, 2003). Nursing researchers M. Good et al. (2002 & 2005) performed RCT studies on patients receiving surgery for various gynecological and gastrointestinal issues. Their studies compared postoperative day one and day two responses to pain in patients who received training in relaxation techniques, along with a music intervention. The results revealed a significant reduction in patient reported levels of pain in the treatment versus control groups.

Thematic in all of these studies was the promotion of relaxation, through various means and modalities, which resulted in the reduction of patient reports of pain. Each of the three modalities reviewed for this paper promotes relaxation towards the goal of wellness. To date limited research has been conducted on Bowenwork, and the exact mechanism of action is unknown (Hansen & Taylor-Pillae, 2010). It is believed the modality promotes balance of the autonomic nervous system (ANS), in conjunction with the reduction of muscular tension. This is accomplished through patient directed breath during manipulation of the soft tissue. Observation confirms patients do enter various states of relaxation (BAA, 2013). When the ANS balances, patients are able to enter into a healing state where the pain syndrome can be mitigated.

The theoretical framework of the Earth Pulse device and the Earthing sheet are based on physiological reduction of the allostatic load. The Earth Pulse is a device which emits pulsed

electromagnetic frequencies (*PEMF*<sup>17</sup>). PEMF devices promote improvement of physiological function through a sedative effect on the nervous system, improved circulation and oxygenation to muscle tissue, and improved sleep (Carmichael, 2009). This device's enhancement of these physiological functions promotes a state of wellness, which has the potential to mitigate the pain syndrome. The mechanism of the Earthing sheet is through the correction of the body's electrical potential, and a reduction of inflammation through the antioxidant effect of free mobile electrons. This results in a reduction of the allostatic load, which has the potential to mitigate the pain syndrome.

The correlation of allostatic load with pain syndromes was documented in the IOM report. The IOM report acknowledged the mind-body connection, and recommended a biopsychosocial approach in treating chronic pain. However, the reduction of the allostatic load and how this translated into short-term and long-term reduction of pain in the heterogeneous chronic pain patient was not clearly identified. The theoretical framework of each of the modalities in this study is consistent with the systems perspective towards wellness. This model is not congruous with the biomedical model, which fuels the continued debate on the appropriateness of CAM modalities by allopathic medicine. This debate continues to limit CAM research. This limitation has affected all three of the modalities in this research study.

The U.S. Army Surgeon General's Task Force defined chronic pain as a condition that does not serve a useful purpose, and it is accompanied by pathophysiological changes in the central nervous system that may adversely affect a patient's physical well-being and quality of life (Delgado, 2014). This population often experience failure of treatment at the primary care level, and move on to treatment in a secondary pain center. Patients with a diagnosis of chronic

---

<sup>17</sup> The definition of this word is found in the Appendix section Definitions

pain are not in a heterogenous population, as the etiology of the pain syndromes has multiple origins.

The Institute of Medicine 2011 report *Relieving Pain in America* identified chronic pain as an escalating public health concern (Pizzo, 2011). Underlying principles of the report identified the need for interdisciplinary approaches and the need for research. Research challenges included the gap between knowledge and the implementation of this knowledge into safe and effective therapies. The report clearly identified the reciprocating effect of pain and psychosocial stressors. Not identified within the report was the emerging IM model. IM is not the introduction and use of CAM modalities within an allopathic model, but rather it has a focus of wellness and Patient-Centered Care. In *The Scientific Basis of Integrative Medicine* Wisneski (2009) provides evidence for his proposed Relaxation System. Thematic throughout this paper is the role of stress and relaxation towards the goal of wellness.

The Bravewell Collaborative implemented the IM model within their chronic pain population with positive results. Not included within the Bravewell study, but scattered throughout the literature, was the identification of abnormal stress markers of HRV (Cain, 2007; Ernest, 2014; Gavi et al., 2014; Heitmann, 2011; Kamath, 2013; Lerma, 2011; Thayer, 2006;) and circadian cortisol levels (Blackburn-Munro, 2004; Bombolt, 2004; Holliday, 2010; Mutsuura, 2009; Turner-Bobb, 2010) in the chronic pain population. Based on the IM theory focus of wellness promotion, the possibility exists that the biomarkers of both HRV and cortisol could be used to evaluate and track the chronic pain population's journey towards wellness when incorporating the three modalities above of Bowenwork, Earth Pulse and Earthing, and this process could mitigate pain syndrome symptoms.

The theoretical foundation for the three modalities of Bowenwork, Earth Pulse and Earthing are based on supporting the body towards states of wellness. The modality Bowenwork promotes wellness through the theoretical construct of autonomic nervous system rebalancing, rehydration of tissues, and the reset of tissue tension (Coleman, 2009; Hansen, 2010; Whitaker, 1997). The modality Earth Pulse promotes wellness through the theoretical construct of improved cellular metabolism and sleep architecture (Bawin, 1976; Carmichael, 2009; Sutbeyaz, 2006; Liboff, 2013). The modality of Earthing promotes wellness through the theoretical construct of system-wide response to the correction of electrical potential (Chevalier, 2012; Ghaley, 2004; Ober, 2010; Oschman, 2007). Based on the theories developed in PNI, movement towards wellness in one system will affect the whole system.

### **Conclusion**

Descartes and Newton left their mark in science and history. Their perceptions, discoveries and influence on philosophy are referred to as the Cartesian model. The Cartesian model along with the advancement of technology led to the many remarkable achievements in the pathophysiology of disease. The development of scientific inquiry, which separated and isolated individual factors that influenced an object under research, set the standard and provided the structure for many discoveries. The evolution of this model progressed to a hidden assumption - that the majority of health issues were resolvable through the dissection and understanding of individual isolated parts of the whole. The biomedical model's foundations are in this world view. The progression of this world view led to the reduction of acute disease syndromes that are pathophysiologic in origin, but overall failed to address the issues endemic in chronic disease syndromes.

As science advanced beyond the microscopic world of pathology to the atomic and subatomic world of quantum physics the direct relationships of the Cartesian model became obsolete. By definition for a therapy to be considered CAM, it is implausible by the Cartesian world-view. The locus of CAM is an alternate world view, one that is congruous with the advancements within quantum physics - systems theory or interconnection. It is here that CAM efficacy in chronic disease arises. Integrative Medicine was born out of the frustration of practitioners who felt the resources or tools available did not meet the needs of this latter segment of their medical practice.

