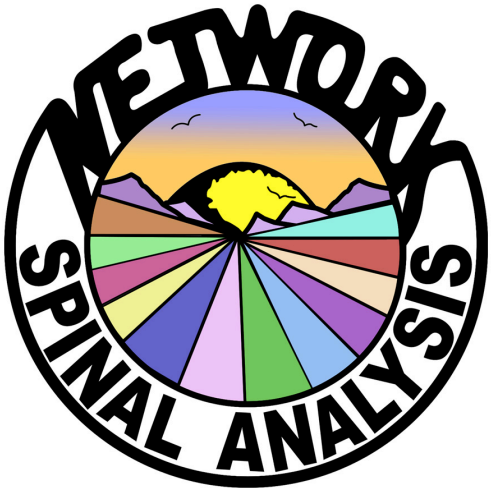


# Network Spinal Analysis Care Research

**Compilation of Published Network Care Research**
**Version 01/2011**

# Network Spinal Analysis Care - Literature Review

*The following is a list of peer-reviewed publications involving Network Spinal Analysis Care. Further information regarding Network Spinal Analysis Research currently in process or programs where information on Network Spinal Analysis Research has been presented is available at www.associationfornetworkcare.com.*

## Editorial: Seeds of Meaning, Transformations of Health Care, and the Future

Senzon SA. Journal of Alternative and Complimentary Medicine. December 2010;16(12):1239-1241. DOI: 10.1089/acm.2010.0785

*No Abstract Available.*

## On a standing wave Central Pattern Generator and the coherence problem

Jonckheere E, Lohsoonthorn P, Musuvathy S, Mahajan V, Stefanovic M.
Biomedical Signal Processing and Control 5 (2010) 336–347. doi:10.1016/j.bspc.2010.04.002

An electrophysiological phenomenon running up and down the spine, elicited by light pressure contact at very precise points and thereafter taking the external appearance of an undulatory motion of the spine, is analyzed from its standing wave, coherence, and synchronization-at-a-distance properties. This standing spinal wave can be elicited in both normal and quadriplegic subjects, which demonstrates that the neuronal circuitry is embedded in the spine. The latter, along with the inherent rhythmicity of the motion, its wave properties, and the absence of external sensory input once the phenomenon is elicited reveal a Central Pattern Generator (CPG). The major investigative tool is surface electromyographic (sEMG) wavelet signal analysis at various points along the paraspinal muscles. Statistical correlation among the various points is used to establish the standing wave phenomenon on a specific subband of the Daubechies wavelet decomposition of the sEMG signals. More precisely, ~10 Hz coherent bursts reveal synchronization between sensory-motor loops at a distance larger, and a frequency slower, than those already reported. As a potential therapeutic application, it is shown that partial recovery from spinal cord injury can be assessed by the correlation between the sEMG signals on both sides of the injury.

## Reorganizational Healing: A Paradigm for the Advancement of Wellness, Behavior Change, Holistic Practice, and Healing

Epstein DM, Senzon SA, Lemberger D. Journal of Alternative and Complimentary Medicine. May 2009;15(5):461-64. PMID: 19450165

Reorganizational Healing, (ROH), is an emerging wellness, growth and behavioral change paradigm. Through its three central elements (the Four Seasons of Wellbeing, the Triad of Change, and the Five Energetic Intelligences) Reorganizational Healing takes an approach to help create a map for individuals to self-assess and draw on strengths to create sustainable change. Reorganizational Healing gives individuals concrete tools to explore and use the meanings of their symptoms, problems, and life-stressors as catalysts to taking new and sustained action to create a more fulfilling and resilient life.

## Editorial: Reorganizational Healing: A Health Change Model Whose Time Has Come

Blanks RH. Journal of Alternative and Complimentary Medicine. May 2009;15(5):461-64. PMID: 19450161

*No Abstract Available.*

## Letter to the Editor: Network Spinal Analysis

Jonckheere EA. Journal of Alternative and Complimentary Medicine. May 2009;15(5):469-70. PMID: 19450163

*No Abstract Available.*

### Improvement in Attention in Patients Undergoing Network Spinal Analysis: A Case Series Using Objective Measures of Attention

Pauli Y. Journal of Vertebral Subluxation Research, August 23, 2007; 1-9

Objective: Anecdotal preliminary evidence suggests that chiropractic care may be of benefits for individuals suffering from ADHD. This case series presents the improvement in attention experienced by 9 adult patients undergoing Network Spinal Analysis.

Methods: Nine adult patients are presented (4 male, 5 female) with a mean age of 40.4 years (range 22 – 58 years old). All patients were evaluated with the Test of Variable of Attention (TOVA) before receiving Network Spinal Analysis (NSA) care and at 2 months into care. The nine patients received level 1 NSA care for two months, as taught by the Association for Network Care. Neurospinal integrity was evaluated with palpation, as well as surface electromyography. Cognitive process of attention was objectively evaluated using a continuous performance test, the Test of Variables of Attention (TOVA).

Results: We evaluated our patient cohort before and after Network care using sEMG and variables from the continuous performance test (TOVA). Before care, all patients had an abnormal ADHD score with a mean of -3.74 (range: - 8.54 to -1.89). After 2 months of care, all patients had a significant change in ADHD score ($p=0.08$) and 88% completely normalized the ADHD score. 77% and 66% of patients experienced significant change in reaction time and variability score, respectively. All patients experienced a significant reduction in sEMG pattern of activation ($p=0.08$). We discuss possible mechanisms by which spinal care may have enhanced the function of the prefrontal cortex, thereby resulting in improved attentional capacities

Conclusion: In this case series the nine adult patients experienced significant improvement in attention, as measured by objective outcomes, after receiving two months of Network Spinal Analysis. The progress documented in this report suggests that NSA care may positively affect the brain by creating plastic changes in the prefrontal cortex and other cortical and subcortical areas serving as neural substrate for the cognitive process of attention. These findings may be of importance for individuals suffering from attention deficit. Further research into this area is greatly needed.

### Quality of Life Improvements and Spontaneous Lifestyle Changes in a Patient Undergoing Subluxation-Centered Chiropractic Care: A Case Study

Pauli Y. Journal of Vertebral Subluxation Research, October 11, 2006; 1-15

Purpose of Study: This case study is to report the improvement in quality of life experienced by a patient undergoing subluxation-centered chiropractic care.

Clinical Features: A 36 year old male presented with primary health concerns of stress, eye pain and left leg pain of 14 years duration radiating to the foot and secondary complaints of gastritis, ulcers, nervousness, depression, lack of concentration and general loss of interest in daily life. The patient also smokes, does not exercise, eats a sub-optimal diet and rated his family and friends support, as well as job satisfaction as sufficient.

Intervention and Outcome: We discuss the various analyses employed to evaluate vertebral subluxations, including paraspinal surface electromyography and thermography. Adjustive care included a combination of Network Spinal Analysis, Torque Release Technique and diversified structural adjustments to correct vertebral subluxations over a six month period. We used visual analog scales, open-ended questions and selected items from the Self-Rated Health and Wellness Instrument to monitor health changes, as well as the positive improvements in quality of life as perceived by the patient himself.

Conclusion: This case study demonstrates that the correction of vertebral subluxations over an 11 month period was associated with significant improvements in the quality of life of the patient.

### Chiropractic Care of a Battered Woman: A Case Study

Bedell L. Journal of Vertebral Subluxation Research, July 20, 2006; 1-6

Objective: This case study documents the chiropractic care of battered woman struggling with Intimate Partner Violence

(IPV). Chiropractic offers battered women a unique service, it is the only profession trained and licensed to detect and correct vertebral subluxations. The relationship between the stresses of abuse and vertebral subluxation, as well as the subsequent changes during chiropractic care, are described.

Clinical Features: A Caucasian, 23-year old female presented with headaches, neck pain, and upper back pain. The initial complaint noted sharp, knife-like pains into the medial scapular borders, worse on the right side. Tingling extended into the right hand, most severe in the 2nd, 3rd, and 4th fingers.

Chiropractic care and outcome: Protocols of both Torque Release and Activator techniques were utilized to evaluate vertebral subluxations. Subjective quality of life issues were evaluated through a Network Spinal Analysis (NSA) Health Status Questionnaire. After commencing chiropractic care, this woman suffered a cervical spine hyper-extension/hyper-flexion type injury from an automobile accident. For the first 30 days after, adjustments were applied twice weekly. Acute exacerbations of symptoms unrelated to the original complaints were displayed and progress became irregular. During the next 60 days, there were various unexplained falls and severe flare-ups of painful symptoms, and she finally admitted to being battered by her husband. Referrals to counselors and programs dealing with domestic violence were provided. Once the physical battering stopped, consistent progress was noted in both clinical symptoms and quality of life issues.

Conclusion: As a battered woman must receive emotional and social support to improve her situation, it is important for chiropractors to recognize the "red flags" of IPV. Chiropractors re-evaluate regularly for changes in vertebral subluxation patterns and can recognize inconsistent responses. They may also be the first caregivers to offer a vitalistic approach; considering a woman's physical, chemical, and emotional quality of life; a perspective that offers significant connection and trust. This article serves as a foundation on the topic of IPV and chiropractic, for use in both communities.

### Wellness lifestyles II: Modeling the dynamic of wellness, health lifestyle practices, and Network Spinal Analysis.

Schuster TL, Dobson M, Jauregui M, Blanks RH. Journal of Alternative and Complimentary Medicine. April 2004;10(2):357-67.
PMID: 15165417

OBJECTIVE: Empirical application of a theoretical framework linking use of Network Spinal Analysis (NSA; a holistic, wellness-oriented form of complementary and alternative medicine [CAM]), health lifestyle practices, and self-reported health and wellness. DESIGN: Cross-sectional self-administered survey study. RESPONDENTS: Two thousand five hundred and ninety-six (2596) patients from 156 offices of doctors who were members of the Association for Network Chiropractic (currently titled Association for Network Care); estimated response rate was 69%. MEASURES: Exogenous variables entered into the structural equation model include gender, age, education, income, marital status, ailments, life change, and trauma. A wellness construct consisted of calculated difference scores between two referents, "presently" and "before Network" care, for self-reported items representing wellness domains of physical state, mental-emotional state, stress evaluation, and life enjoyment. Positive reported change in nine items assembled into dietary practices, health practices, and health risk dimensions serve as indicators of the construct of changes in health lifestyle practices. The NSA care construct consisted of duration of care in months, awareness of energy and awareness of breathing since beginning Network care. RESULTS: Of the exogenous variables only gender, age, and education remain in the final parsimonious structural equation model in these data. Reported wellness benefits accrue to individuals along a direct path from both self-reported positive lifestyle change (0.22), and from NSA care (0.43). The path (0.65) from NSA care to positive health lifestyle changes indicates that NSA care also has an indirect effect on wellness through changes in health lifestyle practices.

CONCLUSIONS: The Structural Equation model tested in these analyses lends support to our theoretical framework linking wellness, health lifestyles, and CAM. This study provides further evidence that our measurements of health and wellness are particularly appropriate for investigating wellness-oriented CAM. There is a positive relationship between the experience of NSA care and self-reported improvements in wellness as well as self-reported changes in lifestyle practices. NSA care users tend toward the practice of a positive health lifestyle, which also has a direct effect on reported improvements in wellness. These empirical links are discussed relative to the sociodemographic characteristics of this population and show that use of NSA care is an aspect of a wellness lifestyle.

**Wellness lifestyles I: A theoretical framework linking wellness, health lifestyles, and complementary and alternative medicine.**
Schuster TL, Dobson M, Jauregui M, Blanks RH. Journal of Alternative and Complimentary Medicine. April 2004;10(2):349-56.
PMID: 15165416

Scholarship concerning complementary and alternative medicine (CAM) practices within the United States could benefit from incorporating sociological perspectives into the development of a comprehensive research agenda. We review the literature on health and wellness emphasizing definitions and distinctions, the health lifestyles literature emphasizing issues of both life choices and life chances, and studies of CAM suggesting utilization as an aspect of a wellness lifestyle. This review forms the foundation of a new theoretical framework for CAM research based on the interrelationship of CAM with health promotion, wellness, and health lifestyles. To date, few studies have sought to bring these various elements together into a single, comprehensive model that would enable an assessment of the complexity of individual health and wellness in the context of CAM. We argue that attention to literatures on health measurement and health lifestyles are essential for exploring the effectiveness and continuing use of CAM.

**The Transition of Network Spinal Analysis Care: Hallmarks of a Client-Centered Wellness Education Multi-Component System of Health Care Delivery**
Epstein D. Journal of Vertebral Subluxation Research, April 5, 2004; 1-7

Network Spinal Analysis TM (NSA) care has been transitioned from a health care system with the objective of correction of two types of vertebral subluxation, to a multi-component system of health care delivery with emphasis on wellness education for participating clients. NSA care is now delivered and communicated in discrete Levels of Care with emphasis on client participation through self-evaluation. Emphasis on wellness education will be introduced into NSA practice through training via a Certificate Program currently under development. This paper considers some hallmarks that delineate a wellness education, patient (client)-centered practice. The concepts presented relative to this wellness model of health care delivery are believed to be applicable to any approach with similar practice objectives. The perspective presented considers that the major aspects of a patient-centered, wellness education health care delivery system is multi-dimensional. Hallmarks include differentiating terms, and establishing a wellness mentality. Substantiation of the discipline must be established through credible published research regarding its efficacy and safety as well as a consistent and valid means of measuring progressive outcomes derived from the care received. The relationship of NSA to other disciplines is discussed.

**Successful In Vitro Fertilization in a Poor Responder While Under Network Spinal Analysis Care: A Case Report**
Senzon SA. Journal of Vertebral Subluxation Research, September 14, 2003; 1-6

Objective: This case report describes the successful in vitro fertilization (IVF) of a 34 year old female who had one previous aborted IVF attempt prior to Network Spinal Analysis (NSA) care. This case report is being presented to add to other case reports that show positive physiological changes in patients receiving NSA care.

Clinical Features: The IVF was attempted due to her partner's azoospermia. The first IVF attempt was on 3/26/02. The patient had a poor follicular growth after the standard hyper-stimulation process of the ovaries, including pre-treatment with Mircette (birth control pills) and 1mg/0.2ml of Lupron (a gonadotropin releasing hormone agonist), and 3-6 amps of Gonal-F (a recombinant fsh) starting on cycle day 3. Her baseline day 3 estradiol and LH levels were only 21.2pg/me and 5.0 I.U./L respectively. On cycle day 8, estradiol was only 56% and LH was 6.6 I.U./L. The Gonal-F was increased to 6amps. This first attempt was canceled due to the poor follicle growth. Only 3-4 follicles of insufficient size between 10-14mm each were found.

Chiropractic Care and Outcomes: On 4/11/02, the patient commenced regular NSA care. The second IVF attempt began on 6/6/02. The change in IVF protocol was the addition of Repronex (also a gonadotropin a combination of LH and fsh). The total increased dose of Gonal-F and Repronex was 6amps, compared to the first attempt of only 3amps which was then increased to 6amps of Gonal-F only.

Conclusion: On the second IVF attempt, estradiol was 1001pg/ml on day 8, and 2019pg/ml on day 11, with LH at 9.3. The Oocyte retrieval after the second attempt was 10 eggs, each approximately 18mm. A successful aspiration of eggs was completed on 6/17/02, and a successful pregnancy followed. The patient is still under NSA care, and is now in her second trimester with normal fetal heart sounds. The possible role of NSA care in the vigorous follicular growth and other health benefits is discussed.

### Insult, Interference and Infertility: An Overview of Chiropractic Research

Behrendt M. Journal of Vertebral Subluxation Research, May 2, 2003; 1

Objective: Infertility is distinct from sterility, implying potential, and therefore raises questions as to what insult or interference influences this sluggish outcome. Interference in physiological function, as viewed by the application of chiropractic principles, suggests a neurological etiology and is approached through the mechanism of detection of vertebral subluxation and subsequent appropriate and specific adjustments to promote potential and function. Parental health and wellness prior to conception influences reproductive success and sustainability, begging efficient, effective consideration and interpretation of overall state and any distortion. A discussion of diverse articles is presented, describing the response to chiropractic care among subluxated infertile women.

Clinical Features: Fourteen retrospective articles are referenced, their diversity includes: all 15 subjects are female, ages 22-65; prior pregnancy history revealed 11 none, 2 successful unassisted, 1 assisted, 1 history of miscarriage. 9 had previous treatment for infertility, 4 were undergoing infertility treatment when starting chiropractic care. Presenting concerns included: severe low back pain, neck pain, colitis, diabetes, and female dysfunction such as absent or irregular menstrual cycle, blocked fallopian tubes, endometriosis, infertility, perimenopause and the fertility window within a religiousbased lifestyle, and a poor responder undergoing multiple cycles of IVF.

Chiropractic Care and Outcome: Outcomes of chiropractic care include but are not limited to benefits regarding neuromuscular concerns, as both historical and modern research describe associations with possible increased physiological functions, in this instance reproductive function. Chiropractic care and outcome are discussed, based on protocols of a variety of arts, including Applied Kinesiology (A.K.), Diversified, Directional Non-Force Technique (D.N.F.T.), Gonstead, Network Spinal Analysis (N.S.A.), Torque Release Technique (T.R.T.), Sacro Occipital Technique (S.O.T.) and Stucky-Thompson Terminal Point Technique. Care is described over a time frame of 1 to 20 months.

Conclusion: The application of chiropractic care and subsequent successful outcomes on reproductive integrity, regardless of factors including age, history and medical intervention, are described through a diversity of chiropractic arts. Future studies that may evaluate more formally and on a larger scale, the effectiveness, safety and cost benefits of chiropractic care on both well-being and physiological function are suggested, as well as pursuit of appropriate funding.

### Chaotic Modeling in Network Spinal Analysis: Nonlinear Canonical Correlation with Alternating Conditional Expectation (ACE): A Preliminary Report

Bohacek S, Jonckheere E. Journal of Vertebral Subluxation Research, December 1998; 2(4): 188-195

Abstract - This paper presents a preliminary non-linear mathematical analysis of surface electromyographic (sEMG) signals from a subject receiving Network Spinal Analysis (NSA).The unfiltered sEMG data was collected over a bandwidth of 10-500 Hz and stored on a PC compatible computer. Electrodes were placed at the level of C1/C2,T6, L5, and S2 and voltage signals were recorded during the periods in which the patient was experiencing the "somatopsychic" wave, characteristic of NSA care. The intent of the preliminary study was to initiate mathematical characterization of the wave phenomenon relative to its "chaotic," and/or nonlinear nature. In the present study the linear and nonlinear Canonical Correlation Analyses (CCA) have been used. The latter, nonlinear CCA, is coupled to specific implementation referred to as Alternating Conditional Expectation (ACE). Preliminary findings obtained by comparing canonical correlation coefficients (CCC's) indicate that the ACE nonlinear functions of the sEMG waveform data lead to a smaller expected prediction error than if linear functions are used. In particular, the preliminary observations of larger nonlinear CCC's compared to linear CCC's indicate that there is some nonlinearity in the data representing the "somatopsychic" waveform. Further analysis of linear and nonlinear predictors indicates that 4th order nonlinear predictors perform 20 % better than linear predictors, and 10th order nonlinear predictors perform 30% better than

linear predictors.This suggests that the waveform possesses a nonlinear "attractor" with a dimension between 4 and 10. Continued refinement of the ACE algorithm to allow for detection of more nonlinear distortions is expected to further clarify the extent to which the sEMG signal associated with the "somatopsychic" waveform of NSA is differentiated as nonlinear as opposed to random.