If CAM and allopathic medicine are to merge into Integrative Medicine there has to be a recognition and acknowledgement of the two world views' manifestations in separation and interconnection. The challenge by Golden (2012) was to find ways to evaluate the nonspecific system wide effects of CAM modalities. The recent findings by numerous researchers on the effects of stress include discoveries of how stress prevents information molecules from flowing freely in the largely autonomic processes that regulate the body (Pert, 2004), the system wide toll stress produces (Sapolsky, 2014) and the relationship of stress, allostatic load and genetic expression (Zalli, et al., 2014), all of which support systems theory. Stress is a systemic phenomenon. Abnormal HRV and cortisol levels as a representation of allostatic load are consistent with the study published by Zalli (2014). These tests are reflective of the body's level of stress. Future research with these two biomarkers and patient self-reports, is an exploratory option fulfilling the challenge by Golden (2012). The use of quantitative data of holistic variables within a systems perspective is an attempt to narrow the divide between CAM and allopathic medicine.

## REFERENCES

- Abrams, D. I., Dolor, R., Roberts, R., Pechura, C., Dusek, J., Amoils, S.,... Wolever, R. Q. (2013). The BraveNet prospective observational study on integrative medicine treatment approaches for pain. *BMC Complementary and Alternative Medicine*, 13 (1): 146, doi: 10.1186/1472-6882-13-146
- Aloisi, A. M., Buonocore, M., Merlo, L., Galandra, C., Sotgiu, A, Bacchella, L., Ungaretti, M, Demartini, L. & Bonezzi, C. (2011). Chronic pain therapy and hypothalamic-pituitary-adrenal axis impairment. *Psychoneuroendocrinology*, 36 (7), 1032 – 1039.
- Ambarish, V., Barde, P., Vyas, A. & Deepak, K. K. (2005). Comparison between pre-prandial and post-prandial heart rate variability. *Indian Journal of Physiology and Pharmacology.*, 49 (4), 436 – 442.
- American Academy of Pain Medicine (2013). *AAPM Facts and Figures on Pain*. Retrieved 02/10/2013 from [http://www.painmed.org/patientcenter/facts\\_on\\_pain.aspx](http://www.painmed.org/patientcenter/facts_on_pain.aspx)
- Applewhite, R. (2005). The effectiveness of a conductive patch and a conductive bed pad in reducing human body voltage via the application of earth ground. *European Biology and Bioelectromagnetics*, 1, 23 – 40.
- Asher, A. (2013). *What is Pain Management?* Retrieved February 10, 2013 from <http://backandneck.about.com/od/chronicpainconditions/f/painmanagement.htm>
- BAA, Bowen Academy of Australia (2013). *The review of the Australian Government rebate on private health insurance for natural therapies*. Brisbane, Queensland, Australia: QCOMP.

- Barrett, B. (2012). American Association of Clinical Chemistry pod cast interview of Paul Ridker. Retrieved February 1, 2013 from [http://www.aacc.org/publications/clin\\_chem/Documents/0109Jupiter.pdf](http://www.aacc.org/publications/clin_chem/Documents/0109Jupiter.pdf)
- Baulieu, E. & Kelly, P.A. (1990). Hormones, from molecules to disease. *Herman Publishers, Chapman & Hall: New York, N.Y.*
- Bawin S. M. & Adey W. R. (1976). Sensitivity of calcium binding in cerebral tissue to weak environmental electric field oscillating at low frequency. *Proceedings of the National Academy of Sciences of the United States*, 73(6), 1999 – 2003.
- Becker, P. (2014) *EarthPulse*. Retrieved June 1, 2014 from <http://www.earthpulsetechnologies.com/>
- Becker, R. O. (1990). *Cross currents; the perils of electropollution, the promise of electromedicine*. New York, N.Y.: Jeremy P. Tarcher/Penguin Group, USA Incorporated.
- Beebe, L. H. (2007). What can we learn from pilot studies? *Perspectives in Psychiatric Care*, 43 (2), 213 – 218.
- Bell, I. R., Caspi, O., Schwartz, G. E. R., Grant, K. L., Gaudet, T. W., Rychener, D., Maizes, V. & Weil, A. (2002). Integrative medicine and systematic outcomes research; issues in the emergence of a new model for primary health care. *Archives of Internal Medicine*, 162, 133 – 140.
- Bell, I.R., Cunningham, V, Caspi, O., Meek, P. & Ferro, L. (2004). Development and validation of a new global well-being outcomes rating scale for integrative medicine research. *BMC Complementary and Alternative Medicine*, Jan 15, 4:1.

- Benedetti, M., Merino, R., Kusuda, R., Ravanelli, M.I., Cadetti, F., dos Santos, P., Zanon, S. & Lucas, G. (2012). Plasma corticosterone levels in mouse models of pain. *European Journal of Pain*, 16(6), 803 – 815.
- Bernston, G. G. et al. (1997). Heart rate variability: Origins, methods and interpretive caveats. *Psychophysiology*, 34, 623 – 648.
- Billman, G. E. (2011). Heart rate variability – a historical perspective. *Frontiers in physiology*, 2(86), doi: 10.3389/fphys.2011.00086.
- Binder, A. (2008). Neck pain. *Clinical Evidence*, 2008 Aug 4;2008. pii: 1103.
- Blackburn-Munro, G. (2004). Hypothalamo-pituitary-adrenal axis dysfunction as a contributory factor to chronic pain and depression. *Current pain and headache reports*, 8(2), 116-124.
- Blackburn-Munro, G. & Blackburn-Munro, R. E. (2001). Chronic pain, chronic stress and depression; coincidence or consequence? *Journal of Neuroendocrinology*, 13 (12), 1009 – 1023.
- Bomholt, S. F., Harbuz, M. S., Blackburn-Munro, G. & Blackburn-Munro, R. E. (2004). Involvement and role of the hypothalamo-pituitary-adrenal (HPA) stress axis in animal models of chronic pain and inflammation. *Stress*, 7(1), 1 – 14.
- Cain, K.C., Jarrett M. E., Burr, R. L., Hertig, V. L. & Heitkemper, M. M. (2007). Heart rate variability is related to pain severity and predominant bowel pattern in women with irritable bowel syndrome. *Neurogastroenterology Motility*, 19, 110-118, doi:10.1111/j.1365-2982.2006.00877.
- Carbone, W.J. (2014). American Board of Integrative Medicine January 2014 Update. *American Board of Physician Specialties*. Retrieved May 1, 2014 from <http://www.abpsus.org/integrative-medicine-board-january-2014-update>