### Reduction of Psoriasis in a Patient under Network Spinal Analysis Care: A Case Report

Behrendt M. Journal of Vertebral Subluxation Research, December 1998; 2(4): 196-200

This case report describes the progress of a 52 year old male with chronic psoriasis, first diagnosed in April of 1992. After the condition exacerbated over a five year period, he was placed on 12.5 mg/week methotrexate, and oral immunosuppressant medication in October of 1997.After commencing the medication, the condition reduced from 6% body coverage, with flares of 15-20%, to a body coverage of 5%. Following a cessation of the oral medication in February, 1998, the condition recurred at the previous uncontrolled level within one month. The patient was again placed on 12.5 mg/week methotrexate, and subsequently the condition reduced to 5% body coverage. The patient's dose was reduced to 10 mg/week, and later to 7.5 mg/week, with the psoriasis remaining at 5% coverage. On 5/18/98, the patient commenced regular NSA care. He reported a reduction in the psoriasis condition on 6/3/98, and was taken off the oral medication on 6/25/98. The reduction continued, and the patient was advised by his medical physician on 7/01/98 to continue the cessation of oral medication. As of 9/30/98 the psoriasis had decreased to 0.5% to 1.0 % of coverage, and prior plans to initiate ultraviolet-A therapy were canceled. As of 11/98, a five month period since cessation of methotrexate, the patient has remained under regular NSA care, with no recurrence of psoriasis body coverage greater than 1%, the only medication being a topical ointment. This is contrasted to the recurrence after one month, following the patient's first cessation of methotrexate, and prior to NSA care. The possible role of NSA care in the reduction of the patient's psoriasis, and other health benefits is discussed.

### Changes in Digital Skin Temperature, Surface Electromyography, and Electrodermal Activity in Subjects Receiving Network Spinal Analysis Care

Miller E, Redmond P. Journal of Vertebral Subluxation Research, June 1998; 2(2): 87-95

A preliminary study was conducted to evaluate changes in digital skin temperature (DST), surface electromyography (sEMG), and electrodermal activity (EDA) in a group of twenty subjects receiving Network Spinal Analysis (NSA) care. Data, simultaneously derived from all three parameters, were considered to be indirect correlates of sympathetic nervous system activity. Subjects, including a group of five controls, were assessed for a period of 17 minutes. The continuous assessment period included a baseline interval of 4.5 minutes, followed by a 12.5 minute period which was divided into five 2.5 minute intervals. Care was administered to the NSA recipient group immediately after the baseline period, whereas controls received no intervention following baseline. Results revealed no significant differences in DST either within or between the two groups. Surface EMG readings were relatively constant over the five intervals following baseline in the NSA group, while controls showed significant ($p < 0.05$) increases in sEMG at the second through fifth intervals relative to the first interval following baseline activity. Electrodermal activity was significantly decreased ($p < 0.01$) in the NSA group in the second through fifth intervals compared to baseline. Moreover, decreases varied between intervals, but exhibited a leveling from the third through fifth interval. Control subjects, alternatively, exhibited an increase in EDA in all intervals following baseline. The extent of increase resulted in EDA activity significantly greater than the NSA group at the third through fifth intervals. It was concluded that the increase in EMG activity in the control groups may have reflected an increasing level of anxiety due to the duration of the recording period. Since the NSA group expressed constancy in sEMG activity during the same period, coupled to significant decreases in EDA, a "sympathetic quieting effect" was postulated to occur in subjects receiving NSA care. This conclusion is consistent with hypothesized neurological pathways linked to responses observed during NSA care, as well as other reports of self-reported improvements in mental/emotional state and stress reduction in patients receiving Network Chiropractic Care.

### Functional Magnetic Resonance Imaging: About the Cover (cover picture)

Journal of Vertebral Subluxation Research, 1998; 2(1): Cover

About the Cover: Functional Magnetic resonance Imaging (fMRI), which measures the relative presence of oxy-hemoglobin, has gained attention as a non-invasive medium through which high resolution images of the brain and

other tissue may be acquired. This technology may provide a useful assessment of cortical changes following chiropractic intervention. Images of the patient depicted on the cover, on the left, reflect cortical activity (lighted areas in the parietal cortex, frontal cortex areas 9, 10; visual association areas 19, 37, and 39) associated with the learning process of a "novel" muscular maneuver of the foot. Images on the right reflect cortical activity following a Network Spinal Analysis (form of chiropractic) adjustment session, taken approximately 20 minutes after the first set of images, involving the same activity. The decrease in "lighted" areas before and after the adjustment session suggests that less cortical "planning" or "activity" is associated with the "novel" foot maneuver. Thus, the ability of fMRI to visualize changes in cortical activity may play a significant role in elucidating the consequences of vertebral subluxation correction on neurological function.

### An Impairment Rating Analysis Of Asthmatic Children Under Chiropractic Care

Graham R, Pistolese R. Journal of Vertebral Subluxation Research, 1997; 1(4): 41-48

A self-reported asthma-related impairment study was conducted on 81 children under chiropractic care. The intent of this study was to quantify self-reported changes in impairment experienced by the pediatric asthmatic subjects, before and after a two month period under chiropractic care. Practitioners, representing a general range of six different approaches to vertebral subluxation correction, administered a specifically designed asthma impairment questionnaire at the appropriate intervals. Subjects were categorized into two groups; 1-10 years and 11-17 years. Parents/guardians completed questionnaires for the younger group, while the older subjects self-reported their perceptions of impairment. Significantly lower impairment rating scores (improvement) were reported for 90.1% of subjects 60 days after chiropractic care when compared to the pre-chiropractic scores ($p < 0.05$) with an effect size of 0.96. As well, there were no significant differences across the age groups based on parent/guardian versus self rated scores. Girls reported higher (less improvement) before and after care compared to boys, although significant decreases in impairment ratings were reported for each gender. This suggested a greater clinical effect for boys which was supported by effect sizes ranging from 1.2 for boys compared to 0.75 for girls. Additionally, 25 of 81 subjects (30.9%) chose to voluntarily decrease their dosage of medication by an average of 66.5% while under chiropractic care. Moreover, information collected from patients revealed that among 24 patients reporting asthma "attacks" in the 30 day period prior to the study, the number of "attacks" decreased significantly by an average of 44.9% ($p <.05$). Based on the data obtained in this study, it was concluded that chiropractic care, for correction of vertebral subluxation, is a safe nonpharmacologic health care approach which may also be associated with significant decreases in asthma related impairment as well as a decreased incidence of asthmatic "attacks." The findings suggest that chiropractic care should be further investigated relative to providing the most efficacious care management regimen for pediatric asthmatics.

[Note: NSA care was one of the chiropractic approaches used in this study supported by the Michigan Chiropractic Council]

### A Retrospective Assessment of Network Care Using a Survey of Self-Rated Health, Wellness and Quality of Life

Blanks RH, Schuster TL, Dobson M. Journal of Vertebral Subluxation Research, 1997; 1(4): 15-31

The present study represents a retrospective characterization of Network Care, a health care discipline within the subluxation-based chiropractic model. Data were obtained from 156 Network offices (49% practitioner participation rate) in the United States, Canada, Australia, and Puerto Rico. Sociodemographic characterization of 2818 respondents, representing a 67-71% response rate, revealed a population predominately white, female, well-educated, professional, or white collar workers. A second objective of the study included the development and initial validation of a new health survey instrument. The instrument was specifically designed to assess wellness through patients' self-rating different health domains and overall quality of life at two "time" points: "presently" and retrospectively, recalling their status before initiating care ("before Network"). Statistical evaluation employing Chronbach's alpha and theta coefficients derived from principle components factor analyses, indicated a high level of internal reliability in regard to the survey instrument, as well as stable reliability of the retrospective recall method of self-rated perceptions of change as a function of duration of care. Results indicated that patients reported significant, positive perceived change ($p < 0.000$) in all four domains of health, as well as overall quality of life. Effect sizes for these difference scores were all large (>0.9). Wellness was assessed by summing the scores for the four health domains into a combined wellness scale, and comparing this combined scale "presently" and "before Network." The difference, or "wellness coefficient" spanning a range of -1 to +1, with zero representing no change, showed positive, progressive increases over the duration of care

intervals ranging from 1-3 months to over three years. The evidence of improved health in the four domains (physical state, mental/emotional state, stress evaluation, life enjoyment), overall quality of life from a standardized index, and the "wellness coefficient," suggests that Network Care is associated with significant benefits. These benefits are evident from as early as 1-3 months under care, and appear to show continuing clinical improvements in the duration of care intervals studied, with no indication of a maximum clinical benefit. These findings are being further evaluated through longitudinal studies of current populations under care in combination with investigation of the neurophysiological mechanisms underlying its effects.

### Network Spinal Analysis: A System of Health Care Delivery Within the Subluxation-Based Chiropractic Model

Epstein, D. Journal of Vertebral Subluxation Research, August 1996; 1(1): 51-59

The theoretical basis and clinical application of Network Spinal Analysis (NSA) is described. NSA delivers health care within the subluxation-based chiropractic model and seeks to contribute to the distinction of the various techniques and methods within the profession by describing and discussing its major characteristics. In this regard, clinical observations relative to the application of the Network Protocol have been described in relation to the monitoring of patient and practitioner outcomes. Relevant research from a separate Network Care retrospective study, which impacts on its characterization, profiles the patient population as predominantly female. Other data indicates that Network Care is widely and consistently practiced. Additionally, patients report significant, positive changes in health-related quality of life measures linked to certain clinical components of Network Care.

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**Editorial**

# Seeds of Meaning, Transformations of Health Care, and the Future

Simon A. Senzon, MA, DC

The year 2010 will be remembered as a turning point in health care. The country with the world's largest single economy, The United States of America, has created a health care system for many of its people. Thirty-two (32) million of the 47 million uninsured Americans will be covered by the new health plan, including the youngest and the sickest. One of the most incredible aspects of the new law is its embrace of prevention and health promotion. The Patient Protection and Affordable Care Act of 2010 (Section 4001), creates the National Prevention, Health Promotion and Public Health Council.[1] Headed by the Surgeon General, this new policy coordinating council of the U.S. government will be run by several cabinet members and will be advised by complementary and alternative medicine (CAM) practitioners. Among other things, the council is tasked to consider innovative, evidence-based models and policies to promote "transformative models of prevention, integrative health, and public health on individual and community levels across the United States." It is now the task of the CAM and integrative medicine community to use this new visionary piece of law to transform health care.[2] If we do not take this chance to redefine health, wellness, and health care, a broken system, teetering on collapse will shatter. Our actions will help define the direction for the future of health care, not only in America but worldwide, because the lifestyle habits of people in the United States of America might just become its greatest export.

The system is broken for many reasons. The United States spends more on health care than any other country; yet, in comparison to other industrialized nations, our health is 37th,[3] and infant mortality is 30th.[4] The United States spends more than $2 trillion annually on health care.[5] To put this into perspective, this is almost as much as the *entire* gross domestic product (GDP) of the United Kingdom or Italy, and more than the GDP of Brazil.[6] The most preventable and deadliest chronic diseases, such as diabetes, cancer, hypertension, mental disorders, and heart disease are costing the U.S economy $1 trillion yearly and this figure will grow to $6 trillion yearly by 2050.[7] Much of this expansion of sickness in America is projected as a result of the aging of the Boomers. In 2011, the first of the 78 million baby boomers will turn 65.[8] On this note, the authors of the Wellness Initiative for the Nation (WIN) document, which helped to inspire the new council described above, write: "Our health care system is a broken disease treatment system, and the time for change is well overdue."[9] Adding 32 million people to a broken system is not a viable solution, and if anything only makes it worse.

The most obvious and impactful approach to transform health care is to shift focus from restorative therapeutics to prevention and health promotion. The role of behavior and lifestyle change on overall health, prevention of chronic disease, and epigenetic changes is profound. The European Prospective Investigation into Cancer (EPIC) study of 23,000 individuals showed how changes in lifestyle behavior could lead to prevention of diabetes (93%), heart attacks (81%), strokes (50%), and cancers (36%).[10] The INTERHEART study of 30,000 individuals demonstrated a 90% prevention of heart disease by changing lifestyle.[10] It is estimated that two thirds of chronic illness can be prevented by lifestyle behavior change.[9] Lifestyle changes even effect epigenetic changes.[11,12]

This shift of focus from fixing problems to promoting health is one way to begin the transformation, especially if it extends to education,[13] public policy,[9] and advertising campaigns.[2] But even such a tectonic shift would not go far enough. Even if people exercised,[14] improved their diets and maintained healthy weights,[15] quit smoking,[16] and learned to meditate,[17] the system would still be broken. The health care system grew out of an era of scientific empiricism, mechanistic thinking, and an overreliance on a reductionist "objective" truth. This system is not designed to help people get well, thrive, and flourish. Individuals are being told to change their behaviors, their very *life's* style, so that they won't get sick, won't die early, and, it is hoped, live a better life. This is still an approach based on linear causation rather than wholeness, systems, and human depth. It is not about the compelling benefits of living life to the fullest, thriving, and accessing one's unique potential.[18]

Embracing a systems and holistic orientation toward health and well-being implies an inclusion of body, emotion, mind, spirit, family, and community. How can we include all of those, embracing the emerging evidence based models for CAM and integrative medicine, in such a way that we can: help people to make the changes they need to at the right time; assist practitioners to embody self-care; and also set an agenda for policy, implementation, and a visionary transformation of health care? What we need is a totally new approach that integrates all of the myriad solutions strewn throughout the CAM and integrative medicine literature.

A new level of thought-leadership is required of the CAM community. There is a long history in the CAM traditions of prevention, promotion, well-being, and wholeness.

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This history needs to be coupled to the emerging evidence based models and embedded into the philosophical maps being created. For example, in a recent article on integrative oncology, Geffen describes the central challenges to the system of health care, especially in terms of cancer.[19] He emphasizes the importance of oncology because, "1 in 3 women and 1 in 2 men alive today are expected to be diagnosed with cancer at some point in their lives."[19] Geffen proposes several ways integrative medicine can move forward with a multidimensional approach to the whole human. He even suggests that meeting the patient's emotional and spiritual needs is part of the doctor's role. Finally, Geffen calls for practitioners to embrace self-care, a deeper and more empathic approach to suffering, and a consensus about "healing vs. curing" within the profession of medicine. It is in such a call for consensus that CAM and integrative medicine could lead together. In fact, an article I recently coauthored with Epstein and Lemberger on Reorganizational Healing,[18] not only shares many commonalities with Geffen's overall approach, but grew out of a CAM tradition rooted in an embodied modality and model of "healing vs. curing."[20] It is this type of coupling of traditions, of breaking down the old barriers between CAM and conventional medicine, which will support the visionary leaders to step forward. By embedding the consensus on healing to the long tradition of CAM with the latest evidence-based and transformative models, medicine and health care can be renewed.

In 1999, Jobst, Shostak, and Whitehouse wrote about diseases of meaning.[21] Their metaphor was simple, compelling, and transformative: "disease is a manifestation of health."[22] The metaphor is simple because it points out the not-so-obvious in such a way that it seems like a given. The maladies of our modern, affluent world, from cancer to depression and heart disease to obesity, are seeds from which each individual, culture, and society can grow meaning. The metaphor is compelling because it directs us away from the way things are normally done, such as viewing symptoms and disease as "things" that can be fixed, cut out, or prevented. Disease, instead, is the natural response in a living system to a perceived imbalance or threat. They write: "perceived meaning and the way it affects how life is lived is at the root of all disease." Our current system of health care appears to have no context with which to embrace such a profound truth. *Just by contemplating it, we are compelled to seek greater meaning*. Their metaphor is transformative because it demands we re-envision the way we view reality, the way we act in the world, and the way we enact things in our world. Accepting their metaphor requires us to transform everything about health care, disease care, wellness care, and ultimately, well-being. Disease, then, can be viewed as a catalyst to develop a new sense of a person's role in his or her own life; a new connection to the body, emotions, spirit, family, community; and even that person's ancestors. Transformative indeed!

In order for a new system to come into being, the older one must fall apart. The broken and collapsing U.S. health care system is based on a view of the world that no longer makes sense. As the world grows more complex, so does the way we construct for ourselves what the world means.[23] We must adapt and develop in our own complexity, if we are to embody new and more integral modes of being, healing, growing, and evolving.[24] Fundamentally, we are *all* deeply connected: we share a world; we have hearts beating in our chests; breath filling and emptying our lungs, moment by moment; and life pulsing through us. This year, 2010, was a year that went by in the vast history of our people, of our world, of our universe. Can we embrace its gifts to move forward with a new vision? Can we go deeper and find more ways to bring more people greater depth of meaning, ease of living, well-being, and joy in life? Let us do this. Let us gather the seeds and plant anew so that our children's children may live to be proud of us.


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Short communication

# On a standing wave Central Pattern Generator and the coherence problem☆

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ABSTRACT

An electrophysiological phenomenon running up and down the spine, elicited by light pressure contact at very precise points and thereafter taking the external appearance of an undulatory motion of the spine, is analyzed from its standing wave, coherence, and synchronization-at-a-distance properties. This standing spinal wave can be elicited in both normal and quadriplegic subjects, which demonstrates that the neuronal circuitry is embedded in the spine. The latter, along with the inherent rhythmicity of the motion, its wave properties, and the absence of external sensory input once the phenomenon is elicited reveal a Central Pattern Generator (CPG). The major investigative tool is surface electromyographic (sEMG) wavelet signal analysis at various points along the paraspinal muscles. Statistical correlation among the various points is used to establish the standing wave phenomenon on a specific subband of the Daubechies wavelet decomposition of the sEMG signals. More precisely, ∼10 Hz coherent bursts reveal synchronization between sensory-motor loops at a distance larger, and a frequency slower, than those already reported. As a potential therapeutic application, it is shown that partial recovery from spinal cord injury can be assessed by the correlation between the sEMG signals on both sides of the injury.