- Carmichael, J. P. (2009). *Magnetic Resonance Stimulation; using the field to maximize your health*. North American Academy of Energy Medicine: Greenwood Village, CO.
- Center for Disease Control (2006). *Health, United States, 2006*. Retrieved February 10, 2013 from <http://www.cdc.gov/nchs/data/hus/hus06.pdf>
- Chevalier, G. et al. (2012). Earthing: Health Implications of Reconnecting the Human Body to the Earth's Surface Electrons. *Journal of Environmental and Public Health*, doi.org/10.1155/2012/291541
- Chevalier, G., Mori, K. & Oschman, J.L. (2006). The effect of earthing (grounding) on human physiology. *European Biology and Bioelectromagnetics*. Retrieved June 1, 2014 from [http://humanscience.tripod.com/sitebuildercontent/sitebuilderfiles/efx\\_science\\_physiology.pdf](http://humanscience.tripod.com/sitebuildercontent/sitebuilderfiles/efx_science_physiology.pdf)
- Cho D.S., Choi J.B., Kim Y.S., Joo K.J., Kim S.H., Kim J.C., & Kim H.W. (2011). Heart rate variability in assessment of autonomic dysfunction in patients with chronic prostatitis/chronic pelvic pain syndrome. *The Journal of Urology*, 78(6), 1369 – 1372. doi: 10.1016/j.urology.2011.07.1379
- Choleris, E., Del Seppia, C. E., Thomas, A. W., Luschi, P., Ghione, S., Moran, G. R. & Prato, F. S. (2001). Shielding, but not zeroing of the ambient magnetic field reduces stress-induced analgesia in mice. *Proceedings of the Royal Society of London*, 269, 192 – 201.
- Claude, C. (2012). What is Bowen Therapy? Retrieved July 1, 2012 from <http://www.listeningtouch.com>.
- Clow, A., Thorn, L., Evans, P. & Hucklebridge, F. (2004). The awakening cortisol response; methodological issues and significance. *Stress*, 7(1), 29-37.

- Cohen, S. & Janicki-Deverts, D. (2012) Who's stressed? Distributions of psychological stress in the United States in Probability Samples from 1983, 2006 and 2009. *Journal of Applied Social Psychology*, 42(6), 1320 – 1334.
- Cohen, S., Kamarck, T. & Mermelstein, R. (1983). The global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 385-396.
- Coleman, J. C. (2009). *Stop Parkin' and Start Livin': Reversing the Symptoms of Parkinson's Disease*. Australia: Read How You Want.
- Connelly, E. N., Elmer, P. J., Morris, C. D. & Zwickey, H. (2010). The Vanguard Faculty Program; research training for complementary and alternative medicine faculty. *The Journal of Alternative and Complementary Medicine*, 16(10), 1117-1123.
- Cortisol, (1974). *Dorland's Illustrated Medical Dictionary, 25<sup>th</sup> edition*. Philadelphia, PA: W.B. Saunders Company. Philadelphia.
- Crawford, C., Lee, C., Frellich, D & Working Group (2014). Effectiveness of active self-care complementary and integrative medicine therapies: Options for the management of chronic pain symptoms. *Pain Medicine*, 15, S86 – S95.
- Davis, et al. (2008). *Neuroscience biomarkers and biosignatures; converging technology and emerging partnerships. Workshop summary*. Washington, D.C.: The National Academies Press.
- Delgado, R. et al. (2014). Assessing the quality, efficacy and effectiveness of the current evidence based of active self-care complementary and integrative therapies for the management of chronic pain: A rapid evidence assessment of the literature. *Pain Medicine*, 15, S9 – S20.

- Depression, (2014). *Oxford Dictionaries*. Oxford University Press. Retrieved 07/05/2014 from [http://www.oxforddictionaries.com/us/definition/american\\_english/depression](http://www.oxforddictionaries.com/us/definition/american_english/depression)
- Diette, G. B., Lechtzin, N., Haponik, E., Devrotes, A., & Rubin, H. R. (2003). Distraction Therapy with nature sights and sounds reduces pain during flexible bronchoscopy; a complementary approach to routine analgesia. *Chest Journal*, 123 (3), 941-8.
- Dionne, I. J., White, M. D., & Tremblay A. (2002). The reproducibility of power spectrum analysis of heart rate variability before and after a standardized meal. *The Journal of Physiology and Behavior*, 75 (3), 267 – 270.
- Electricity (2014). *Oxford Dictionaries*. Oxford University Press. Retrieved June 1,2014 from <http://www.oxforddictionaries.com/definition/english/electricity>
- Magnet, (2013). *Entomology On Line*. Retrieved February 1, 2013 from <http://www.etymonline.com/index.php?term=magnet>
- Ernest, G. (2014). *Heart rate variability*. London, England: Springer-Verlag.
- Evans, S, et al. (2013). Heart rate variability as a biomarker for autonomic nervous system response differences between children with chronic pain and healthy control children. *Journal of Pain Research*, 6, 449-457.
- Fairbanks, J. C. T. & Pynsent, P. B. (2000). The Oswestry disability index. *Spine*, 25(22), 2940 - 2953.
- Ferreira-Valente, M. A., Pais-Ribeiro, J. L. & Jensen, M. P. (2011). Validity of four pain intensity rating scales. *Pain*, 152(10), 2399-2404.
- Flor, H., Fydrick, T. & Turk, D. C. (1992) Efficacy of multidisciplinary pain treatment centers; a meta-analytic review. *Pain*, 49(2), 221-230.

- Forestier, R., Francon, A., Saint-Arromand, F., Guillemot, A., Graber-Duvernay, B., Slikh, M. & Duplan, B. (2007). Are spa therapy and pulsed electromagnetic field therapy effective for chronic neck pain? Randomized clinical trial. Part I. *Annals of Readaptation of Physical Medicine*, 50(3), 140 – 147.
- Frederickson, B. L. & Losada, M. F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychology*, 60(7), 678-686.
- Gaskin, D. J. & Richard P. (2012). The economic costs of pain in the United States. *The Journal of Pain*, 13(8), 715-724.
- Gavi, M. B. R. O., Vassalo, D. V., Fabian T. A, Macedo, D. C. F. Pablo, L. G, Dantas, E. M. & Valim, V. (2014). Strengthening exercises improve symptoms and quality of life but do not change autonomic modulation in fibromyalgia: A randomized clinical trial. *PLOS One*, 9(3),1-8, doi:10.1371/journal.pone.0090767.g001.
- Geisser, M. E, Roth, R. S. & Robinson, M. E. (1997). Assessing depression among persons with chronic pain using the Center for Epidemiological Studies Depression Scale and the Beck Depression Inventory; a comparative analysis. *The Clinical Journal of Pain*, 13(2), 163 – 170.
- Ghaly, M. & Teplitz, D. (2004). The Biologic Effects of Grounding the Human Body During Sleep as Measured by Cortisol Levels and Subjective Reporting of Sleep, Pain, and Stress. *The Journal of Alternative and Complementary Medicine*, 10(5), 767-776. doi:10.1089/acm.2004.10.767.
- Giombini, A., Di Cesare, A., Quaranta, F. Giannini, S., Di Cagno, A., Mazzola, C., Pigozzi, F., & Saraceni, V. M., (2013). Neck balance system in the treatment of chronic mechanical

- neck pain; a prospective randomized controlled study. *European Journal of Physical Rehabilitation Medicine*, 49(3), 283 – 290.
- Gockel, M. Lindholm, H. Niemisto, L. & Hurri, H. (2008). Perceived disability but not pain is connected with autonomic nervous function among patients with chronic low back pain. *Journal of Rehabilitation Medicine*, 40 (5), 355 – 358. doi: 10.2340/16501977-0172.
- Godfrey, J. (2001) The Bowen technique – gentle and effective antidote to pain. *N2N - Nurse to Nurse*, 1(12), 1-2. Retrieved May 1, 2014 from <http://www.bowenclinicfrome.co.uk/downloads/Pain%20Control%20-%20NURSE2NURSE.pdf>
- Gold, J. (1985). Cartesian dualism and the current crisis in medicine – a plea for a philosophical approach; discussion paper. *Journal of the Royal Society of Medicine*, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1289841/pdf/jrsocmed00206-0064.pdf>
- Golden, I. (2012) Beyond randomization controlled trials; evidence in complementary medicine. *Journal of Evidence-Based Complementary & Alternative Medicine*, 17(1), 72-75.
- Good, M., Anderson, G. C., Stanton-Hicks, M., Grass, J. A. & Makii, M. (2002). Relaxation and music reduce pain after gynecological surgery. *Pain Management Nursing*, 3(2), 61 – 70.
- Good, M., Anderson, G. C., Ahn, S., Cong, X., & Stanton-Hicks, M. (2005). Relaxation and music reduce pain following intestinal surgery. *Research in Nursing & Health*, 28, 240-251.
- Goodman, R. & Blank, M. (2002). Insights into electromagnetic interactions mechanisms. *Journal of Cellular Physiology*, 192 (1), 16 – 22.
- Hansen, C. & Taylor-Pilliae, R. E. (2011). What is Bowenwork®? A Systematic Review. *The Journal of Alternative and Complementary Medicine*, 17, 1001 – 1006.

- Heitmann, A., Hueber T., Schroeder, R., Perz, S & Voss, A. (2011). Multivariate short-term heart rate variability: A prediagnostic tool for screening heart disease. *Medical Biological Engineer Computing*, 49, 41-50, doi: 10-1007/s11517-01000719-6.
- Heron, J. (1978). *Holistic Medicine*. British postgraduate Medical Federation University of London. Retrieved February 1, 2012 from <http://www.human-inquiry.com/hummed.htm>
- Hertzog, M. A. (2008) Considerations for determining sample size for pilot studies. *Research in Nursing and Health*, 31 (2), 180 – 191.
- Holliday, K. L., Nicholl, B. I., Macfarlane, G. J., Thomson, W., Davies, K. A., & McBeth J. (2010). Genetic variation in the hypothalamic-pituitary-adrenal stress axis influences susceptibility to musculoskeletal pain: Results from the EPIFUND study. *Annals of Rheumatoid Disease*, 69(3), 556-560.
- Hoolihan C., (2013) The papers of Robert Ader, Ph.D. Retrieved May 30, 2014 from [https://www.urmc.rochester.edu/libraries/miner/historical\\_services/archives/Faculty/PapersofRobertAder.cfm](https://www.urmc.rochester.edu/libraries/miner/historical_services/archives/Faculty/PapersofRobertAder.cfm)
- Imbe H., Iwai-Liao, Y. & Senba, E. (2006). Stress-induced hyperalgesia: Animal models and putative mechanisms. *Frontiers in Bioscience*, 11, p. 2179 – 2192.
- Inflammation, (2014). *English Word-Information*. Retrieved June 1, 2014 from <http://wordinfo.info/unit/1100/ip:6/il:I>
- Jungquist, C. R., O'Brien, C., Matteson-Rusby, S., Smith, M. T., Pigeon, W. R., Xia, Y., Lu, N. & Perlis, M. (2010) The efficacy of cognitive behavioral therapy for insomnia in patients with chronic pain. *Sleep Medicine*, 11 (3), 302 – 309.
- Kabat-Zinn, J., Lipworth, L. & Burney R. (1985) The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of Behavioral Medicine*, 8(2), 163-90

- Kamath, M.V., Watanabe, M.A. & Upton A.R.M. (2013). *Heart rate variability (HRV); Signal analysis – clinical applications*. Boca Raton, FL: CRC Press Taylor & Francis Group.
- Kang, J.H., Chen, H.S., Chen, S.C. & Jaw, F.S. (2012). Disability in patients with chronic neck pain. *The Journal of Clinical Pain* 28 (9), 797-803.
- Kanodia, A. K. et al. (2010). Perceived benefit of complementary and alternative medicine for \$back pain; a national survey. *Journal of the American Board of Family Medicine*, 23 (3), 354 – 62.
- Karam, F., Bérard, A., Sheehy, O., Huneau, M. C., Briggs, G., Chambers, C., ... OTIS Research Committee (2012). Reliability and validity of the 4-item Perceived Stress Scale among pregnant woman; results from the OTIS antidepressant study. *Residents in Nursing Health*, 35(4), 363-75.
- Kazdin, A. E. (1992). *Methodological issues and strategies in clinical research*. Washington, D.C.: American Psychological Association.
- Kendall, E. C. (1950). The development of cortisone as a therapeutic agent. *Nobel Lecture*. Retrieved May 1, 2014 from [http://www.nobelprize.org/nobel\\_prizes/medicine/laureates/1950/kendall-lecture.pdf](http://www.nobelprize.org/nobel_prizes/medicine/laureates/1950/kendall-lecture.pdf)
- Korff, M. V. & Simon, G. (1996). The relationship between pain and depression. *The British Journal of Psychiatry*, 168(30), 101 – 108.
- Kroeling, P., Gross, A. R. & Goldsmith, C. H. (2005) A Cochrane review of electrotherapy for mechanical neck disorders. *Spine*, 30(21), E641-648.
- Kroeling, P., Gross, A. R. & Goldsmith, C. H. (2005). Electrotherapy for neck disorders. *Cochrane Database System Review*, 18(2), CD004251.