## 1. Introduction

Central Pattern Generator (CPG) is a concept still in search of a final definition [13,38]; however, it is admitted that it is an interconnection of neurons that produces a movement of the limbs and/or the trunk that has the following attributes:

1. The movement is rhythmic [50].
2. It does not require (patterned) sensory input [45].
3. The neuronal circuitry in vertebrates is embedded in the spine, without higher cerebral function involvement [26].
4. It requires some learning or entrainment [45] and it might undergo resetting [25].
5. In case of a CPG controlling the movement of the spine of a vertebrate, the latter exhibits some wave properties [13].

Items 1–3 are the most traditional ones, while the consensus is not completely unanimous on Items 4–5. The purpose of this paper is to show evidence of a *human* CPG that produces an undulatory movement of the spine. It satisfies all five criteria, provided Criterion #2, absence of sensory input, is interpreted in a way that *allows* but *does not require* sensory inputs [38], something that will be discussed separately in Section 4.3. In this paper, we more specifically address Criterion #5, since wave properties of CPG movement have lately attracted growing attention [13]. What distinguishes the present paper from [13] is that here we deal with *standing* wave, while [13] dealt with *traveling* wave. We also quite specifically address Criterion #3 by showing that a quadriplegic subject[2] can sustain the undulatory movement. Yet another quadriplegic case study has been reported in [48]. An issue closely related to #3 is whether the CPG is a simple neuronal circuitry, like a bistable oscillator, or something more complicated. For gait CPG, the paradigm of one bistable oscillator CPG per joint [55] seems adequate. Simple bistable oscillators also appear adequate for lower vertebrates (although more complicated models have already been proposed [24]). However, when one reaches the complexity of the human spine, the coordinated movement of its many intervertebral muscles definitely requires a more complicated spatially distributed circuitry.

This rocking motion of the spine, which occurs in the coronal or saggital plane or both depending on the subject, is elicited by light

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[2] Recording on such a vulnerable subject was done with special IRB permission.

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pressure contact on the spine at some precise cervical and sacral points. At the cervical level, it is conjectured that the attachment of the spinal dura to the C1–C6 vertebra [4,63] creates a sensory-motor loop oscillation, which is easily visualized as a twitching of the trapezius and sternocleidomastoid neck muscles. (See e.g., [34] for the concept of anatomical loop.) After some entrainment, the skin area overlaying the dural-vertebral attachments is sensitized [54] to the point where a slight pressure contact is enough to elicit the oscillation. The oscillation rapidly becomes self-sustained without the need for further external pressure sensory input from the practitioner. Likewise, at the sacral level, the attachment of the filum terminale (the distal end of the spine) to the coccyx also creates a sensory-motor loop oscillation, which takes the external appearance of a rocking motion of the pelvis. Subject to appropriate entrainment, this pelvic motion can be made to bear some resemblance with human gait. (See [20,11] for the CPG of gait.)

The overall *spinal wave* procedure consists of the following steps: After sensitization of the sacral area, a light pressure contact at S3–S4 engages the sacral oscillator. From the sacral area, an electrophysiological wave phenomenon propagates upward, but initially dissipates before reaching the cervical area. Nevertheless, after some entrainment, eventually the upward wave reaches the cervical area and triggers the neck area to go in oscillation. When extended across the whole spine, the headward traveling wave reflects off the sphenoid, which happens to be the most cephalad attachment of the dura [4], and then travels caudally. Visually, the upward/downward traveling waves can be seen to collide, and survive the collision in some soliton-like propagation [27,22]. Eventually the upward and downward waves settle in a standing wave pattern [1], during which the neck movement is perfectly coordinated with the pelvic movement [28].

It is the latter coordinated movement that has the attributes of a CPG. While the typical CPG features #1, #4, and #5 can be visualized [23], our approach has been to demonstrate the CPG hypothesis by the more objective analysis of the surface electromyographic (sEMG) activity recorded on the paraspinal muscles during the procedure. As such, the rhythmic property was proved in [43] by the burst analysis of the sEMG signals (see also [19] for some closely related research). The learning/entrainment was proved in [30,3] by ARIMA and ACE modeling of the sEMG signals and by showing that the ability of the models to predict the signals improves dramatically along the entrainment. Resetting (e.g., transition from traveling to standing wave) was demonstrated by some qualitative changes in the neck signal models [30].

In this paper, we more specifically demonstrate the standing wave hypothesis #5 by analysis of the sEMG signals recorded at four points (cervical, thoracic, lumbar, and sacral) along the spine [31]. A standing wave across a propagation medium is concurrent with synchronization between the motions of the ends. This synchronization is revealed by a correlation method. The latter further reveals a (s)EMG coherence at ∼10 Hz, a frequency slower than the traditional ∼20 Hz one, because here the coherence is across larger distances [17,49,14,2,16]. Next, we demonstrate that the neuronal circuitry is embedded in the spine (#3) by analyzing the sEMG data recorded on a quadriplegic subject, who, despite a near complete severage of the spine at C5, was able to experience the spinal wave. Finally, the issue of absence of sensory input will also be investigated and a CPG circuitry model will be proposed.

## 2. Methods

### 2.1. Data collection

Before data collection, the two research subjects upon which this study is based had signed the *Informed Consent Form* in a protocol approved by the Institutional Review Board (IRB) of the University of Southern California (case USC UPIRB #01-01-009). The control subject is a female in her early 30's and the quadriplegic subject is a male in his 30's. The latter subject had a swimming pool accident: he dove in the end of a pool with 4 ft. of water sustaining a spinal cord injury at C-5 (similar to the case reported in [46]); the C-5 vertebrae was surgically removed and replaced with a titanium plate from C-4 to C-6. Due authorization of the IRB was granted to take recordings on such a vulnerable subject.

To record sEMG signals, we utilized "Uni Patch Tyco EMG Electrodes Round Disk 7500 2.25 diameter Ag snaps." These are ungelled, noninvasive, tripolar electrodes. The patch has 2.25 in. diameter and supports three 0.5 in. Silver disks electrodes arranged at the apexes of an equilateral triangle of 0.75 in. side. Two of the snaps are inputs to a differential amplifier, while the third snap is the ground. The front-end amplifier directly snaps on the patch in order to immediately amplify the signals. The patches were placed at cervical (C2–C3), thoracic (T4–T6), lumbar (L3), and sacral (S2–S4) positions along the spine. The data was recorded with the differential amplifier snaps aligned with the paraspinal muscle fibers [9].

The raw sEMG data was collected over a bandwidth of 10–500 Hz by an Insight$^{TM}$ Millennium machine and the amplified signals (of the order of 2.5 V) were available relative to a ground reference potential. The latter signals were the inputs to a 16 bit precision PC-CARD-DAS16/16, manufactured by *Computer Boards* (now, *Measurement Computing*), configured in "single-ended" mode, and fitting in the PCMCIA slot of a laptop computer. The sampling frequency was 4000 samples/s. It has indeed been argued that it is necessary to sample EMG signals much faster than the Nyquist frequency [47], up to 8000 samples/s; however, a mutual information criterion [48] rather calls for 2000 samples/s. Hence a rate of 4000 samples/s appears a compromise, possibly with some risk of oversampling, which will be removed by the multiresolution wavelet analysis.

In order to assess noise or other irrelevant pattern, before entrainment but with the research subject in the same position and with the same electrode placement and wiring as during entrainment, time-series signals were recorded to be used as control or testing signals. Then, keeping the same experimental environment, the subject was entrained and the spinal wave was recorded. Comparing the wavelet decompositions of the control and the spinal wave signals allowed us to determine which components of the wavelet decomposition were true spinal wave signals as opposed to noise or other parasitic effects.

### 2.2. Wavelet analysis

Assume we are given a bi-indexed orthonormal family $\{\psi_{mn} : m \in \mathbb{Z}, n \in \mathbb{Z}\}$ of functions, where $\psi_{mn}(t) = 2^{-m/2}\psi(2^{-m}t + n) \in \ell^2$ is obtained by scaling and shifting a "mother function" $\psi \in \ell^2$. This family of functions defines the signal space $\mathcal{Y}$:=span$\{\psi_{mn} : m \in \mathbb{Z}, n \in \mathbb{Z}\}$. As such, any signal $y \in \mathcal{Y}$ can be decomposed as

$$y(k) = \underbrace{\sum_{m>M}\sum_{n} y_{mn}\psi_{mn}(k)}_{A_M(k)} + \underbrace{\sum_{m\le M}\sum_{n} y_{mn}\psi_{mn}(k)}_{\sum_{m\le M} D_m(k)}$$

where the $y_{mn}$'s are the coefficients of the expansion of the signal in the bi-indexed wavelet basis. $\sum_{m>M}\sum_n y_{mn}\psi_{mn}$ can be interpreted as the (low resolution) *approximation* of the signal, while $\sum_{m\le M}\sum_n y_{mn}\psi_{mn}$ is the (high resolution) *detail* of the signal.

If we define $V_M = \text{span}\{\psi_{mn} : m > M, n \in \mathbb{Z}\}$, we obtain a sequence of signal approximation spaces $\cdots \subset V_{m+1} \subset V_m \subset$

$V_{m-1} \subset \cdots$ Furthermore, we write $V_{m-1} = V_m \oplus W_m$, where $W_m = \text{span}\{\psi_{mn} : n \in \mathbb{Z}\}$. It turns out that there exists a scaling function $\phi$ such that $V_m = \text{span}\{\phi_{mn} : n \in \mathbb{Z}\}$, $\phi_{mn}(t) = 2^{-m/2}\phi(2^{-m}t + n)$. This function is computed via a wandering subspace argument [37]. Define the "outgoing" subspace $V_{0+} = \text{span}\{\psi_{mn} : m > 0, n \in \mathbb{N}\}$ and the positive shift $T_+ : V_{0+} \to V_{0+}, (T_+\psi)(k) = \psi(k+1)$. Then clearly, $T_+V_{0+} \subset V_{0+}$ and we pick $\phi \in V_{0+} \ominus T_+V_{0+}$ (see [39, Section 5, Proposition 5]).

With the above defined subspaces, and taking $M = 1$ as reference resolution level, the signal can be dyadic decomposed down to eight levels as

$$\begin{aligned}
Y(k) &= \sum_n c_{1n}\phi_{1n}(k) + \sum_{m\le 1}\sum_n c_{mn}\psi_{mn}(k)\\
Y(k) &= \sum_n c_{2n}\phi_{2n}(k) + \sum_n c_{2n}\psi_{2n}(k) + \sum_{m\le 1}\sum_n c_{mn}\psi_{mn}(k)\\
&\vdots \qquad\qquad \vdots\\
Y(k) &= \sum_n c_{8n}\phi_{8n}(k) + \sum_n c_{8n}\psi_{8n}(k) + \sum_n c_{7n}\psi_{7n}(k)\\
&\quad + \cdots + \sum_n c_{2n}\psi_{2n}(k) + \sum_{m\le 1}\sum_n c_{mn}\psi_{mn}(k)
\end{aligned}$$

For the specific case $y \in V_0$, the above is rewritten more conceptually in terms of various approximation ($A$) and detail ($D$) components:

$$\begin{aligned}
Y(k) &= A_1(k) + D_1(k)\\
Y(k) &= A_2(k) + D_2(k) + D_1(k)\\
&\vdots \qquad \vdots\\
Y(k) &= A_8(k) + D_8(k) + D_7(k) + \cdots + D_1(k)
\end{aligned}$$

The experimental problem is to determine *what* wavelet and *what* subband signals among the $D's$ are most relevant to the spinal wave.

### 2.3. Correlation approach to wave analysis

The wave analysis proceeds from the correlation properties of the signal recorded at one point along the spine and the time-shifted signal recorded at another point (see [40] for a related analysis). Here the sEMG signals recorded at two points along the spine are treated as stationary random processes $Y_i(k)$, $Y_j(k)$. (The stationary assumption is approximately verified over a small enough time window [43].) The scalar correlation coefficient [5, p. 74] between the random variables $Y_i(k)$ and $Y_j(k+s)$ is defined as

$$\rho_{ij}(s) = \frac{E((Y_i(k) - EY_i(k))(Y_j(k+s) - EY_j(k+s)))}{\sqrt{E(Y_i(k) - EY_i(k))^2}\sqrt{E(Y_j(k+s) - EY_j(k+s))^2}}$$

This approach is statistically implemented as follows [5, Chap. 12]:

$$r_{ij}(s) = \frac{\sum_{k=1}^{K-s}(Y_i(k) - \bar{Y}_i(s))(Y_j(k+s) - \bar{Y}_j(s))}{\sqrt{\sum_{k=1}^{K-s}(Y_i(k) - \bar{Y}_i(s))^2}\sqrt{\sum_{k=s+1}^{K}(Y_j(k) - \bar{Y}_j(s))^2}}$$

where

$$\bar{Y}_i(s) = \frac{1}{K-s}\sum_{k=1}^{K-s} Y_i(k)$$

$$\bar{Y}_j(s) = \frac{1}{K-s}\sum_{k=s+1}^{K} Y_j(k)$$

Given that $r_{ij}(s) \neq 0$, it is necessary to determine, with enough confidence, whether $\rho_{ij}(s) \neq 0$. This confidence analysis is based on the fact that, when $Y_i(k)$, $Y_j(k+s)$ are independently normally distributed ($\rho_{ij} = 0$), the variable

$$t_{ij} = r_{ij}\frac{\sqrt{K-s-2}}{\sqrt{1-r_{ij}^2}}$$

approximately follows a $t$-distribution with $K - s - 2$ degrees of freedom [5, p. 224], where $K$ is the length of the data record and $s$ the time shift.[3] To compute the $(100 - 2\alpha)\%$ confidence interval, define $t_\alpha$ to be the value of the $t$-variable that is exceeded with probability $\alpha$. Then the confidence interval is given by $[-r, +r]$, where $r$ is the solution to $t_\alpha = r\left(\sqrt{K-s-2}/\sqrt{1-r^2}\right)$, that is,

$$r \approx \frac{t_\alpha}{\sqrt{K-s-2}} \tag{1}$$

## 3. Results

### 3.1. Wavelet decomposition

The initial intent was to find a specific wavelet and the specific subband signals that could achieve the most sizable distinction between some "test" signals and the spinal wave signals. Here, "test" means that the sEMG data was recorded during some voluntarily controlled mild motion of the trunk. Another criterion was to find the subband signals that exhibit best correlation (hence highest confidence). After trial and error, it was found that the Daubechies DB3 wavelet [8,61,7] was the best suited relative to the above-mentioned criteria.

In Fig. 2, a "test" signal segment and the first half of the raw spinal wave signal as shown in Fig. 1, are dyadic decomposed down to 8 levels with the Daubechies wavelet function [8,61,7] of order 3. These two segments, both of a length of approximately 2.5 s, were chosen as "most relevant" within the sEMG database of the control subject in a sense elaborated on in [30, Section 2.3]. In a few words, the whole control subject data record was subdivided in some smaller "segments." Each segment was represented by the sum of the absolute values of its partial correlation coefficients $b_k$ and the sum of the absolute values of its autocorrelation coefficients $a_k$. Then the relevant data $\left\{\left(\sum_{k=1}^{25}|a_k|, \sum_{k=1}^{25}|b_k|\right)\right\}$ was displayed as a cluster in $\mathbb{R}^2$. Then the "most relevant" signal segment was defined as the center of mass of the cluster. The raw signals of Fig. 2 were obtained as the most relevant ones.

By comparing the "test" and spinal wave signals, it becomes evident that the signals in $A_8$ are just base line drifting or low frequency noises (long term evolution) and as such are signals of no interest; neither are the signals in the $D_1$ to $D_5$ subbands of interest, because there is no difference between the test and the spinal wave signals and as such these signals consist mainly of high frequency noise. On the other hand, the $D_6$, $D_7$, $D_8$ components are of more interest, because there is now a sizable difference between

[3] Also recall that the sample distribution of $(1/2)\log((1+r)/(1-r))$ is approximately normal with mean $(1/2)\log((1+\rho)/(1-\rho))$.

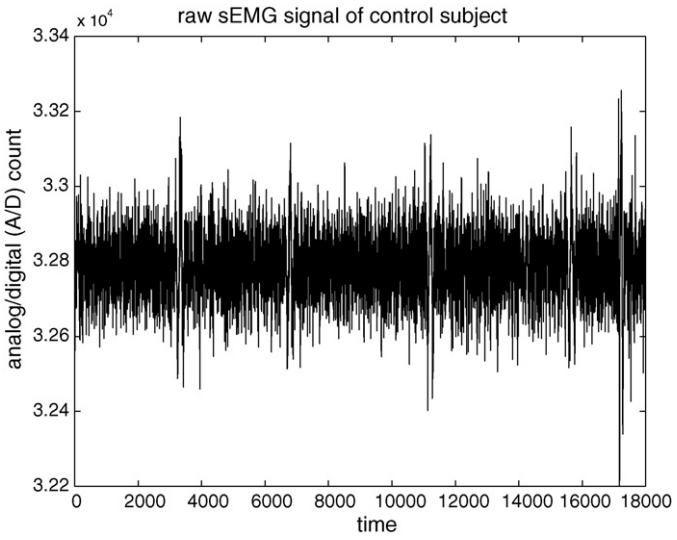


**Fig. 1.** Raw sEMG signal of control subject. The abscissa is the number of samples at a rate of 4000/s; the ordinate is the analog/digital (A/D) count among the $2^{16}$ available in the 16-bit precision analog-to-digital converter.

the test and spinal wave signals. "Wavelet packets" can be observed in the $D_7$, $D_8$ subband signals, which, as will be shown, are coherent bursting phenomena [17,16] running up and down the spine and establishing a "standing" wave pattern. Quantitatively, looking at the $D_8$ subband signal, it appears that the bursts occur at a rate of 1 every 4000 samples, that is, at a rate of 1 burst per second, which is consistent with the visually observed motion of the spine. Zooming at a burst of the $D_8$ subband signal, it is easily seen that it is composed of several cycles of a more fundamental oscillation, at a frequency of roughly 13.5 Hz.

While a correlation analysis on $D_7$ could be carried out, we selected the $D_8$ signal, because it showed the better correlation properties. Another motivation for focusing on the $D_8$ (and possibly the $D_7$) subband signals is that comparison between Fig. 1 and Fig. 2, right panel, reveals that the mild bursts in the raw signal occur when the $D_8$ ($D_7$) subband signals show doublets.

Observe that Fig. 2 only provides a 2.5 s snapshot of the wavelet decomposition, whereas the correlation analysis is based on a much longer data records: 1 min and 20 s for control subject and 50 s for quadriplegic subject.