- Kuehl, L.K., Michaux, G.P., Richter S., Schachinger H. & Anton F. (2010). Increased basal mechanical pain sensitivity but decreased perceptual wind-up in a human model of relative hypocortisolism. *Pain*, 149(3), 539 – 546.
- Lee, C., Crawford, C., Swann, S. & Working Group (2014). Multimodal, integrative therapies for the self-management of chronic pain symptoms. *Pain Medicine*, 15, S76 – S 85.
- Lee, C., Crawford, C., Teo, L, Spevak, C and Working Group (2014). An analysis of the various chronic pain conditions captured in a systematic review of active self-care complementary and integrative medicine therapies for the management of chronic pain syndromes. *Pain Medicine*, 15, S96 – S103.
- Lee, E. (2012). Review of the psychometric evidence of the Perceived Stress Scale. *Asian Nursing Research*, 6, 121-127
- Lerma, C, Marinez, A., Ruiz, N., Vargas, A., Infante, O. & Martinez-Lavin, M. (2011). Nocturnal heart rate variability parameters as potential fibromyalgia biomarker; correlation with symptoms severity. *Arthritis Research & Therapy*, 13(6), 1 – 9. R185. doi: 10.1186/ar3513
- Liboff, A. R. (2013). Why are living things sensitive to weak magnetic fields? *Electromagnetic biology and medicine*, 08/05/13, p. 1-5. doi: 10.3109/15368378.2013.809579
- Lind, B. K., Lafferty, W. E., Tyree, P. T. & Diehr, P. K. (2010). Comparison of health care expenditures among users and nonusers of complementary and alternative medicine in Washington state: A cost minimization analysis. *The Journal of Alternative and Complementary Medicine*, 16 (4), 411 – 417.
- Liptan, G. L. (2010). Fascia; a missing link in our understanding of the pathology of fibromyalgia. *Journal of Bodywork and Movement Therapies*, 14, 3- 12.

- Logan, J. G. & Barksdale D. J. (2008). Allostasis and allostatic load; expanding the discourse on stress and cardiovascular disease. *Journal of Clinical Nursing*, 17(7B), 201-8.
- Long, L., Huntley, A. & Ernst E. (2001). Which complementary and alternative therapies benefit which conditions? A survey of the opinions of 223 professional organizations *Complementary Therapies in Medicine*, 9, 178 – 185.
- Lu, C., Zou, X., Orr, W. C. & Chen, J. D. Z. (1999). Postprandial Changes of Sympathovagal Balance Measured by Heart Rate Variability. *Disgestive Diseases and Sciences*, 44 (4), 857 – 861.
- Maizes, V., Rakel, D. & Niemiec, C. (2009). Integrative medicine and patient-centered care. *IOM Summit on Integrative Medicine and Health of the Public*. Retrieved from May 1, 2014 from [http://www.canyonranchinstitute.org/storage/documents/Integrative\\_Medicine\\_and\\_Patient\\_Centered\\_Care.pdf](http://www.canyonranchinstitute.org/storage/documents/Integrative_Medicine_and_Patient_Centered_Care.pdf)
- Marino, A. A. & Becker, R.O. (1977). Biological effects of extremely low frequency electrical and magnetic fields; a review. *Physiological Chemistry and Physics*, 9, 131 – 146.
- Markov, M. S. (2007). Pulsed electromagnetic field therapy history, state of the art and future. *Environmentalist*, 27(4), 465-475.
- Marshall, B. J. (1995). Helicobacter pylori; the etiological agent for peptic ulcer. *Journal of the American Medical Association*, 274(13), 1064-1066.
- Martel, B. A., et al. (2007). Systematic review: Opioid treatment for chronic back pain, prevalence, efficacy, and association with addiction. *Annals of Internal Medicine*, 16(2), 116 - 127.

- Martin, B. (2013). What are the risk factors for depression? *PsychCentral*. Retrieved May 8, 2014 from <http://psychcentral.com/lib/what-are-the-risk-factors-for-depression/000515>
- Mayo Clinical Staff, (2014). Irritable bowel syndrome. Retrieved June 23, 2014 from <http://www.mayoclinic.org/diseases-conditions/irritable-bowel-syndrome/basics/definition/con-20024578>
- McBeth, J, Chiu, Y. H., Silman, A. J., Ray, D., Morriss, R., Dickens, C., Gupta, A., & MacFarlane, G. J. (2004). Hypothalamic-pituitary-adrenal stress axis function and the relationship with chronic widespread pain and its antecedents. *Arthritis Research & Therapy*, 7 (5), R992-R1000.
- McBeth, J., Silman, A. J., Gupta, A, Chiu, Y. H., Ray, D., Morriss, R, Dickens, C., King, Y. & MacFarlane, G. J., (2007). Moderation of psychosocial risk factors through dysfunction of the hypothalamic-pituitary-adrenal stress axis in the onset of chronic widespread musculoskeletal pain; findings of population-based prospective cohort study. *Arthritis and Rheumatism*, 56 (1), 360-371.
- Mostoufi, S.M., Afari, N., Ahumada, S.M., Reis, V., & Wetherell, J.L. (2012). Health and distress predictors of heart rate variability in fibromyalgia and other forms of chronic pain. *Journal of Psychosomatic Research*, 72(1), 39-44.  
doi:10.1016/j.jpsychores.2011.05.007.
- Mutsuura, H., Kanbara, K., Fukunaga, M., Yamamoto, K., Ban, I, Kitamura, K & Nakai, Y. (2009). Depression and anxiety correlate differently with salivary free cortisol in the morning in patients with functional somatic syndrome. *Applied Psychophysiological Biofeedback*, 34 (4), 291 – 298.

- Nakagawa, K. (1976). Magnetic field deficiency syndrome and magnetic treatment. *Japan Medical Journal*, 2745, 1 – 12. Retrieved June 20, 2014 from <http://4data.ca/ottawa/archive/health/biomagnetic.html>
- NCCAM (2007) What is CAM? *National Center for Complementary and Alternative Medicine, National Institutes of Health.*
- Ober, C., Sinatra, S & Zucker, M. (2010). *Earthing; The Most Important Health Discovery Ever?* Laguna Beach, CA: Basic Health Publications, Incorporated.
- Ober, C. & Coghill, R. Does grounding the human body to earth reduce chronic inflammation and related pain? Paper presented at the European Bioelectromanetics Association annual meeting November 2003. Budapest Hungary. Retrieved June 1, 2014 from [http://healingnh.com/wp-content/uploads/2013/08/EFX\\_science\\_Ober\\_chronicInflammation1.pdf](http://healingnh.com/wp-content/uploads/2013/08/EFX_science_Ober_chronicInflammation1.pdf)
- Oliveira, L.R., et al. (2012). Induction of chronic non-inflammatory widespread pain increases cardiac sympathetic modulation in rats. *The Journal of Autonomic Neuroscience*, 167(1-2), 45-49. doi.org/10.1016/j.autneu.2011.12.004
- Oschman, J. L. (2000). *Energy medicine; the scientific basis*. New York, NY: Churchill Livingstone.
- Oschman, J. L. (2007). Can electrons act as antioxidant? A review and commentary. *Journal of Alternative and Complementary Medicine*, 13(9), 955- 967.
- Oschman, J. L. (2008). Perspective: Assume a spherical cow; the role of free or mobile electrons in bodywork, energetic and movement therapies. *Journal of Bodywork and Movement Therapies*,12, 40-57.