### 3.2. Correlation plots

The correlation plots $r_{ij}(s)$ for various time-shifts of the $D_8$ subband signals of the control (normal) subject are shown in Figs. 3(a)–6(a).

The confidence level was set to 99%. The confidence intervals were computed from Formula (1), with $\alpha = 0.005$, $t_{0.005} = 2.576$ (for the Gauss approximation of very high degree of freedom $t$-distribution), $s = 0$, and $K = 327,680$ for control subject and $K = 196,608$ for quadriplegic subject. The resulting confidence intervals are $[-0.0045, +0.0045]$ for control subject and $[-0.0058, +0.0058]$ for quadriplegic subject. They are displayed by two lines parallel to the $s$-axis in Figs. 3–6. The correlation is significant whenever the $r_{ij}(s)$ versus $s$ curve is outside the horizontal band bounded by the two lines parallel to the $s$ axis.

Observe that the curves are well outside the "slit" along the $s$ axis, indicating a 99% confidence in the correlation. Next, observe that all correlations are maximum for $s = 0$; in other words, the cervical, thoracic, lumbar and sacral bursts are synchronous, a first sign of a standing wave pattern. Most importantly, observe the consistent phase pattern, with "zero correlation nodes." (A "zero correlation node" is defined as a point where all $r_{ij}(s)$ versus $s$ curves cross the $r = 0$ axis.) Also observe that the two successive maxima of $r_{11}(s)$ occur for $\Delta s \approx 275$ samples $\approx 0.06875$ s, which is consistent with the fundamental frequency of 13.5 Hz. observed in Section 3.1.

To allow for an easy comparison between the control and quadriplegic subjects, the correlation curves of Figs. 3(a)–6(b) are organized with the control subject curves on the left and

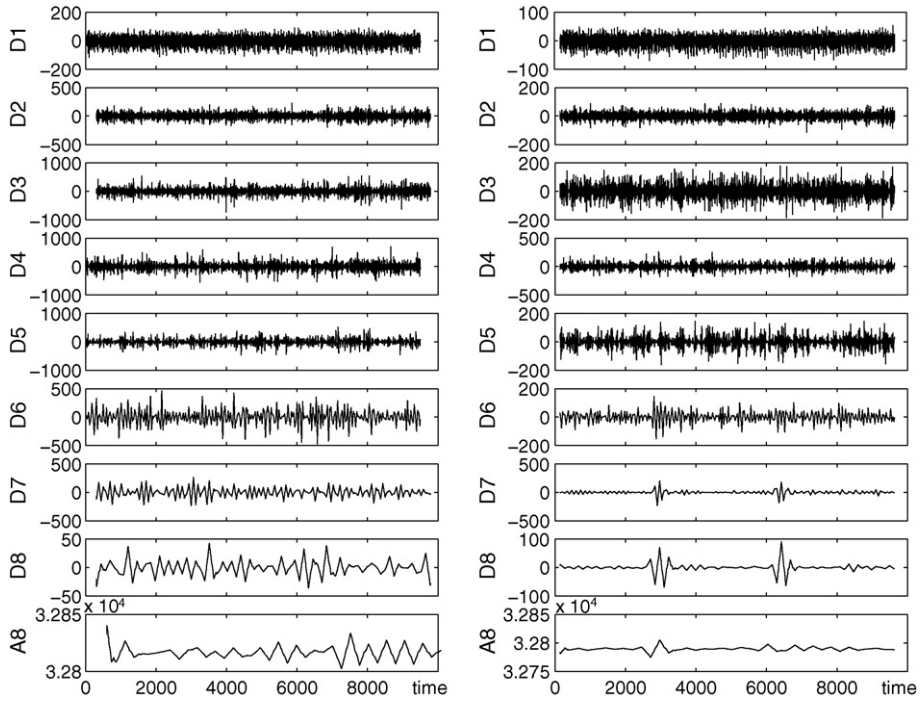


**Fig. 2.** Comparison between wavelet decompositions of test signal (left) and spinal wave signal (right). The sampling rate is 4000/s. The raw spinal wave signal is the first half of the signal shown in Fig. 1.

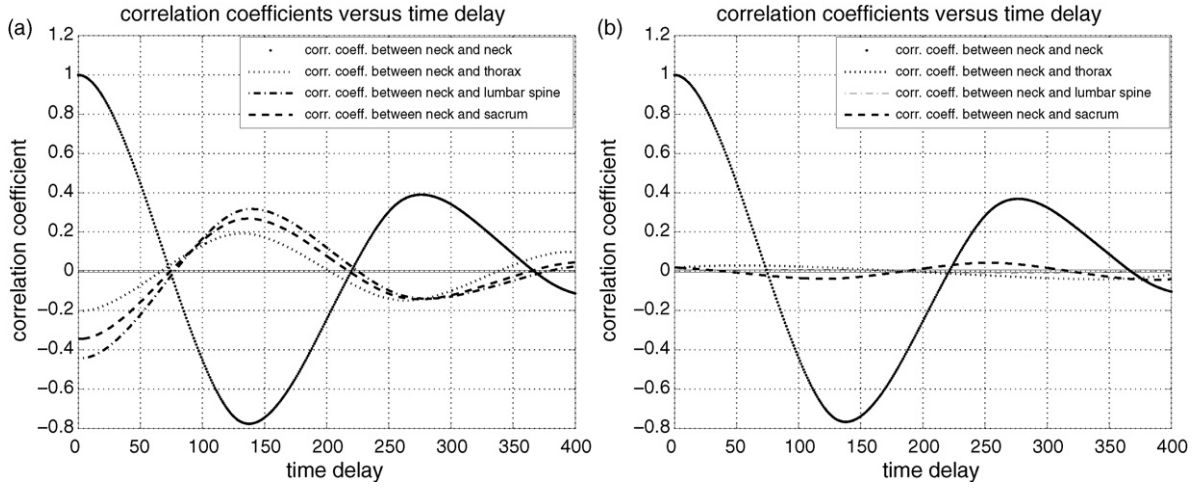


**Fig. 3.** (a and b) Correlation between $D_8$ subbands of neck and other signals for control subject and quadriplegic subject. Solid line: neck–neck correlation; dotted line: neck–thorax correlation; dashed-dotted line: neck–lumbar spine correlation; dashed line: neck–sacrum correlation. Confidence interval for control subject: [−0.0045, +0045]; for quadriplegic subject: [−0.0058, +0.0058].

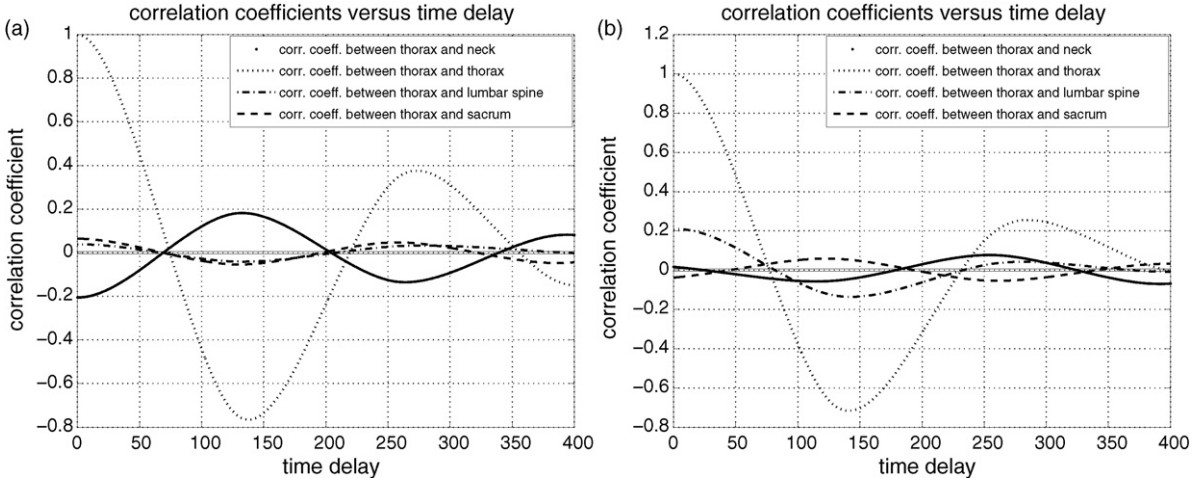


**Fig. 4.** (a and b) Correlation between $D_8$ subbands of thorax and other signals for control subject and quadriplegic subject. Solid line: thorax–neck correlation; dotted line: thorax–thorax correlation; dashed-dotted line: thorax–lumbar spine correlation; dashed line: thorax–sacrum correlation. Confidence interval for control subject: [−0.0045, +0045]; for quadriplegic subject: [−0.0058, +0.0058].

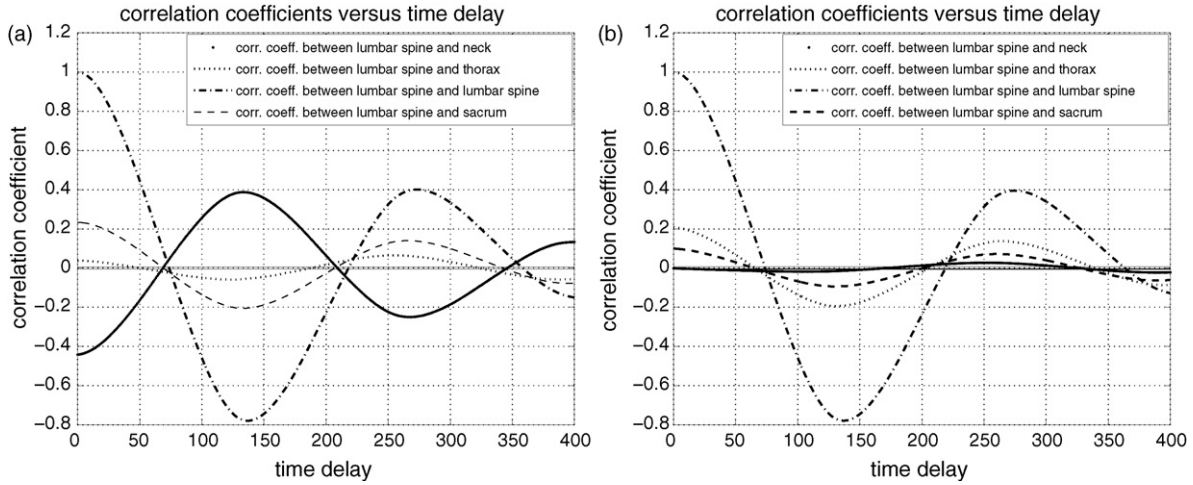


**Fig. 5.** (a and b) Correlation between $D_8$ subbands of lumbar spine and other signals for control subject and quadriplegic subject. Solid line: lumbar spine–neck correlation; dotted line: lumbar spine–thorax correlation; dashed-dotted line: lumbar spine–lumbar spine correlation; dashed line: lumbar spine–sacrum correlation. Confidence interval for control subject: [−0.0045, +0045]; for quadriplegic subject: [−0.0058, +0.0058].

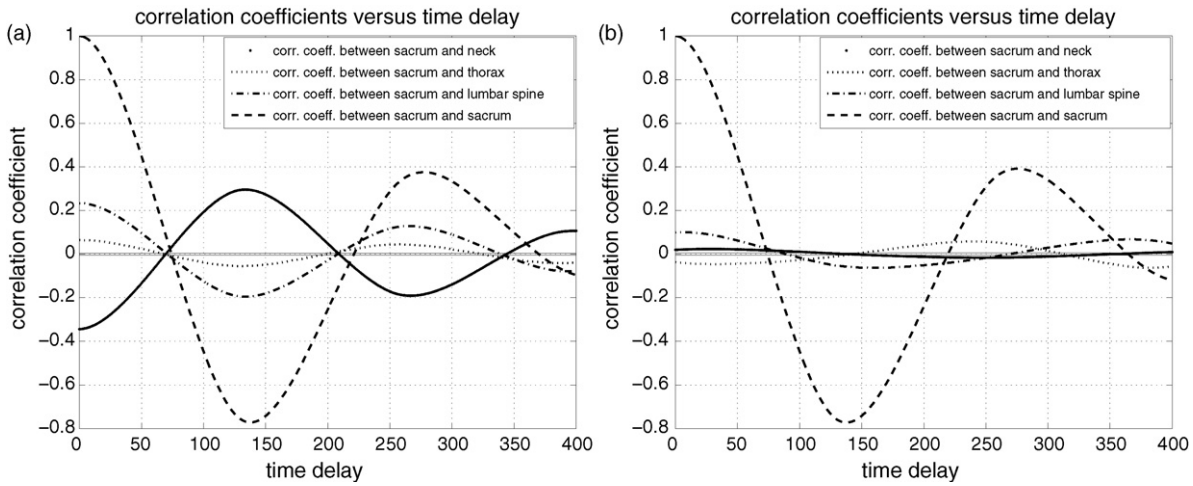


**Fig. 6.** (a and b) Correlation between $D_8$ subbands of sacrum and other signals for control subject and quadriplegic subject. Solid line: sacrum–neck correlation; dotted line: sacrum–thorax correlation; dashed-dotted line: sacrum–lumbar spine correlation; dashed line: sacrum–sacrum correlation. Confidence interval for control subject: [−0.0045, +0045]; for quadriplegic subject: [−0.0058, +0.0058].

the quadriplegic subject curves on the right. The first and most striking difference between the control subject (Fig 3(a)) and the quadriplegic subject (Fig 3(b)) is a weaker correlation between, on the one hand, the neck and, on the other hand, the cervical, thoracic, lumbar or sacral signals, as can be anticipated because of the neck injury. However, no matter how weakened, the correlations involving the neck *are still in the 99% confidence interval.* Second, observe that the pattern of "zero crossing nodes" is not as clear as that of the control subject. However, the thoracic, lumbar, and sacral plots (Figs. 4(b), 5(b), and 6(b), respectively) do show zero crossing nodes, *if we remove the neck signals from those plots.* Another striking difference is that, in the thoracic, lumbar and sacral plots of Figs. 3(a)–6(b), the correlation involving the neck signal of the quadriplegic subject is off phase as compared with the control subject.

### 3.3. Comparison with other case studies

Among the two dozens case studies we have conducted, the present control subject case is among the best we have analyzed from the point of view of zero correlation crossing pattern. (The very best case is one that does not even require preprocessing of the data by wavelet transform, as the zero correlation crossing pattern already appears on the raw signal.) Among the cases that require wavelet transform pre-filtering, the present control case study stands out as a nice one in the sense that (i) the neck–neck correlation curve crosses the time delay axis at the same points where the other correlation curves cross the same axis, and (ii) the zero crossing nodes appear all along the time delay axis. In some cases, there are difficulties at either (i) getting the neck–neck curve crossing the time delay axis at the right places, or (ii) having the zero crossing node pattern already present at small time delays.

## 4. Discussion

### 4.1. Wavelet decomposition

The finding that the DB3 wavelet is the best relative to the criteria of Section 3.1 is fully consistent with [60], where $DB_3$ was also adopted, for the different reason that this wavelet mimics the single Motor Unit Action Potential (MUAP) detected by the electrodes. This explains the experimentally observed fact that the DB3 subband signals have better correlation properties. The nice $D_8$ subband signal reveals that the muscle fibers and hence efferent nerve fibers [58, p. 66] are in sync; indeed, there is evidence that the sEMG signal is the algebraic summation of motor-unit action-potential trains [10,44].

The bursts are easily seen to occur at a rate of approximately one per second, which is consistent with the observable mechanical motion of the spine. The bursts appear to be doublets [14,2,32], which from the point of view of the classification of [49, Fig. 1] are of the "resonant" type. The in-burst frequency of ∼13.5 Hz appears closely related to a ∼10 Hz phenomenon conjectured to exist in EMG [17, the question of frequency], but this issue is relegated to Section 4.2.5.

### 4.2. Standing wave interpretation of correlation

#### 4.2.1. Mathematical modeling: general function analytic analysis

Let the space-sampled, time-sample signal $(y_{\text{neck}}(k), y_{\text{thorax}}(k), y_{\text{lumbar}}(k), y_{\text{sacrum}}(k))$ be smoothly extended as a function of the continuous variables $x \in [0, L]$ and $t \in [0, T]$. $x$ is the position along the spine, $L$ is the length of the spine, $t$ is the time, and $T$ is the length of the data record. By fundamental bandwidth limitation, $y(x, t)$ is continuous, it is furthermore bounded by the saturation of the amplifiers, so that the Hilbert-Schmidt condition $\int_0^L \int_0^T y^2(x,t)\,dx\,dt < \infty$ holds. Hence the data $y(x, t)$ can be viewed as the kernel of an integral operator $Y : L^2[0, T] \to L^2[0, L]$ of the Hilbert-Schmidt type [12, p. 1009], where $L^2[0, T]$ denotes the classical Lebesgue space of functions square integrable over $[0, T]$.

Form the adjoint $Y^* : L^2[0, L] \to L^2[0, T]$ along with the self-adjoint operator

$$\begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix} : L^2[0,T] \oplus L^2[0,L] \to L^2[0,T] \oplus L^2[0,L]$$

This operator is also clearly Hilbert-Schmidt, hence compact. It is furthermore nonsingular if it is assumed that $Y$ is nonsingular. It is also easily seen that its eigenvalues come in opposite pairs. Write the eigenvector equation

$$\begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix} \begin{pmatrix} f_n \\ \pm g_n \end{pmatrix} = \pm\sigma_n \begin{pmatrix} f_n \\ \pm g_n \end{pmatrix}, \quad n \in \mathbb{N}^*$$

where $\sigma_n > 0$, $\sum_n \sigma_n^2 < \infty$ (as a corollary of the Hilbert-Schmidt property [12], Th. XI.6.25), and $\{f_n\}$, $\{g_n\}$ are orthonormal systems. Then applying Mercer's theorem [12, p. 1088] to the projections of

$\begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix}$ on its positive and negative spectra yields

$$y(x,t) = \sum_{n\in\mathbb{N}^*} \sigma_n f_n(t) g_n(x)$$

where the convergence is to be interpreted in the sense of the Hilbert-Schmidt norm [12, Th. XI.6.4]. (See [51] for the formalization of Mercer's theorem extended to non sign definite operators.)

Before proceeding further, some lemmas are needed; the proofs are relegated to Appendix A.

**Lemma 1.** *The functions $f_n : [0,T] \to \mathbb{R}$ and $g_n : [0,L] \to \mathbb{R}$ are continuous.*

Observe that the continuity of $g$ does not preclude $g_n(0) = \infty$ or $g_n(L) = \infty$. However, the boundedness of $y(x,t)$ does preclude this to happen. So, $g_n$ is bounded, but not uniformly in $n$.