Oschman, J. L. (2009) Charge transfer in the living matrix. *Journal of Bodywork and Movement Therapies*, 13, 215- 228, doi: 10.1016/j.jbmt.2008.06.005.

Pacific College, 2014. Benefits of Tui Na Massage. Retrieved June 23, 2014 from <http://www.pacificcollege.edu/acupuncture-massage-news/articles/913-benefits-of-tui-na-massage.html>

Pakozdi, R. (2014). Research on the effectiveness of Bowen therapy in treating pain. *Advanced Health Therapy Center*. Retrieved May 31, 2014 from <http://www.advancedhtc.com/cms/index.php?page=about-us>

Passarelli, T. (2008) Complementary and alternative medicine in the United States. Retrieved May 1, 2014 from [http://www.cwru.edu/med/epidbio/mphp439/complimentary\\_meds.pdf](http://www.cwru.edu/med/epidbio/mphp439/complimentary_meds.pdf)

Pelka, R. B., Jaenicke, C. & Gruenwald, J. (2001). Impulse magnetic-field therapy for insomnia; a double-blind, placebo-controlled study. *Advances in Therapy*, 18 (4), 174 – 180.

Pennington, K. (2012). Bowen therapy: A review of the profession. *Journal of the Australian Traditional Medicine Society*, 18(4), p. 217-220.

Pert, C. (1986). The wisdom of the receptors; neuropeptides, the emotions and body mind. *Advances in Mind Body Medicine*, 18(1), 30-5.

Pizzo, P.A. Chair Committee on Advancing Pain Research, Care, and Education Board on Health Sciences Policy. (2011) *Relieving pain in America; a blueprint for transforming prevention, care, education, and research*. Washington, D.C.: The National Academies Press.

Powell, M.J. (2014) History. *Fibromyalgia Treatment and Learning Center*. Retrieved May 1, 2014 from <http://www.fmtlc.com/history.html>

- PSS-10 (2014) International RDC-TMD Consortium. Retrieved 07/19/2014 from <http://www.rdc-tmdinternational.org/OtherInstruments/PerceivedStressScale10.aspx>
- Rakel, D. (2012) *Integrative Medicine: Expert consult, 3<sup>rd</sup> Edition*. Philadelphia, PA: Elsevier Saunders.
- Reese, M. (2014). A biography of Moshe Feldenkrais. Retrieved June 23, 2014 [http://www.feldenkrais.com/about/a\\_biography\\_of\\_moshe\\_feldenkrais/](http://www.feldenkrais.com/about/a_biography_of_moshe_feldenkrais/)
- Reis, R. S., Hino, A. A. & Anez, C. R. (2010). Perceived Stress Scale; reliability and validity study is Brazil. *Journal of Health Psychology*, 15(1), 107-14.
- Rentsch, O. & Rentsch E. (2005). *Bowtech: The Original Bowen Technique*. Victoria, Australia: The Bowen Therapy Academy of Australia.
- Rentsch, O. (2010). Interview on Good Morning New Zealand News Program. Retrieved May 1, 2014 from <https://www.youtube.com/watch?v=rgcOnFeqQxs>
- Richardson, T., Ryder, J., Rozkovec, A, Meckes, C, Thomas P. & Kerr, D. (2004). Influence of caffeine on heart rate variability in patients with long-standing type 1 diabetes. *Diabetes Care*, 27 (5), 1127.
- Riva, R, Mork, P. J., Westgaard, R. H. & Lundberg, U. (2012). Comparison of the cortisol awakening response in women with shoulder and neck pain, and women with fibromyalgia. *Psychoneuroendocrinology*, 37 (2), 299 – 306.
- Rolf Institute, 2014. What is Rolfing Structural Integration? Retrieved June 23, 2014 from <http://www.rolf.org/about>
- Rubik, B. (2002) The biofield hypothesis; its biophysical basis and role in medicine. *The Journal of Alternative and Complementary Medicine*, 8 (6), 703 – 717.

- Salkind, Neil J. (2012) *One hundred questions and answers about research methods*. Washington, D.C.; Sage.
- Sandercock, G. R. H., Bromley, P. D. & Brodie, D. A. (2005). The reliability of short-term measurements of heart rate variability. *International Journal of Cardiology*, 1003(03) 238 – 247.
- Sapolsky, R. M. (2014) *Stress and your body*. Chantilly, VA; The Teaching Company.
- Sarkar, J. (2014) Therapeutic uses of pulsed electromagnetic field and design of a TENS pain relief unit. *Institute of Electrical and Electronics Engineers ACES conference reports*. doi: 10.1109/ACES.2014.6808027
- Scarlata, S. Chair (2002). *Careers in Biophysics*. Bethesda, MD: Biophysical Society.
- Schlitz, M., Amorok, T. & Micozzi, M. S. (2004) *Consciousness and healing; integral approaches to mind-body medicine*. New York, N.Y.: Elsevier Health Sciences.
- Selye, H. (1976) *The stress of life*. New York, N.Y.: McGraw-Hill Book Company.
- Shapiro, G. (2004). The Bowen technique for pain relief. *Positive Health Online*, 106, p. 1-4. Retrieved May 1, 2014 from <http://www.positivehealth.com/article/bowen-technique/the-bowen-technique-for-pain-relief>
- Shupak, N. M., McKay, J. C., Nielson, W. R., Rollman, G. B., Prato, F. S. & Thomas, A. W. (2006). Exposure to a specific pulsed low-frequency magnetic field; a double-blind placebo-controlled study on the effects on pain ratings in rheumatoid arthritis and fibromyalgia patients. *Pain Research and Management*, 11 (2), 85 – 90.
- Simon, M. K. (2011). *Dissertation and scholarly research: Recipes for success*. Seattle, Wa: Dissertation Success, L.L.C.

- Smith, M. T. & Haythornthwaite, J. A. (2004). How do sleep disturbance and chronic pain interrelate? Insights from the longitudinal and cognitive-behavioral clinical trials literature. *Sleep Medicine*, 8 (2), 119 – 132.
- Solomon, G. F. & Moos, R. H. (1964). Immunity and disease; a speculative theoretical integration. *Archives of General Psychiatry* 11(6):657-674. doi:10.1001/archpsyc.
- Staud, RN. M.. (2008). Heart rate variability as a biomarker of fibromyalgia syndrome. *Future Rheumatology*, 3(5), 475-483. doi:10.2217/17460816.3.5.475.
- Steinberg, H., Herrmann-Lingen, C. & Himmerich, H. (2013). Johann Christian August Heinroth: Psychosomatic medicine eighty years before Freud. *Psychiatria Danubina*, 25 (1) 11-16.
- Stone, et al. (2008). Nonrestorative sleep. *Sleep Medicine Review*, 12(4) 275-88.
- Storella, R. J., Shi, Y., O'Conner, D. M., Pharo, G. H., Abrams, J. T., & Levitt, J. (1999). Relief of chronic pain may be accompanied by an increase in a measure of heart rate variability. *International Anesthesia Research Society*, 89(2), 448 – 450.
- Sutbeyaz, S. T., Sezer, N. & Koeoglu, B. F. (2006). The effect of pulsed electromagnetic fields in the treatment of cervical osteoarthritis; a randomized, double-blind, sham-controlled trial. *Rheumatoid International*, 26, 320-324.
- Tak, L. M., Janssens, K. A. M., Dietrich, A, Slaets, J. P. J. & Rosmalen, J. G. M. (2010). Age specific associations between cardiac vagal activity and functional somatic symptoms: A population-based study. *Psychotherapy and Psychosomatics*, 79, 179 – 187, doi: 10.1159/000296136.

- Tanriverdi, F., Karaca, Z., Unluhizarci, K. & Kelestimur, F. (2007). The hypothalamo-pituitary-adrenal axis in chronic fatigue syndrome and fibromyalgia syndrome. *Stress*, 10(1), 13 – 25.
- Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. *European Heart Journal*, 17, 354 – 381.
- Thabane, et al. (2010). A tutorial on pilot studies; the what, why and how. *BMC Medical Research Methodology*, 10 (1), 1 – 10, doi:10.1186/1471-2288-10-1
- Thayer, J. F., Ahs, F., Fredrikson, M., Sollers, J. J. & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: Implications for heart rate variability as a maker of stress and health. *Neuroscience and Biobehavioral Reviews*, 36 (2), 747-756. doi: 10.1016/j.neubiorev.2011.11.009
- Thayer J. F. & Sternberg E. (2006). Beyond heart rate variability, vagal regulation of allostatic systems. *Annal of the New York Academy of Sciences*, 1088, 361-372, doi:10.1196/annals.1366.014.
- Thomas, Alex W., Graham, K., Prato, F. S., McKay, J., Forster, P. M., Moulin, D. E. & Chari, S. (2007). A randomized, double-blind, placebo-controlled clinical trial using a low-frequency magnetic field in treatment of musculoskeletal chronic pain. *Pain Research and Management*, 4 (12), 249-258. Retrieved February 10, 2013 from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2670735/>
- Trager International, 2005. What is the Trager approach? Retrieved June 23, 2014 from <http://www.trager.com/approach.html>

- Turner-Cobb, J. M., Osborn, M. DaSilva, L., Keogh, E. & Jessop, D. S. (2010). Sex differences in hypothalamic-pituitary-adrenal axis function in patients with chronic pain syndrome. *Stress*, 13(4), p. 292 – 300.
- Vanderlei, L.C.M., Pastre, C.M., Hoshi, R.A., Carvalho, T.D. & Godoy, M.F. (2009). Basic notions of heart rate variability and its clinical applicability. *Brazilian Circulatory Cardiovascular Review*, 24(2), 205-217.
- Van Teijlingen E. & Hundley, V. (2002). The importance of pilot studies. *Nursing Standard: Clinical, research and education*, 16(40), 33 – 36.
- Weil, A. (2004). *Health and healing: The philosophy of integrative medicine*. New York, N.Y.: Houghton Mifflin Company.
- Weil, A. (2009). Testimony before the United States Senate Committee on Health, Education, Labor & Pensions. Retrieved May 1, 2014 from <http://www.help.senate.gov/imo/media/doc/Weil.pdf>
- Wells, R. E., Phillips, R. S, Schachter, S. C. & McCarthy, E. P. (2010). Complementary and alternative medicine use among US adults with common neurological conditions. *Journal of Neurology*, 257 (11), 1822 – 1831.
- Whitaker, J., Gilliam, P. P. & Seba, D. B. (1998). The original Bowen technique; a gentle hands-on healing method that effects the autonomic nervous system as measured by heart rate variability and clinical assessment. *Journal of Musculoskeletal Pain*, 6(2), p.1-8.
- Wilder, P. (2013.) About Us. *The Consortium of Academic Health Centers for Integrative Medicine*. Retrieved May 1, 2014 from <http://www.imconsortium.org/about/home.html>

- Wingenfeld, K., Wagner, D, Schmidt, I., Meinlschmidt, G., Hellhammer, D. H., & Heim C. (2009). HPA axis reactivity in chronic pelvic pain; association with depression. *Journal of Psychosomatic Obstetrics and Gynaecology*, 30 (4), 282 – 6.
- Wilson, J. L. (2001) *Adrenal Fatigue, the 21<sup>st</sup> century stress syndrome*. Petaluma, CA: Smart Publications.
- Wisneski, L. A. & Anderson, L. (2009). *The scientific basis of integrative medicine*. Boca Raton, FL: CRC Press.
- Wolever, R.Q., et al. (2015). Integrative medicine patients have high stress, pain and psychological symptoms. *Explore*, 11(4), 296-303.
- Wu, S. M. & Amtmann, D. (2013). Psychometric evaluation of the Perceived Stress Scale in multiple sclerosis. *ISRN Rehabilitation*, doi.org/10.1155/2013/608356
- Yilmaz, U., Liu, Y.W., Berger, R.E. & Yang, C.C. (2007). Autonomic nervous system changes in men with chronic pelvic pain syndrome. *The Journal of Urology*, 177(6), 2170-2174. doi.org/10.1016/j.juro.2007.01.144
- Zalli, A., Carvalho, L. A., Lin, J., Hamer, M., Erusalimsky, J. D., Blackburn, E. H. & Steptoe, A. (2014) Shorter telomere with high telomerase activity are associated with raised allostatic load and impoverished psychosocial resources. *Proceedings of the National Academy of Sciences of the United States of America*. Retrieved on 07/15/2014 from <http://www.pnas.org/content/111/12/4519.full.pdf+html>

## APPENDIX

### Definitions

*Adrenal glands, cortex and medulla:* The adrenal gland is a small gland that sits atop each kidney. It contains both the adrenal cortex and the adrenal medulla. The cortex is the receptor site for informational hormones from the hypothalamus. In response the cortex secretes corticosteroids – long-lasting messengers to regulate blood volume, break down proteins and fats, and meet the glucose requirements of the brain. The medulla is the receptor site of the quicker neural messages from the hypothalamus. In response the medulla secretes catecholamines – neurotransmitters such as epinephrine and norepinephrine (Wisneski, 2009).