Next, form

$$\overline{f_n(t) f_m(t+s)} := \frac{1}{T}\int_0^T f_n(t) f_m(t+s)\,\mathrm{d}t$$

It is readily observed that the above is continuous and uniformly bounded in $s$; specifically, $\left|\overline{f_n(t) f_m(t+s)}\right| \le 1/T$, as a consequence of the Cauchy-Schwarz inequality.

Now, we construct the crucial mathematical object: the correlation between the signal at one spatial point $x$ and the time shifted signal at another spatial location $x'$:

$$R_{x,x'}(s) := \overline{y(x,t) y(x',t+s)}$$

From its definition, it is easily seen that $R_{x,x'}(s) : [0,L]^2 \times [0,T] \to \mathbb{R}$ is continuous and bounded. Next, we would like to show that in the above $y(x,t)$ can be replaced by its Mercer-like expansion. But another lemma is needed.

**Lemma 2.** *The trace class property $\sum_{n=1}^{\infty} \sigma_n < \infty$ holds.*

Now, we are in a position to formulate a property of the spatio-temporal correlation that will appear crucial in the sequel; the proof of it is relegated to Appendix A.

**Theorem 1.**

$$R_{x,x'}(s) = \sum_{n,m=1}^{\infty} \sigma_n \sigma_m \overline{f_n(t) f_m(t+s)} g_n(x) g_m(x')$$

*and the convergence is in the Hilbert-Schmidt norm.*

From the various plots of $R_{x,x'}(s)$ for the control subject and *continuity* of the correlation, it is clear that, $\forall x$, there exists a $x^*$ such that

$$R_{x,x^*}(s) = \sum_{n,m=1}^{\infty} \sigma_n \sigma_m \overline{f_n(t) f_m(t+s)} g_n(x) g_m(x^*) = 0, \forall s$$

In particular, the above is true for $s = 0$ and upon integration relative to $t$, it is found that

$$\sum_n \sigma_n^2 g_n(x) g_n(x^*) = 0$$

In view of the orthogonality of $\{g_n\}$, the above yields

$$g_n(x^*) = 0, \forall n$$

It follows that $y(x^*,t) = 0, \forall t$, so that $x^*$ is a *mode shape node*, indicative of a *standing wave*.

#### 4.2.2. Mathematical modeling: harmonic analysis

From the correlation plots, the cervical ($x = 0$) and sacral ($x = L$) activities of the control subject are easily seen to be in opposite phase. (This is an example of *synchronization across a significant distance* [35, Fig. 2].) This opposite phase phenomenon at the end points along with the standing wave property justifies an approximate model of the form:

$$y(x,t) = \sum_{n=1}^{\infty} a_n \sin(n\omega t) \cos\left(\frac{(2n-1)kx}{2}\right) \tag{2}$$

where $k = 2\pi/L$ is the wave number and $L$ is the length of the propagation medium. In this model, the mode shape node is located at $x^* = L/2$, which is consistent with the experimentally observed *muscle activity* node between the neck and the thorax. This simple harmonic model is useful to clarify the fundamental frequencies involved in this phenomenon.

With such a model, the correlation is easily obtained as

$$R_{x_1,x_2}(s) := \overline{y(x_1,t) y(x_2,t+s)} = \sum_{n=1}^{\infty} a_n^2 \cos(n\omega s) \cos\left(\frac{2n-1}{2} k x_1\right) \times \cos\left(\frac{2n-1}{2} k x_2\right)$$

The zero correlation nodes reveal that $R_{x_1,x_2}(s^*) = 0, \forall x_1, x_2$. From

$$\int_0^L \int_0^L R_{x_1,x_2}(s^*) \cos\left(\frac{2N_1-1}{2} k x_1\right) \cos\left(\frac{2N_2-1}{2} k x_2\right) \mathrm{d}x_1\, \mathrm{d}x_2 = 0$$

it follows that $\cos N\omega s^* = 0, \forall N$, so that $s^* = (2m - 1/2N)(\pi/\omega)$. To be consistent with the experimentally observed pattern of $s^*$, the expansion can only contain one term $n = 1$. As such the pattern $\{s^* = (2m - 1/2)(\pi/\omega) : m \in \mathbb{N}^*\}$ is remarkably consistent with the zero correlation pattern of the figures. Pursuing further, the first ($m = 1$) zero correlation node occurs at $s^* = 80$ samples points, that is, $s^* = 80/4000$ s. Hence $\omega = (1/2)(\pi/s^*)$ yields a frequency of 12.5 Hz.

It is interesting to observe that the Step 2 of the algorithm of [13] also involves truncation of an infinite series like (2), so that our analysis provides the justification for this truncation.

#### 4.2.3. Mathematical modeling: wavelet analysis

Let $\psi$ be the (continuous time) DB3 mother function and let $\{\psi_{8,n}(t) = 2^{-4}\psi(2^{-8}t + n) : n \in \mathbb{Z}\}$ be the orthonormal basis of the $D_8$ space [7], where $n$ is the shift. Here an analysis similar to that of the preceding paragraph is developed, except for a wavelet instead of a sine time dependence:

$$y_8(x,t) = \sum_n g_{8,n}(x) \psi_{8,n}(t) \tag{3}$$

where the $g_{8,n}$'s are the mode shapes. In this wavelet setup, the correlation becomes

$$\begin{aligned} R_{x_1,x_2}(s) &:= \overline{y_8(x_1,t) y_8(x_2,t+s)} \\ &= \sum_{n_1}\sum_{n_2} g_{8,n_1}(x_1) g_{8,n_2}(x_2) \overline{\psi_{8,n_1}(t)\psi_{8,n_2}(t+s)} \\ &= \sum_{n_1} g_{8,n_1}(x_1) g_{8,n_1-2^{-8}s}(x_2) \end{aligned}$$

Therefore, the zero correlation nodes are given by the $s$-solutions to

$$\sum_{n_1} g_{8,n_1}(x_1) g_{8,n_1-2^{-8}s}(x_2) = 0, \forall x_1, x_2$$

From the structure of the plots, such solutions appear in a pattern with period $2^8$.

Next, setting $s = 0$ in the preceding yields

$$R_{x_1,x_2}(0) = \sum_{n_1} g_{8,n_1}(x_1) g_{8,n_1}(x_2)$$

If we set $i = 1, 2, 3$,and4 for the neck, thorax, lumbar spine, and sacrum, respectively, the matrix of canonical correlations $\{r_{x,x_j}(0)\}_{i,j=1,\ldots,4} := \{(R_{x_i,x_j}(0))/(R^{1/2}_{x_i,x_i}(0) R^{1/2}_{x_j,x_j}(0))\}_{i,j=1,\ldots,4}$ is obtained numerically as $\begin{pmatrix} 1.0000 & -0.2000 & -0.4400 & -0.3400 \\ -0.2000 & 1.0000 & 0.0300 & 0.0600 \\ -0.4300 & 0.0300 & 1.0000 & 0.2400 \\ -0.3400 & 0.0600 & 0.2600 & 1.0000 \end{pmatrix}$. It is symmetric, up to rounding error, as expected, but most importantly, observe the change of sign in the correlation from the neck to the thorax. Hence there exists a point $x^* \in (x_1, x_2)$ such that $r_{x_1,x^*}(0) = 0$ and furthermore from the shape of the plots $r_{x_1,x^*}(s) = 0$, $\forall s$. It follows that

$$\sum_{n_2} g_{8,n_2+2^{-8}s}(x_1) g_{8,n_2}(x^*) = 0$$

Since $g_{8,n_2+2^{-8}s}(x_1) \neq 0$ because of the neck activity, we get $g_{8,n_2}(x^*) = 0$. The latter indicates existence of a *mode shape node* at $x^*$. Clearly, there exists such a node somewhere along the nervous pathway between the neck electrode and the thoracic electrode. Besides, at the skeletomuscular level, such a mode shape node can be directly observed during the spinal wave motion [23].

#### 4.2.4. Standing wave versus coherence

Here, the *standing wave* pattern between the various signals has been derived from the *zero crossing nodes* of the *time-domain* correlation:

$$\rho_{ij}(s) = \frac{E(Y_i(t) Y_j(t+s))}{(EY_i^2(t))^{1/2} (EY_j^2(t))^{1/2}} \tag{4}$$

On the other hand, Farmer [17,16] defines the frequency-dependent *coherence* between two signals $Y_i, Y_j$ as *peaks* in the *frequency-domain* correlation plot[4]:

$$\hat{\rho}_{ij}(\jmath\omega) = \frac{|S_{ij}(\jmath\omega)|}{(S_{ii}(\jmath\omega))^{1/2} (S_{jj}(\jmath\omega))^{1/2}} \tag{5}$$

where $S_{k\ell}(\jmath\omega)$ is the (cross)spectral density, that is, the Fourier transform of $E(Y_k(t) Y_\ell(t+s))$ relative to $s$.

The relationship between the time-domain and frequency-domain concepts is a bit tenuous:

$$\rho_{ij}(0) = \frac{\int_{-\infty}^{+\infty} S_{ij}(\jmath\omega)\, \mathrm{d}\omega}{\left(\int_{-\infty}^{+\infty} S_{ii}(\jmath\omega)\, \mathrm{d}\omega\right)^{1/2} \left(\int_{-\infty}^{+\infty} S_{jj}(\jmath\omega)\, \mathrm{d}\omega\right)^{1/2}} \overset{???}{\approx} \frac{S_{ij}(\jmath\omega)}{S_{ii}^{1/2}(\jmath\omega) S_{jj}^{1/2}(\jmath\omega)}$$

Besides, under a time shift in one of the signals $Y_j(t) \to Y_j(t + \Delta T)$, $\hat{\rho}_{ij}(\jmath\omega)$ remains unchanged, while $\rho_{ij}(s)$ would be changed and the zero crossing node pattern would be shattered. Therefore, the standing wave pattern as revealed by the "zero crossing nodes" is a property stronger than the "coherence," but the neurophysiological phenomena that both techniques attempt to pin down are unmistakenly the same.

[4] See Matlab Signal Processing toolbox function `mscohere`.

#### 4.2.5. Bursts: coherence and the questions of frequency and phase

To summarize, the $D_8$ bursts occur synchronously at the neck, thorax, lumbar spine, and sacrum. Thus the bursts occur in a standing wave pattern. Next, the in-burst oscillations in the thoracic, lumbar, and sacral areas are in phase, and in opposite phase relative to the in-burst oscillations at the cervical level. Thus there is also a standing wave pattern within each $D_8$ burst and the in-burst oscillations encode the movement phase information.

A 180° phase locking phenomenon, similar to the one observed between the cervical and the thoracic to sacral levels but for EEG-EMG coherence, has also been reported in [21, p. 6].

EMG coherence across the ∼2 cm distance between the adductor pollicis (AdP) and the first dorsal interosseous (1DI) has been observed at ∼25 Hz [17, Fig. 5(G)], [16, Fig. 2(D)] as the peak of $\hat{\rho}_{\mathrm{AdP,1DI}}(\jmath\omega)$. Here, the slower frequency of ∼12.5–13.5 Hz is observed across significantly larger (∼1m) distances. Also observe that our coherence of about ∼0.3 is larger than the ∼0.24 observed in [17, Fig. 5(G)], especially since the former was observed across substantially longer distances.

#### 4.2.6. Standing wave: control versus quadriplegic subject

The cervical electrode was positioned at C2–C3 on the upper trapezius, which is innervated by C2–C3. The sacral electrode was positioned at S2–S4 on the latissimus, which is innervated by C6–C8. Since the injury was at C5, the correlations $r_{14}, r_{41}$ provide a measure of the correlation of the innervation signals on both sides of the spinal cord injury. The fact that $r_{14}, r_{41} > 0$, as shown by Fig. 3,6, indicates that nerve impulses pass through, or peripherally around, the injury area, consistently with the partial motor recovery.

Second, the standing wave pattern does not appear as clearly as for the control subject, as can be seen from the defective "zero correlation nodes." Nevertheless, it appears that there is some standing pattern involving the thorax, lumbar spine, and sacrum, but not involving the neck. Again, this is fully consistent with the C5 injury.

The abnormal synchronization observed on the quadriplegic subject is consistent with a similar observation made in [17, Fig. 3]): the loss of coherence between two single motor units of the first dorsal interosseus (1DI) of a subject who had suffered a infarct of the right internal capsule. Along the same line, in [17, the question of frequency], the lack of Magnetoencephalographic-EMG coherence at ∼10 Hz led to the conjecture that the "*slow movement* ∼10 Hz *drive may not be expressed at the level of the motor cortex*" but may involve the somatosensory cortex and the cerebellum. The fact that the quadriplegic subject had deficient ∼10 Hz coherence provides some evidence in favor of this last conjecture. Ref. [33] points to the severage of the *sensory pathway* as more specifically responsible for the deficient coherence. Clinical results on another quadriplegic subject have recently been collected [15,48], with the major result that the cervical oscillator is chaotic while the sacral oscillator is not, with of course the impossibility to have coherence between a chaotic and a nonchaotic motion.

### 4.3. Absence of sensory input

It is usually admitted that a CPG does not necessitate sensory input to produce a rhythmic motion, except during entrainment and resetting [13,45]. Here, during entrainment, the CPG certainly uses sensory input from the mechanoreceptors. After entrainment, the spinal wave becomes self-sustained without practitioner's *external* pressure input. The extent of the involvement of the sensory-motor loop in the self-sustained spinal wave phenomenon is unclear at this stage, but our conjecture is that some sensory input is still generated, probably not as significantly as during entrainment/resetting. The situation would be a bit like the lamprey experiment [45], where the mechanoreceptors send some

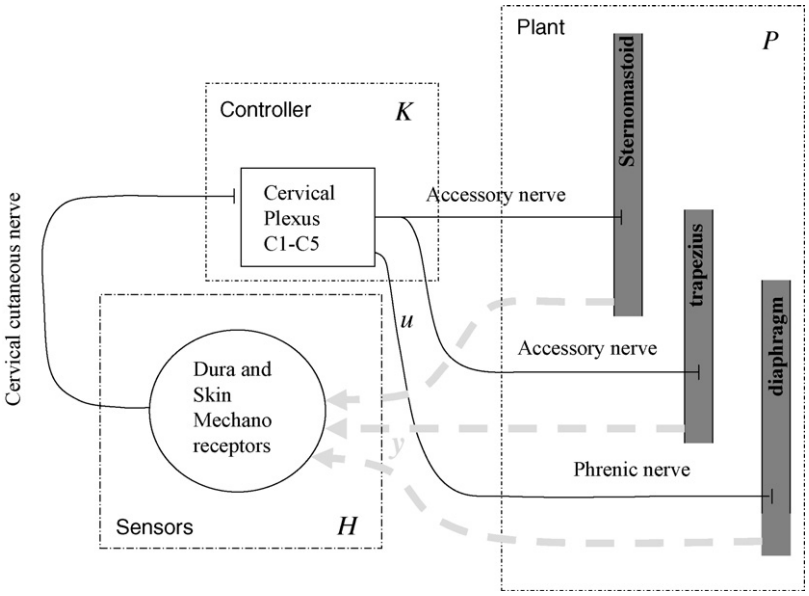


**Fig. 7.** Sensory-motor loop at cervical level. The hard lines are established pathways, whereas the dotted lines are the conjectured paths through which the loop closes. This diagram is drawn using control conventions: *K* is the controller, *u* is the control action, *P* is the plant, and *H* is the sensor array.

*internal* sensory input to the spine [41], and an anatomical loop closes.

The fact that a CPG does not necessitate sensory input to sustain a rhythmic motion does not, however, preclude some sensory input to "*modulate*" the CPG [56]. This is, we believe, what happens here: the CPG is modulated by the neck and sacrum oscillators to go in a standing wave pattern. In [38], it is argued that the combination of a feedforward CPG oscillator and sensory feedback is the best strategy to secure proper functioning in case of poor sensory feedback and external disturbances. The quadriplegic subject case produces such an example: our best assessment is that the burst fracture was at the place of, or below, the dural-vertebral attachment, so that the neck sensory information was severely distorted, or simply unavailable, resulting in a partial loss of the standing wave property, yet the spinal wave phenomenon was still present.

## 5. Further discussion: anatomical loops and CPG circuitry model

### 5.1. Biological oscillators

The cervical and sacral anatomical loops are shown in Figs. 7 and 8. In both of them, it is conjectured that the loop closes via the mechanoreceptors, which pick up muscle activity and send proprioceptive signals to some specific plexus of the cord. Even though mechanoreceptors are distributed all along the lateral portion of the human spine [57], it does not appear possible to elicit

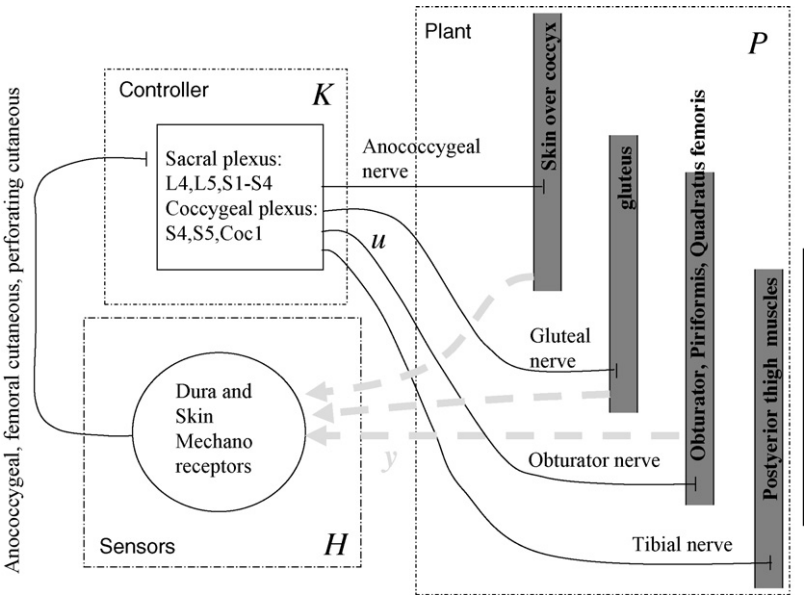


**Fig. 8.** Sensory-motor loop at sacrum. The hard lines are established pathways, whereas the dotted lines are the conjectured paths through which the loop closes. This diagram is drawn using control conventions: *K* is the controller, *u* is the control action, and *P* is the plant, and *H* is the sensor array.

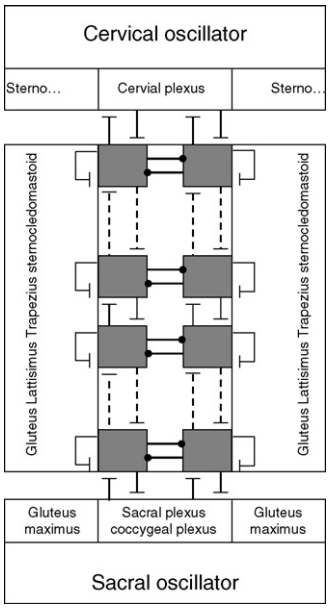


**Fig. 9.** Overall CPG circuitry extending all along the spine. The diagram is drawn using neurophysiological conventions: Each shaded cell is a bistable oscillator consisting itself of several neurons. There are inhibitory connections between the left and right half centers. The vertical connection are excitatory. The vertical line between the cord and the muscle mass denotes the distributed mechanoreceptors. It is a unique area, the marginal neucleus, in which neurons (in particular α-motoneurons not shown) and mechanoreceptors are congregated [57].

the wave other than by contact at the cervical and sacral areas. This leads us to the conjecture that the neck and sacrum dural vertebral attachment [4] play a crucial role in generating mechanoreceptor signals.

Naturally, for the feedback hypothesis to hold, the bandwidth of the dural mechanoreceptors should be broad enough to allow for the observed $D_8$ signal.[5] Here, we refer to the experiment of [42, Fig. 1], showing the spike response of mechanoreceptors to unit step pressure stimuli on the dura. From a more quantitative point of view, the shortest latency of the mechanoreceptor response in the tentorium area was estimated to be 27 ms [62, p. 414], which is consistent with the fundamental 13.5 Hz frequency reported in Section 3.1. A related issue depicted in [42, Fig. 1] is the sensitivity of the mechanoreceptors, which respond only above a certain pressure threshold on the dura. It has been consistently observed that the pressure necessary to elicit the oscillation decreases along entrainment, which can be justified by the release of serotonin in the cerebro-spinal fluid [54] along entrainment.[6]

The factorization of the loop function $PKH$ is meant to make the loop fit within the traditional control paradigm, where $H$, the mechanoreceptors, are the sensors, $K$, the solar/sacral plexus, is the controller, and $P$, the innervation of the various muscles, is the plant. In this setup, $u = KHy$, the nerve activity, is the control input. At this stage, it appears difficult to identify $P$ and $KH$ separately, since this would require monitoring the nerve activity $u$. However, an identification of the composite loop function $PKH$ appears possible. Indeed, the relationship $y = (PKH)y$ indicates that $KPH$ is an operator of which the observed sEMG signal $y$ is a Schauder fixed point.

The conjectured overall circuitry, showing the specific role of the cervical and sacral oscillators, is shown in Fig. 9. This model is based on a chain of bistable oscillators [24,57], with their half centers controlling the opposite motion of the right and left spinal muscles. In a certain sense, it is a bidirectional extension of the model of [24, Fig. 1]. The latter only accommodates for a descending nearest-neighbor excitatory synaptic pathway, while here there is an additional ascending pathway. In another sense, Fig. 9 is a distributed parameter version of the "one CPG per joint" paradigm of [55,38].

This model of course only explains the lateral wave, whereas the longitudinal wave might require other concepts.

### 5.2. Synchronization of biological oscillators

It is conjectured that the standing wave pattern is the result of the synchronization *at a distance* of the cervical and sacral oscillators. A generic theoretical foundation of synchronization of biological oscillators has been proposed in [52,53]. However, given the rather unique nature of the sacro-cervical synchronization, a more specific synchronization mechanism, based on the network-theoretic concept of incident and reflected waves, was developed in [28]. Spatio-temporal correlation techniques have indeed revealed that, when the wave is still in the traveling mode, traveling bursts reflect on the neck and the sacrum [29].

A related paradigm is the synchronous pattern between the motor nerve firings of the wing and the tail of the marine mollust *Clione* during hunting episodes [40, Figs. 1 and 2]. The connection with the sacro-cervical $D_8$ coherence can probably be established by performing a wavelet analysis of the signals of [40, Fig. 1].

## 6. Conclusions

This paper can be looked at either (i) from the viewpoint of standing wave Central Pattern Generator (CPG) or (ii) from the viewpoint of coherence at a significant distance.

From the CPG viewpoint, this paper is an extrapolation of the *traveling wave* CPG concept of [13], inspired from the swimming of the lamprey, to a new *standing wave* CPG concept, better suited for research subjects on the table. Since in both cases this CPG controls many degrees of freedom, at the limit it controls a distributed parameter system, and especially since it involves a traveling wave before synchronization between the distal ends, it is fair to conjecture that this CPG has a circuitry, along with mechanoreceptors, extending all along the spine [57]. The latter is some departure from the other paradigm of simple circuit achieving complex task [18]. The synchronization of the neck and sacral oscillators, concurrent with the standing wave pattern, seems to involve sensory mechanoreceptor input. While the latter might be perceived as a shift from the "no sensory input" paradigm, recent and independent research results [56,38] are already leaning towards a CPG concept that does not require sensory input to develop rhythmic oscillation, but that nevertheless utilizes sensory input for more complicated tasks. Indeed, while there is ample evidence that rhythmic pattern can be generated without sensory input, such a complex behavior as synchronization at a distance seems hard to explain without some sensory input.

The other point of view of coherence at a significant distance is closely related to the first one, as a standing wave along a medium implies coherent motion between the distal ends, with the additional property of $0^\circ$ or $180^\circ$ phase locking. Perhaps the most significant contribution of the paper is the confirmation of the statement made in [17] that coordinated motion of different muscles involves EMG coherence at ∼10 Hz. Another somewhat novel feature is that such coherence has been observed over distances significantly larger than those already reported. From a pure signal processing point of view, perhaps another contribution of the paper is the utilization of the DB3 wavelet decomposition in the hunt for

[5] Thanks to Dr. Rolf Johansson, Lund University, for bringing this to our attention.
[6] Thanks to Dr. D. Epstein for this insight.

coherences. As such, instead of asking the question of at *what frequency* the coherence $\hat{\rho}_{ij}(j\omega)$ is maximum as done in [17], here the question has been rephrased as *what subband* of the DB3 wavelet decomposition reveals the best coherence. We also offered a new technique, the "zero crossing nodes," which detects coherence and the stronger standing wave property.

The coherence frequency of ∼12.5–13.5 Hz is at the low end of the β rhythm [36]. This is probably not coincidental, as coherence at that frequency between EMG and EEG signals have been reported [21], but this remains to be investigated further.

The conjectural feedback circuits proposed in Section 5 still need to be positively confirmed. Whether the wave analysis can be used as a tool to asses spinal cord damage and/or recovery [46,59,6] is an issue that is also currently being investigated.

## Appendix A. Proofs

**Proof of Lemma 1.** The function $(f_n \quad g_n) : [0,T] \times [0,L] \to \mathbb{R}^2$ is continuous as an eigenvector of an integral operator with continuous kernel. Indeed, if $(f_n \quad g_n)$ were not continuous, because of the continuity of the kernel of $\begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix}, \begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix} \begin{pmatrix} f_n \\ g_n \end{pmatrix}$ would be continuous, contradicting the eigenvector equation. □

**Proof of Lemma 2.** It suffices to apply the trace theorem to the projection of the operator $\begin{pmatrix} 0 & Y^* \\ Y & 0 \end{pmatrix}$ on its positive spectrum. This projection is clearly $\sum_n \sigma_n \begin{pmatrix} f_n \\ g_n \end{pmatrix} (f_n \quad g_n)$. Then the trace is

$$\sum_n \sigma_n \left( \int_0^T f_n(t) f_n(t)\,\mathrm{d}t + \int_0^L g_n(x) g_n(x)\,\mathrm{d}x \right) = \sum_n \sigma_n$$

The left hand side of the preceding is clearly bounded, so is the right hand side. □

**Proof of Theorem 1.** It suffices to show that $\{R^N_{x,x'}(s) := \sum_{n,m=1}^N \sigma_n \sigma_m \overline{f_n(t) f_m(t+s)} g_n(x) g_m(x') : N \in \mathbb{N}^*\}$ is a Cauchy sequence for the Hilbert-Schmidt norm [12, XI.6.4]; in other words, $\lim_{N,M\to\infty} ||R^N - R^M||_{HS} = 0$. Specifically,

$$\begin{aligned}
\|R^N - R^M\|^2_{HS} &:= \int\int\int \left(R^N_{x,x'}(s) - R^M_{x,x'}(s)\right)^2 \mathrm{d}x\,\mathrm{d}x'\,\mathrm{d}s \\
&= \int\int\int \left( \sum_{m,n=N}^{M} \sigma_n \sigma_m \overline{f_n(t) f_m(t+s)} g_n(x) g_m(x') \right)^2 \mathrm{d}x\,\mathrm{d}x'\,\mathrm{d}s \\
&= \int\int\int \left( \sum_{n,m,k,l=N}^{M} \sigma_n \sigma_m \sigma_k \sigma_l \overline{f_n(t) f_m(t+s) f_k(t) f_l(t+s)} g_n(x) \right. \\
&\quad \left. \times\ g_m(x') g_k(x) g_l(x') \right) \mathrm{d}x\,\mathrm{d}x'\,\mathrm{d}s \le \frac{1}{T} \int\int \left( \sum_{n,m,k,l=N}^{M} \sigma_n \sigma_m \sigma_k \sigma_l g_n(x) \right. \\
&\quad \left. \times\ g_m(x') g_k(x) g_l(x') \right) \mathrm{d}x\,\mathrm{d}x' = \frac{1}{T} \int\int \left( \sum_{n=N}^{M} \sigma_n g_n(x) \right)^2 \\
&\quad \times \left( \sum_{l=N}^{M} \sigma_l g_l(x') \right)^2 \mathrm{d}x\,\mathrm{d}x'
\end{aligned}$$

and convergence follows from the trace class property. □

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## *Paradigms*

# Reorganizational Healing: A Paradigm for the Advancement of Wellness, Behavior Change, Holistic Practice, and Healing

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### Abstract

Reorganizational Healing, (ROH), is an emerging wellness, growth and behavioral change paradigm. Through its three central elements (the Four Seasons of Wellbeing, the Triad of Change, and the Five Energetic Intelligences) Reorganizational Healing takes an approach to help create a map for individuals to self-assess and draw on strengths to create sustainable change. Reorganizational Healing gives individuals concrete tools to explore and use the meanings of their symptoms, problems, and life-stressors as catalysts to taking new and sustained action to create a more fulfilling and resilient life.

*"Instead of being meaningless, people's problems become diseases of meaning, enabling people to see that things are not necessarily "going wrong" but are, in fact, helping them become stronger, to live more fully and with more understanding."*

—Jobst, Shostak, and Whitehouse, 1999[1]

*"We conceptualize wellness as the generalized self-perception of health. From this perspective, wellness is distinct from health-illness; an individual can deem themselves to be in an acceptable state of wellness whether they experience suboptimal "health" in any given domain or area of functioning."*

—Schuster, Dobson, Jaregui, and Blanks, 2004[2]

### Introduction

This journal has forged new ground in emphasizing the relationship between an individual's subjective perceptions and their attributed meaning to health and wellness. The inescapable intersection between one's internal perception and the state of one's body and whole life facilitates sustainable change toward optimal mental and physical health. Three papers in particular stand out in this regard.[1–3] These seminal manuscripts have had a significant influence in shaping the model of Reorganizational Healing. Reorganizational Healing, (ROH), is an emerging wellness, growth and behavioral change paradigm, which may be applied to various approaches and disciplines in health care, therapeutics and professions of change and transformation.

Jobst, Shostak, and Whitehouse[1] introduced two key terms: "diseases of meaning" and "disease as a manifestation of health," highlighting the importance of internal perspective and empowerment to the entire spectrum of disease and health. They described diseases as representations of various aspects in an individual's life and as a manifestation of health in that these aspects can be seen and can serve as a source of growth, understanding and opportunity for greater awareness, all ultimately reflections of the meaning attributed to the event or phenomenon. With such a depth of meaning, disease can be viewed as a catalyst for persons to grow, and in so doing, to heal themselves. Diseases of meaning are diseases attributed to and arising from an individual's or society's perspectives, worldviews, and overall life stressors. Thus problems can be viewed as calls to know the self, the body–mind, more intimately in order to facilitate change and to grow stronger, healthier and wiser. These diseases inextricably link the individual's self-perception and meaning to the problem.

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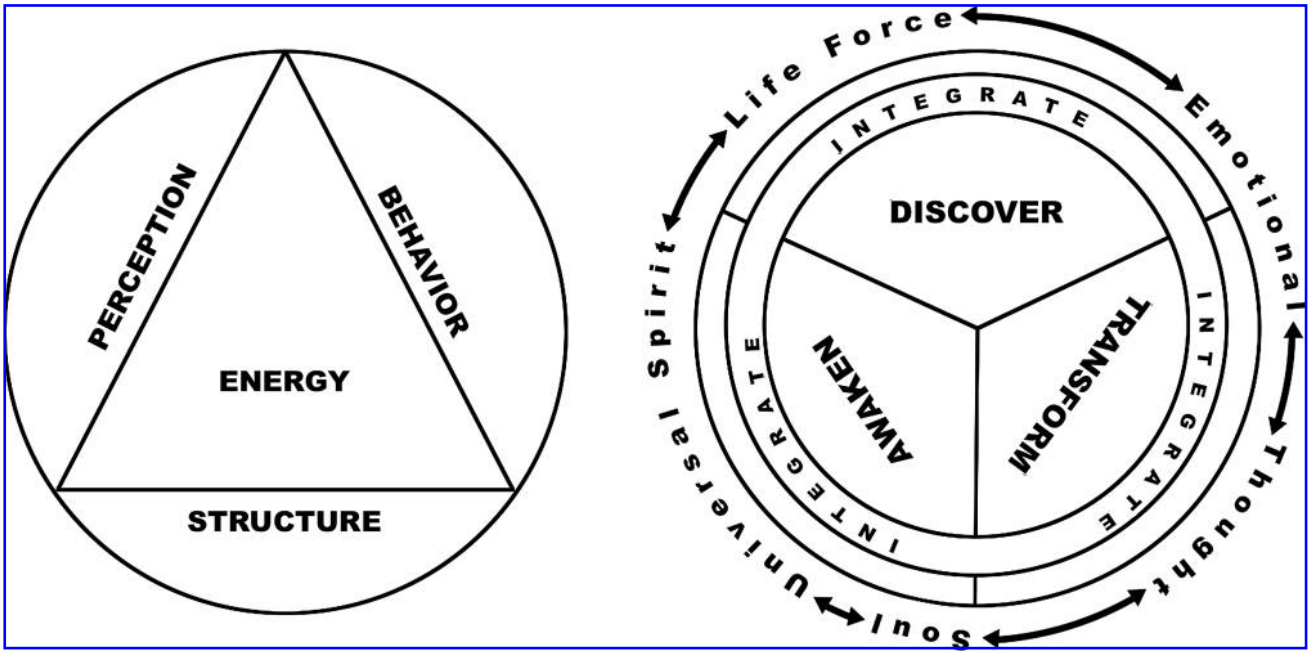


**FIG. 1.** The Elements of Reorganizational Healing.

Schuster, Dobson, Jauregui, and Blanks[2,3] located wellness in subjective perception, demonstrating objectively powerful links among wellness, complementary and alternative medicine (CAM) use, and health lifestyles. As meaning is integral to every aspect of ROH, self-perception becomes a key modulator between wellness and health-illness. To this end disease and health are part of a matrix of organization of energy, structure and meaning.

ROH is founded on these principal propositions articulated in the papers by Jobst et al.[1] and Schuster et al.[2,3] These propositions are incorporated into the structure and function, the very fabric, of the whole of ROH. This is, in fact, how it arose through the empirical work of Epstein,[4–6] now continuing to be objectively researched in academic and clinical research centers.[3,7–14]

ROH helps create a map for individuals to self-assess and draw on strengths to create sustainable change. ROH gives individuals concrete tools to use the meanings of their symptoms, problems, and life stressors as a catalyst to taking new and sustained action and creating a more fulfilling and resilient life.

## A Healing Paradigm

ROH is a paradigm about helping people be well. It is an approach to outcomes-based wellness and change. It can be applied to growth, healing and the individual's life. ROH facilitates a dynamic responsive awareness to enable optimization of structural, perceptual, behavioral and energetic elements in a coherent sequenced fashion. In the model designed by one of the authors (Epstein) of the current article, ROH has three central elements: (1) The Four Seasons of Well-Being; (2) The Triad of Change; and (3) The Five Energetic Intelligences (Fig. 1).

The elements of ROH assist the individual to take an active role in his/her life so that increasing well-being on a regular basis becomes the norm. In ROH, it is essential that individuals have mechanisms by which they can have an awareness of the present time; how they drop to a lower level of functioning, behavior, and perception in the face of disease, problems, or life stressors; and what they can do to function at a "higher level," a new baseline of well-being, in spite of life's challenges. In this context, reorganization relates to the increasing ability to thrive in the face of greater demands in every domain (physical, biologic, emotional, mental, spiritual, social, and cultural). We define social as the interobjective or functional fit and organization of 2 or more individuals and cultural as the intersubjective or shared meanings and mutual resonance of 2 or more individuals.[15–19] This ability to thrive in every aspect of life is considered a new measure of well-being and function; in lay terms, and to paraphrase Anthony Robbins, a new standard to "step up" to.[20]

Reorganization implies that the system functions at a higher level of complexity. This increase in the baseline level of organization of a system allows for enhanced utilization of energy, adaptability, and the development of new attractors,[21–24] thereby facilitating an emerging state of stability of the system in spite of a greater range and intensity of perturbations in the environment.[23,25,26] Increased complexity of the living system allows for new energetic strategies, and enables the system to remain far from equilibrium.[15,27] As a model of transformational change, ROH is consistent with theories based on the chaotic and quantum nature of behavior change[28,29] and life transitions.[30] Successful reorganization at a higher baseline can be identified because the individual reaches a new level of gratitude, love, and connection (subjective, somatic, relational, and social). This new

baseline can be in relation to various aspects of life from disease to personal growth, from behavioral change to organizational change.

ROH is a model rather than a method. A broad range of methodologies and applications can utilize ROH. In this way, ROH may contribute to the literature on the set-point theory of well-being,[31] positive psychology,[32,33] the field of behavior change[34–40] and the more-allopathic approaches to health and medicine, herein termed Restorative Therapeutics (RET).