*Allostatic load:* Complex physiological systems adapt to physical and emotional challenges. Allostatic load refers to the state when normal allostatic processes become dysfunctional, typically due to prolonged and chronic stress. Physiological systems that become dysregulated include the HPA axis, the sympathetic nervous system and the immune system (Logan, 2008).

*Autonomic nervous system (ANS):* The nervous system has two main divisions. The central nervous system (CNS) is comprised of the brain and spinal cord. The peripheral nervous system (PNS) is comprised of the somatic nervous system and the autonomic nervous system. The ANS is further divided into the enteric, sympathetic and parasympathetic systems. The ANS innervates the internal organs to include the heart, lungs, liver, stomach, pancreas, kidneys, and colon, in addition to connections with the thymus, spleen, bone marrow, and lymph nodes (Wisneski, 2009).

*Biomarkers:* A “*quantitative measurement* that provide information about biological processes, a disease state, or about response to treatment, providing much-needed insight into

preclinical and clinical data. Biomarkers hold the potential of a better understanding of the etiology and pathogenesis of a given disorder, providing researchers and clinicians with valuable insight into diagnosis, treatment, and prognosis for many debilitating disorders and diseases.”

(Davis, et al., 2008)

*Central nervous system:* See Autonomic nervous system.

*Chronic fatigue:* A disorder characterized by a constellation of symptoms to include persistent fatigue of at least six months' duration with poor sleep architecture, malaise, joint and muscle pains developing into cognitive and psychological problems. There is no known etiology of the disorder (Tanriverdi, Karaca, Unluhizarci, & Kelestimur 2007).

*Comorbid depressive disorder:* The medically diagnosed condition of depressive disorder present simultaneously with other diagnoses.

*Cortisone and cortisol:* Cortisone is the inactive precursor compound to cortisol. Cortisol is the informational steroid hormone which plays a role in fat and water metabolism, excitation of nerve tissue and gastric processes. The synthetic form is used as an anti-inflammatory agent (Cortisol, 1974). Cortisol secretions have a diurnal or circadian pattern. These indices can be captured through either saliva or blood (Clow, Thorn, Evans & Hucklebridge, 2004).

*Depression:* “Severe despondency and dejection, typically felt over a period of time and accompanied by feelings of hopelessness and inadequacy...Clinical depression is a condition of mental disturbance characterized by depression to a greater degree than seems warranted by the external circumstances, typically with lack of energy and difficulty in maintaining concentration or interest in life.” (Depression, 2014)

*Diurnal:* Changes that routinely oscillate throughout a 24-hour cycle.

*Feldenkrais*: A style of patient re-education in movement with a focus of the reciprocating effect of awareness of thought and awareness body movements can enhance mental creativity. The modality was developed by Moshe Feldenkrais after training in Jujitsu (Reese, 2014).

*Fibromyalgia*: One of the syndromes within the diagnosis of Functional Somatic Disorders. Diagnosis is made through examination by a specialist. The disorder is characterized by a constellation of points of tenderness and global pain of unknown etiology (Liptan, 2010).

*Heart rate variability (HRV)*: The phenomenon that is the oscillation in the interval between consecutive heart beats. It describes the variability in the length between the RR intervals. RR refers to the peak in the recording displayed on a tachogram (Task Force, 1996).

*Irritable bowel syndrome (IBS)*: One of the syndromes within the diagnosis of Functional Somatic Disorders. It is a disorder of the large intestine, where the patient has symptoms of cramping, abdominal pain, bloating, flatulence, diarrhea and constipation. These symptoms do not cause permanent damage or carry an increased risk for colon cancer. Symptoms may be controlled through lifestyle changes (Mayo, 2014).

*Mechanists*: The biologists who adhere to the theory that a set of physical and chemical laws govern both living and nonliving matter (Becker, 1985).

*Non-restorative sleep*: The state a person reports following a normal night sleep whereupon awakening they feel unrefreshed. This occurs in the absence of a sleep disorder (Stone et al., 2008).

*Oswestry disability index*: An index used in the evaluation and management of spinal disorders. It was first published in 1980 and disseminated at a conference in 1981. It has been

published in nine languages. Re-evaluation by J. C. T. Fairbanks and P. B. Pynsent in 2000 found the measurement to be valid, vigorous and worthwhile. (Fairbanks & Pynsent, 2000).

*Pilot study:* Studies conducted prior to a phase III research project that are designed to provide preliminary information on the efficacy of an intervention (Thabane, 2010).

*Parasympathetic nervous system (PaNS):* The branch of the ANS which leads to relaxed states. The PaNS is involved in the system wide “rest/digest” response (Wisneski, 2009).

*Pulsed electromagnetic frequency (PEMF):* A device that emits low-energy time-varying frequency of the earth’s electromagnetic field with an objective to enhance healing and promote health.

*Rolfing:* A style of massage or bodywork that reorganizes the body’s connective tissue or fascia in an effort to resolve discomfort and alleviate pain. The modality was developed by Ida Rolf, Ph.D. (Rolf Institute, 2014).

*Stress:* A state “manifested by a specific syndrome which consists of all the nonspecifically-induced changes within a biological system” (Selye, 1976, p. 64).

*Stress biomarkers:* Biomarkers that are directly influenced by stressors.

*Sympathetic nervous system (SNS):* The branch of the ANS which leads to arousal states. The SNS is involved in the system wide “fight/flight” response (Wisneski, 2009).

*Trager bodywork:* A style of patient re-education in movement. The modality is both passive (the client lies passively on a table and is moved) and active (home activities that complement the table work). The modality was developed over the span of 65 years by Milton Trager, M.D. (Trager International, 2005).

*Tui Na:* A form of therapeutic massage developed in China more than 2,000 years ago (Pacific College, 2014).

*Vitalists*: The biologists who adhere to the theory that living things are fundamentally different due to the spirit. (Becker, 1985).