ROH contrasts with RET, the common paradigm in health and medicine/surgery, generally associated with the Western medical model whereby one party (the "healer"/therapist/professional) does something to restore the other (the healee/therapee/patient) to a prior state of functioning. The "extreme" version of the RET approach views diseases as problems that must be fixed usually isolated from the rest of life, and denied their depth of meaning. A common motivator for individuals seeking RET is constancy and certainty.[41] This distinction between ROH and RET is summed up by Jobst et al.:

> The proposition that disease is a manifestation of health links diseases of meaning and aspirational health creatively: aspirational health being the means of transformation of diseases of meaning through changes in understanding and perception and consequently changes in behavior, relationships, and physiology. … Critical to the negative spiral that gives rise to the diseases of meaning …, is the perception that the "disease" … is unavoidable and can only be remedied by being excised, eradicated, pharmacologically blocked, or genetically modified.[1]

The goal of RET even in a "moderate" form (which could include many CAM methods) is to restore the person to where (and who) they were before the problem. Conversely, in ROH, the intention is for the outcome to be dynamical change in the individual and the life system; to develop new resources so that the individual may use the experience consciously to bring his/her life to a greater level of understanding and appreciation; and to increase the individual's ability to thrive under most circumstances, a motivation inspired by an ability to contribute to others and fulfill a greater purpose in life.[41,42]

ROH is a way to bring the insights from diseases of meaning to the practice of traditional and alternative medicine,[1,43] using those insights to transform the entire life system. The treatment of symptoms, solely for their alleviation, while possibly necessary at times, may dissipate the depth of meaning and the energy required to establish a new and higher baseline. This is a critical distinction; by understanding ROH, the practitioner can assess when a nontherapeutic approach—such as utilizing the symptom as an opportunity for congruence among the individual's Season, Triad of Change, and Energetic Intelligence—may assist individuals to bring their entire lives to new levels of successful reorganization. This change is always used with the person's map of the life-system. Congruence in this sense is similar to the concept of the triangle in geometry, "coinciding at all points when superimposed."[44] Congruence of the elements of ROH and thus successful reorganization can be utilized alongside RET.

The acknowledgment that there is an inherent wisdom that manifests as the body, emotion, mind, soul, and spirit with increasing depth and fullness, range, and freedom is also central to ROH. This wisdom has inner and outer attributes, an internal subjective state of consciousness associated with each level of the multileveled energetic field,[17,45,46] and has been described as a causative agent of the wellness benefits associated with some of Epstein's wellness approaches.[47]

## Background

ROH developed from Epstein's wellness approaches, Network Spinal Analysis (NSA),[4–6] The Twelve Stages of Healing,[48] and Somato Respiratory Integration (SRI).[48–50] Network Spinal Analysis Care is a dynamical system of assessment and intervention involving the creation of emerging organizational properties in the spine and nervous system. These properties enhance cognitive self and body awareness, personal behavioral states, increased wellness, and spinal induced self-organizing phenomena. NSA is an application of spinal ROH currently practiced by chiropractors. It involves gentle touches to the spine accessing unique "spinal gateways" in applications termed spinal entrainments or network adjustments. It is accompanied by client-reported wellness, levels of care, and organization-specific outcomes. SRI is a system of exercises that includes focused attention, specific breathing, energetic awareness, and movement protocols directed through the body to produce states of perception congruent with the Twelve Stages of Healing. SRI enhances and creates conscious awareness and participation with the body as a tool to experience life with increasing depth of internal connection and wider ranges of human expression.

As in ROH, the central tenet of both NSA and SRI states that change rarely comes directly from the area in the body or life that is defensive, guarded, and wounded. Instead, it comes after the individual becomes aware of the area and acknowledges it as it is or finds another area where resources exist. Once awareness is engaged, change comes through the area as energy or as an acknowledgment or acceptance of that energy on various levels (cognitively, neurologically, somatically, etc). Energy is here defined as the fuel for the expression of consciousness through action, and the means of maintaining a system far from equilibrium.[27,51,52] Energy previously bound through lack of awareness as fixation, tension, facilitation and defense releases its stores or becomes redirected into a new level of organization. Meaningful change comes when a place of connection is brought to awareness and "inspires" or entrains other parts of the system. The synergy developing with this approach is central to the process of reorganization because new resources of connection and meaning are liberated as energy for constructive use. With the physiology less in defense and the body more cognitively aware of the breath, energy, and movement it is hypothesized that the frontal lobes of the cerebral cortex and vagal centers are more available to reassess perception structure and behavior.[6] As a result of repeated state change, liberated energy available for enhanced function can now be utilized to restructure to the next increased level of order.

NSA has been researched in regard to self-reported wellness outcomes[3,7] and mathematical modeling of a

spinal wave that develops during care as a nonlinear attractor,[8] which can be dynamically modeled.[9] This wave involves undulation and specific rocking/oscillation of spinal segments and the development of what appears as a central pattern generation.[10,*] In preliminary research, this wave has been shown to develop and move through and around the area of spinal-cord injury in patients who have quadriplegia, with evidence of partial motor recovery.[11,12] Inspired by data on the timing of outcomes of wellness benefits,[13] and subsequent mathematical modeling of surface electromyographic studies indicating an increase in organization of the central nervous system,[12,14,†] distinct levels of care have proven identifiable, and are sequenced into three levels, each with specific self-reported wellness, structural, perceptual, behavioral, and constructive life changes and assessments.

Other research on NSA helped advance its development and understanding, and thus lay the foundation for ROH. Empirical findings and published research evidence patients recovering from a wide range of illnesses and thriving in at least four domains of wellness.[3,7,13] A longitudinal study found that people's physical and emotional challenges improved within 2–4 months, while stress relief and life enjoyment continued to improve for the duration of the 12-month study.[13] Wellness outcomes for Network Care have been shown to significantly enhance the benefits of other wellness practices.[3] Case reports have been published or presented on psoriasis,[53] post-traumatic stress disorder (PTSD),[54] child oppositional–defiant disorder,[54] substance abuse,[54] fertility coupled with an increased quality of life, [55] general quality-of-life (QoL) improvements[56] and attention deficit–hyperactivity disorder (ADHD).[57] Additional research has shown that NSA induces a "sympathetic quieting effect"[58] and decreased cortical processing time for newly learned motor activities.[59,60]

The concept of an Energetic Intelligence (EI) emerged from an evolving discipline Epstein has been advancing since 1999. Through applying NSA and SRI and adding an energetic, informational field or "biofield" application, Epstein observed significantly different responses of the nervous system relative to the organization and level of care in regard to the distance from the spine he approached and exited from. He observed further the various sensory motor strategies for the NSA levels of care and the 12 Stages of Healing were influenced and initiated by consciously varying these distances. To date, the codification, applications, and descriptions of the energetic or informational fields have only been explored at private healing retreats. A future unique discipline based upon these principles and relationships is in development. However, information about the EI, as an internal experience and resource, has been taught via programs that include the principles of ROH.[43]

NSA, SRI and Epstein's emerging discipline, are distinct and complementary approaches to wellness. By observing similarities between these approaches, commonalities emerged leading to the development of the transdisciplinary and unifying model of ROH (Table 1).

### The Three Elements of ROH

The four Seasons of Wellbeing, the Triad of Change, and the EI have wide-ranging possibilities to contribute to many fields to help create sustained change by synchronizing the timing of change, the process of change, and the energetic aptitudes that change requires.

### The Seasons of Wellbeing

The Four Seasons of Wellbeing—*Discover, Transform, Awaken, and Integrate* (Fig. 2)—refer to distinct rhythms or periods during one's journey in life. As a metaphor for the journey, season is appropriate to "readiness" for reorganization just as seeds are planted or fruit ripens—all in their time. The seasons are different from developmental stages of life[61–64,‡] although they may correspond at times to such stages. The seasons are used as part of the process of change by embracing the individual's readiness for change in the context of the unique moment of his/her life. Thus, the seasons are not always sequential. They represent moments or periods in life. As higher baselines of reorganization emerge in the person's life it becomes easier to live in certain seasons. After one has learned the gifts that each season presents, a new flexibility as a result of increased complexity, allows one to use each season to reorganize specific aspects of his/her life consciously.

The seasons appear to be universal in human experience as each encourages or influences unique perceptions, actions, thoughts, experiences, and energies. The seasons add timing to the self-assessment. This timing is distinct from other staged approaches to behavior change[35–39] or any RET approaches. The influence of the season affects the type of intelligence one uses, the way a person goes about daily activities, and the resources available to that person. Each season represents the way a person receives and influences his/her environment and how this environment influences the person. Within each corresponding season, aspects of daily life are either encouraged or rendered difficult or impossible. The first three seasons, Discover, Transform, and Awaken, represent the stages individuals cycle through during stages of life and circumstances in life. The fourth season, Integrate, represents the ability to know and consciously choose the combination of seasons called for in various circumstances or life changes, and represents a high level of organizational integrity and communication across aspects of the individual's life.

### The Four Seasons of Wellbeing Defined

In the season of *Discover* one focuses on physical problems, causation, and attachment. Discover is about discovering how one has caused pain for oneself or others in an

*Jonckheere E, Lohsoonthorn P, Mahajan V, Musuvathy S, Stefanovic M. On a standing wave central pattern generator and the coherence problem. Biomed\ Signal Processing Control submitted.

†Jonckheere E, Lohsoonthorn P, Boone WR. Dynamical modeling in network spinal analysis: Level specificity of sEMG signals at cervical, thoracic, lumbar, and sacral points. J Altern Complement Med submitted.

‡Cook-Greuter S. Postautonomous ego development: Its nature and measurement. Doctoral dissertation. Cambridge, MA: Harvard Graduate School of Education 1999.

Table 1. Relationship of Network Spinal Analysis (NSA), Somato Respiratory Integration and Elements of Reorganizational Healing

| *NSA level of care* | *Stage of healing* | *Common client questions* | *Common emotions and Expressions experienced by client* | *Energetic intelligence most commonly experienced* | *Season of Wellbeing* |
|---|---|---|---|---|---|
| Level 2A Level 1 | Suffering<br>One Separateness | Why me? or Why not me?<br>What is wrong with me?<br>Why does this happen to me?<br>Why does this not end? | Helplessness, loss, despair, peace, reassurance | Bioenergetic | DISCOVER |
| | Polarities and Rhythms<br>Two Attachment/ Projection | What is the cause of this?<br>Who was wrong/right?<br>Who can fix/get rid of this?<br>What is the best or worst ____?<br>Why did he/she do this to me?<br>What is the pattern here? | Anger, hunger, happiness, identification, energy | Emotional energetic | |
| | Stuck in a Perspective<br>Three Frustration | Why can't I make the breakthrough?<br>Why do I keep doing this?<br>Why am I stuck?<br>Why am I so blocked?<br>Why can't I solve this now? | Frustration, peaceful waiting | | |
| Level 2C Level 2B | Reclaiming Our Power<br>Four Courage | What can I do to never disempower myself again?<br>How can I express more of my courage now? | Inner strength, determination, courage, power | Thought energetic | TRANSFORM |
| | Merging with the Illusion<br>Five Merging Beyond the Wall | What else is going on?<br>What is really happening here?<br>How can I face this now?<br>What is on the other side? | Curiosity, anticipation, temporary confusion, sense of knowing more | | |
| | Six Preparation for Resolution | What can I do to really be ready?<br>How can I prepare myself?<br>What must I do now? | Determination, resolve, flexibility, excitement of something big and new | | |
| | Seven Resolution | How can I resolve this?<br>How can I conduct an inventory and get rid of that which no longer serves me?<br>How can I dump the old stuff/energy/patterns? | Excitement, focus, strength, resolution, peace | | |
| Advanced Care | Eight Emptiness in Connected-ness | How can I embrace the space?<br>Where is the rhythm?<br>How can I hold the space?<br>Where is the gratitude? | Peace, stillness, rhythmic connection, gratitude for connection | Soul energetic | AWAKEN |
| | Nine Light/Love Beyond the Form | What is the energy/ love telling me?<br>Where is the connection within spirit?<br>How can I express the love more?<br>How can I grow the gratitude?<br>How can I feel the real energy behind the form? | Gratitude for love and for the energy of life, joy, passion, heightened perception of joy, gratitude, beauty | | |
| | Ten Ascent | What gift has been given to me?<br>How can I receive and embody the light I am?<br>How can I express my soul and the one love? | Witnessing from beyond the soul, exhilaration, joy, awe, gratitude, oneness | Universal spirit energetic | |
| | Eleven Descent (Service) | How do I give my gifts in joy and gratitude?<br>Where is the joy, love, gratitude, gift?<br>How can I sponsor the sharing of my abundance? | Gratitude, acceptance of core paradoxes, humor, courage, humility, grace, strength, passion, determination | | |
| | Twelve Community | How can I receive others/ circumstances with gratitude as gifts?<br>Where is the gift in this?<br>How can we be each other's wisdom/medicine? | Coming home, acceptance of others as also souls or travelers, passion for synchronicity, total spectrum with foundation in benevolence and gratitude and conscious experience | | |

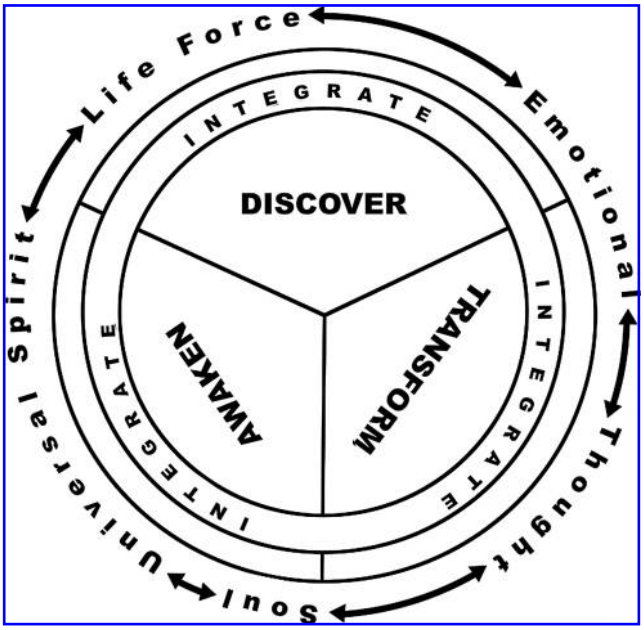


FIG. 2. The Four Seasons of Wellbeing.

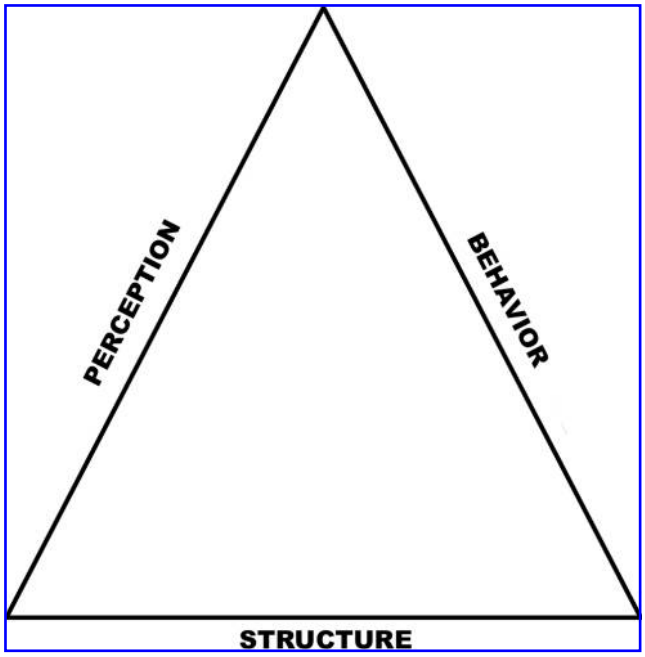


FIG. 3. The Triad of Change.

attempt to disconnect or avoid pain. Discover is about recognizing how one has experienced disconnection or the experience of separateness. Discover is moving away from something and experiencing one's sense of disempowerment. Ultimately, in Discover one becomes aware of the disempowerment, acknowledges it, and accepts it. It is about one's connection to energy, breath, movement, touch, emotion, and rhythm. This language and syntax underlying the nature of what we experience is very important in Discover. It defines one's movement and limits. In Discover individuals determine how they are anchored to tension and stress, ease, and peace. The season of Discover is driven by fear and reaction, and may motivate individuals driven by the need for security or safety, especially when life circumstances appear to be changing rapidly. As an example, when individuals in the season of Discover seek Complimentary Alternative Medicine (CAM), their focus is fear, reaction, frustration, or hopes of "magical" cures.

*Transform* is about transforming one's relationships and one's world through focused attention and action. Transform is about fully associating with whatever seems like a source of pain as a source of opportunity. In Transform, the concept of a problem or blame does not exist, as it is irrelevant. Problems are replaced by opportunities, goals, and deliberate action. One redefines one's self through the structure of the body and changing one's relationship to focused energy, breath, strength, courage, and motion. It is about defining one's self through empowered actions and dissolving the attachments to ideas, concepts, memories, and stories which limit one's future journey. As an example, Transform is the Season of Wellbeing in which an individual is likely to choose CAM procedures to seek autonomy in the health or healing process.

*Awaken* is about the experience of effortless being and knowing. In Awaken, one develops the power of gratitude, awe, amazement, love, and benevolence through the experience of an unlimited source of spacious body, breath, energy, and possibility. It is about the experience of the energy of human spirit and love. It is about claiming a new life and formulating new actions based on an expanded, conscious and awakened perspective of our interdependence and connection. This season is more likely to be associated with the need to give love, spiritual growth, and the need to contribute beyond oneself. As an example, a person in the season of Awaken seeks CAM to advance his/her own evolution, connect with his/her subtle energies, and achieve optimal health and wellbeing so he/she can fulfill his/her life purpose and also serve others more fully.

The season of *Integrate* happens when a person revisits a previous season while maintaining the perspectives from a subsequent season. The season of Integrate allows an individual to create a greater depth of experience through elements of more than one season at a time while gaining the wisdom or gift of the previous season. Integrate is initiated through physical/structural, emotional, mental, social, cultural, and/or spiritual changes creating a need for a greater level of depth of a previous season. Integrate is the season of conscious choice about one's life, the energies and types of intelligence one uses, the resources one has available, one's resourcefulness, one's style and the ways one will experience one's reality and share one's gifts. As an example, a person in Integrate may choose CAM from any and/or multiple reasons noted above, to advance objectives related to a deepening of one or more seasons simultaneously.

It is important to note that the Seasons of Wellbeing continue to change throughout an individual's lifetime. While over the span of life, most people will develop from Discover through Awaken, this is not guaranteed. Low-functioning individuals may continually experience the season of Discover. Overachievers may continually experience the season of Transform. It is common in new age circles that people expound the experience of the season of Awaken. Self-actualizers[42] may

Table 2. The Triad of Change in the Seasons of Wellbeing[43]

| | *Discover* | *Transform* | *Awaken* |
|---|---|---|---|
| Structure | Constricted; inflexible; designed to keep failures or painful experiences segregated and not visible; painful; does not share ideas; hierarchical without effective steps in between; no room for questioning or growth; supports reactionary behavior | Flexible; growth-oriented; poised for rapid change; adaptable; can accommodate for exchange of ideas and criticism; supports optimism and association with pain as a tool for growth | Expansive; inclusive; contribution and making a difference to others; creating a legacy to uplift; empowering; inspiring; celebrates diversity and creativity |
| Behavior | Reactionary; attacking; judgemental; accusatory; dissociative from pain; linked to past behavior; over, or underreacting; fear-based; procrastination; perfectionism | Decisive; deliberate; opportunity seizing; transformative of concepts, stories, and relationships; associative with pain and pleasure toward gain; making changes | Loving actions; actions demonstrating gratitude; developing and acting on a natural style of giving; compassion; accepting of others; inspiring and awakening others; celebrating others and life; serving others; bringing wisdom, beyond just information |
| Perception | Victim; judgmental; anger; fear; loss; dissociative; focused on problem; problem or circumstance equals reality; past equals future and present; wound; cause; polarized; stuck; move away from; eliminate or get rid of or seek less of | Courage; focus; associative; gain; focused on opportunity or solution; future created by habit of present actions; active; focused on goals or plan; excitement; progress | Love; compassion; gratitude; energy; beyond physical form; emptiness; soul gifts; synchronicity, Serendipity; grace; gifts in all people and events; communion; community; acceptance |

continually experience the season of Awaken or Integrate. The keys to working with one's Season within ROH are for the individual to be congruent with the season that the person is truly in now. This may not be the season he or she wants and it may not be the season that person is used to. This is done most effortlessly in congruence with the other elements of ROH. Importantly, an individual can visit each of these seasons at appropriate times during life experiences, especially when this is done through the season of Integrate.

### The Triad of Change

*The Triad of Change* is the central focus of the map around which the other elements of reorganization occur. The premise of the triad is simple: All change includes *structure, behavior,* and *perception* (Fig. 3). Plainly stated, for each structure, there is an accompanying behavior and perception; for each behavior, there is a structure and a perception; and, for each perception, there are certain structures and behaviors that define and support it.

*Behavior* is defined as an observable pattern of actions expressing or manifesting an internal state or meaning (the implicit becoming explicit) and purposeful movement toward a goal or objective. Behavior is the expression of a meaning and the outcome of the relationship between action and purpose/objective. All behavior is purposeful even if it is "unconscious" and not immediately apparent.

*Perception* is defined as a chosen perspective—a mode or style or manner of focus that defines meaning (the way one focuses one's attention)—and the connections among body sensation, focus, and meaning. For example, pain is often associated with suffering. What causes the individual suffering is not always the experience of pain but the meaning attributed to it. Suffering is different from pain. Not everyone in pain experiences suffering. Suffering is a response to the perception of the pain added to a specific meaning associated with it. Perception is a consequence of focus and meaning.

*Structure* refers to any form serving as a carrier of information or energy. Structure relates to virtually every domain: consciousness; internal focus; body; posture; relationships; mutual understanding; business, organizations; and even schedules. As a resonant structure, the consciousness, perception, and behavior of the body is in relationship to the condition, tone, tension, and form of its structure. Structure defines the relationship between the physical and energetic systems of the body.

The real synergy that emerges with the congruence of the triad comes from understanding the power of two sides to entrain the third. Perception and Behavior entrain Structure and help to make new forms. Behavior and Structure entrain Perception, and help meaning to come from action and form. Structure and Perception inspire Behavior, which is an action born of meaning and form. The triad is not season-specific; an individual can work with the triad in any season. In fact, different sides of the individual's triad could be in different seasons simultaneously. It is important to uncover what creates the greatest congruence for an individual and what that individual wishes to create or express in life.

Congruence is the key to successful and sustainable change. In ROH, the focus is on the greatest resource and potential agent to fuel change. When all three of these sides are congruent change is inevitable, which becomes obvious as the change the individual had been trying to achieve becomes more effortless. Change in any one parameter naturally leads to change in the whole. However, this will only produce a temporary, nonsustainable change for the individual.

It is proposed that simultaneous change in two or more sides lead to synergy and emergent balanced states, which

Table 3. Characteristics of the Energetic Intelligences

| *Energetic intelligence* | *Bioenergetic intelligence* | *Emotional energetic intelligence* | *Lower-thought energetic intelligence* | *Upper-thought energetic intelligence* | *Soul energetic intelligence* | *Universal spirit energetic intelligence* |
|---|---|---|---|---|---|---|
| **Associated with** | Safety, survival, constancy | Experience of variety, nonconstancy; reactivity | Beliefs, stories and routine actions; associated with "this or that" | Complex models of reality, culture, map of the world | Transpersonal and subtle energetic experience | Primacy of oneness or interdependence of all souls and beings—Non dualistic |
| **Energetic Source** | Life force | Emotions; inward and outward expression | Simple mental focus on things, events, locations, words and routine tasks | Complex mental focus; conceptual models, maps and reasons | Spiritual focus | Spiritual realm of nonduality and oneness with integration of other energetic sources |
| **Actions** | Creates sustainable function in reaction to environment; organizes cellular function and biochemical constant expression; responsible for energy utilization, baseline survival | Instantaneous behavior change induced | Inhibitory or reactive; freezes event and special boundaries, as if to make time and space solid object to be inspected, held as real; replays events answers questions: "what, where and when?"; tends to use induction | Questions, challenges and establishes the story or metaphor for model or context; questions the status quo; Asks: "why and how"; focuses on distinctions; tends to employ deduction | Gratitude, benevolence, love-based percep tions, compassion and behaviors; chest rises and heart as a structure and metaphor has primacy in life; internal validators in relation to simplicity; gratitude and one's personal soul gifts and style; about resource-fulness; focused on similarities; recognizes others as also souls or spiritual beings; all of importance and worthy of dignity as such | Celebrates both unique-ness of individuals and the oneness of the all; remembers and integrates the ground of being or of creation; experiences creation as ongoing process; receives others and circumstances as gifts; finds and honors serendipity as the expression of reorganizational living; cares for and loves all of life; awakens community |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Energy utilization** | Biochemical and energy pathways | Creates a radical shift in baseline bioenergetic function, pathways and energy utilization; fuel for change in baseline | Uses story or belief to maintain habitual bio- and emotional energetic behaviors | Can direct lower mental, emotional and bioenergetic experience and expression | Engages other subtle awareness systems that are latent until the thought intelligence is more entrained with the heart and other structures; modulates, softens and directs all lower intelligences | Integrates all of the intelligences |
| **Requires** | Constant sense of environment | Sense of rapid change in behavior | Rules, structure, questions: "what, when, where?" | Reassessment of models, maps of life and reality; questions how and why? | Giving of one's personal "gifts," love, and gratitude | Celebration of diversity within oneness, suspension of temporal and spatial sense of separateness when appropriate |
| **When challenged** | Concerned with safety, survival, need to keep environmental demands, energy use constant or predictable | Difficulty in producing the range of emotions needed; inappropriate or generalized emotional response; when inhibited by higher intelligences, appropriate adaptive response is subjugated and emotional expression is not allowed | Tends to fixate on an event or circumstance, rigid, mental chatter, argumentative, pushy, rules and beliefs equal reality and fight for dominance of story; routines and administration of life has primacy; difficulty with mental focus and memory and needs guidance to do simple tasks. | Life becomes one's models; models of reality equal reality; supremacy of the thinking mode replaces other relationships; tends to desire enlightenment of mind and tends to lead to exclusionary/elitist thinking; challenges with finding the answer to why or how; gets confused with contextual models. | Does not accept or relate to culture or cultural rules; challenges with supporting and creating what is correct for the perfect soul; will help manifest what asked of it by thought energy intelligence; difficulty in knowing its attributes or expressing them if not given the opportunity or spaciousness to act; difficulty with love, compassion, gratitude for all. | Feels pain of all humanity as one's own and can be overwhelmed by the personal inability to receive all as gifts; challenges in the ability to work with the interdependence of all and to celebrate the uniqueness/oneness paradox; has difficulty being in the center of timelessness and spaciousness of the paradox |

are sustainable. The individual utilizes the sides of the triad easiest to create change with. This will often inspire the third side to change.

In RET, the focus is on the side of the triad that is most difficult and most challenged, and season is rarely considered. This is usually the side of the triad that tends to be more elusive, the side an individual tends to feel less adequate at and tends to obsess about. Our greatest wounds are usually located here. This is the place where the person generally feels as if what he she does is "not enough" and like "a nobody," or says: "I tried everything to change my perspective on it." Trying to create change from here is very difficult because it is met by resistance and defensiveness and often results in struggle. By attempting to fix and manipulate a single side of the triad, there is a tendency of the other two sides of the triad to return the challenged side to its prior state. By directing change toward the sides of the triad that are easiest for the individual to access, that individual's body, emotion, mind, soul, and spirit are honored. Add to this the right timing (season) and the accessible energetic wisdom, and reorganization happens.

## EIs

Mystics, yogis, healers, and shamans have observed energies within the body and multiple levels of energies around the body for ages. Scientific evidence of energy within and around the body is extensive.[51,52,65–77] Uniting subjective observation of the body's energies with scientifically verifiable observation leads to at least one significant insight; energies related to the complex biologic form are associated with states of consciousness.[45,46] Combining this insight with the research into subtle energies, years of empirical practice using "energetic applications" and, more recently, correlating these applications to a preliminary survey instrument (questionnaire)[§] designed to explore individuals' aptitudes for certain types of energies, Epstein developed the terminology for EI as one way to describe this unique domain of human experience.

Driven by these factors, EI has been furthered by utilizing the recent writings of philosopher Wilber[45] and collaboration with another one of the authors of the present article (Senzon).[78–80,¶] The concepts of these "energetic applications" extend to the research of Jonckheere[†] about the coherent and soliton nature of the waves in the spine during NSA entrainments, to the current literature on the biofield as a dissipative structure and complex dynamic standing wave,[51] the use of solitons by the connective tissues to transmit energy,[66] nonclassical forms of energy,[42] the role of electron-excited states in biologic processes,[68] and the soliton and acoustic nature of the action potential.[81–83]

With further study and verification of the survey instrument, EI may represent a developmental stream[64] along other multiple intelligences.[84,85] For now, it stands as a useful heuristic device to assist individuals to access their inner resources in the easiest way possible to create the most dynamic change in their Triads of Change and to have greater success as reorganizers. Research is planned to explore this energetic application in detail. There is enough consistent empirical evidence for this third component of ROH that it too can be applied across many disciplines.[45,51,52,65–77]

One of the ways the individual may suspect incongruence in his/her Triad of Change is through the feeling of a drop in available energy and resources. With greater congruence in the triad, greater energy and resources become instantly available. With these greater resources, the system evolves and a new level of congruence/consciousness emerges, providing for what feels like a new life. Associated with each type of energy, there is an energetic intelligence.

ROH combines the wisdom of the ages with objective science by acknowledging that each individual is comprised of at least five complex fields of energy and information associated with specific EI (Table 3); bioenergetic intelligence, emotional energetic intelligence, thought EI, soul energetic intelligence, and universal-spirit EI. Based on the background described above, it has been observed that each individual has competencies around specific energetic intelligences and these competencies are a way to harness important resources for the process of reorganization. In this way, the individual can learn to utilize resources efficiently and gain the intelligence associated with each.

Each of these intelligences exist within a matrix encompassing a range between high aptitude (abundance) and low aptitude. The low aptitude state is associated with a heightened energetic threshold for its expression. This means that it can take significantly more energy to utilize these types of intelligence in those individuals who have a lower aptitude for these types of intelligence. These individuals often fear and/or worry about this type of intelligence, and either obsess about being a good enough person with this type of intelligence, or tend to bypass using this type of intelligence and default to another type of intelligence instead. When EI provide a high aptitude, it will be experienced as spontaneous and effortless.

Just like aspects of each triad may exist in each season, EI can be utilized in each season as well, although each energetic intelligence seems to have an affinity for a specific season (for example, bioenergetic and emotional EI are mostly associated with the season of Discover; thought EI is associated with the season of Transform; and soul EI and universal spirit EIs are associated primarily with the season of Awaken). An individual will always use every EI in every season. The point is congruence. When the EI is used in conjunction with the season and the triad and *this is an EI that the person has an aptitude for,* ROH ensues. Also, in the season of Integrate, the individual may have a wider range of aptitudes and competencies.

We hypothesize further that both spiritual EIs (soul EI and universal-spirit EI) develop as the need to defend oneself is no longer a central theme and that the development of these are a higher-order functioning capacity of greater depth for the human. The hypothesis is congruent with Wilber's theory that there are increasing levels of subtle energy, which correspond to increasing levels of interior depth of awareness.[45] The linkages of these spiritual intelligences with the lower ones transform the use of those intelligences to spiritually guided or inspired expressions.

[§]Epstein D. Energetic Life Inventory Questionnaire. 2006. Available by request from authors.

[¶]Epstein D, Senzon SA. Organizing fields of subtle energy in relation to five rays of consciousness and the advancement of Network Spinal Analysis: Certification Level Intensive [seminar notes]. Longmont, CO: Innate Intelligence, November 2004.

## Discussion

The real keys to ROH are congruence within and between all three elements while utilizing optimum resources. Reorganization happens when the timing is just right (the right season of Wellbeing), and perception, structure, and behavior (the Triad of Change) coincide, while also accessing the wisdom from the most accessible aspect of the self-system: bioenergy EI; emotional EI; thought EI; soul EI; or universal spirit EI (the EI).

The emergence of ROH was driven by common patterns of successful "reorganizers." Individuals successfully reorganizing within NSA and SRI demonstrate common patterns of structural, behavioral, and perceptual change. ROH aims to establish new strategies to access required energetic, mental, emotional and physical resources. This nontherapeutic approach gives the model flexibility to be applied across many disciplines.

Successful reorganizers embody this congruence, as all three elements work as one. Success in ROH is not about the symptom going away although that often happens.[7,13,86] Success is when the individual uses the elements of ROH to bring his/her life to the next level. Some examples of this are demonstrated as (in case studies in preparation): a veteran whose back pain disappeared but decided to take his life back, to quit smoking, get his own apartment, and go back to school at age 52 to become a veterinary technician; a woman who discovered a gift within bodily pains, which started after an auto accident years ago, and used her recovery to heal her dysfunctional family relationships; a woman who, "suffering" or experiencing end stages of pancreatic cancer found through the pain a resource to have greater love, benevolence, and acceptance for herself and others in the last days of her life.

Even if the symptoms were to reoccur or return, the individuals would develop new lives at higher baselines of function and new strategies to deal with life's stressors and symptoms. Each reorganizer identified relationships among their previous lower-level function, their symptoms, and actions needed to live life more fully in a healthier state.

Changes represented in the first two examples may be explained in part by the reduction or elimination of pain. In every case, however, the reorganizers used experience and meaning, to lift their lives to a new level. Often, this occurred through more action guided by inner direction, human connection, depth and meaning. These commonalities are hallmarks of successful reorganization. The individual learns the relationships between symptoms, meaning, the life-system, and growth.

ROH has been successfully taught on three continents,[43] and elements of ROH are currently being practiced worldwide. Research and further discussion is needed to examine this crossdisciplinary healing paradigm.

## Conclusions

ROH offers a valuable paradigm in understanding human change and creating sustained change. It is distinct from Restorative Therapeutics as ROH does not seek to fix problems or restore individuals to a previous state of function. Rather than restoring an aspect of the individual's experience to a prior state, ROH helps to consciously develop the individual's life to the next level. In this way ROH assists the person achieve higher standards of health and wellbeing no matter what challenges or limitations they face. It is a personalized approach to human transformation that acknowledges the need for timing, self-assessment, and energy in the process. It compels us to ask new questions of ourselves in healing and in life. Instead of asking "what is wrong with me?," an individual may ask "where am I at?"; "where must I go?"; and "how do I get there?" To these ends, ROH makes its contribution to the literature.

ROH offers the opportunity for an individual to engage in a journey of self-assessment and self-regulation either on their own, or with a practitioner, to create a map for a new and sustainable future. ROH as a paradigm offers various disciplines the opportunity to establish an outcomes assessment practice, which goes beyond restoration, prevention or maintenance, and the challenge to determine outcomes for reorganizational states for structure, perception, and behavior. When reorganization develops, new levels of organized complexity, applications and systems are able to develop and emerge.

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## *Editorial*

# Reorganizational Healing: A Health Change Model Whose Time Has Come

Robert H.I. Blanks, Ph.D.

On rare occasions, one can step back and say: "Wow, that is a really good idea." Now might be that time. The article on Reorganizational Healing (ROH) in this issue by Epstein et al. (pp. 475–487) presents a viable big-picture option for improving the health of individuals and addressing the current health care crisis in the United States and worldwide.

In their article (pp. 475–487), Drs. Epstein, Senzon, and Lemberger also present a radically new "big-picture" view of health and health care that challenges the dominant disease-care model of biomedicine. Currently, when people require care they receive diagnoses and treatments to return them to their former states of health. Cost reimbursement as well as diagnostic and treatment parameters are driven by this disease-based, "restorative healing" system by medical necessity. Prevention is also a growing part of the biomedical model and is practiced largely through patient education (primary prevention) and symptom management (secondary prevention). But preventive strategies are still disease-based and poorly reimbursed. Indeed, Julie Gerberding, M.D., M.P.H., former director of the Centers for Disease Control and Prevention (CDC), estimates that, of the annual medical budget in the United States (i.e., $2.4 trillion in 2008),[1] the overwhelming majority goes toward treatment of ill patients, and less than 5% goes toward keeping Americans healthy.[2] Recognizing the need for more emphasis on prevention, the CDC recently launched the "Healthiest Nation Campaign" to keep Americans healthy by promoting prevention and integrating health into social policies across all sectors of the economy (e.g., consider the broad-reaching implications of promoting health by providing better public transportation, assistance with health-related transportation, healthier environmental strategies, more bike and hiking trails, and facilities for child care that enable parents to attend regular health visits, etc.). The new director of the CDC, Richard Besser, M.D., has expanded the vision of the CDC as "Healthy People in a Healthy World—through Prevention" to stress the importance of preventive approaches, but this is still a disease-based model.[3]

So what is the novelty of the approach presented by Epstein and colleagues? In contrast to "Restorative Healing" (i.e., disease-based and preventive medicine), the new ROH paradigm is about helping people to be well and stay well. ROH reflects the highly complex and dynamic nature of health across all biologic psychologic, social, and spiritual domains. The intention of ROH is to bring about changes in individuals, helping them to develop new resources so that these individuals use the health challenge consciously to effect changes in their lives and bring about greater understanding and increased ability to thrive under most circumstances. ROH was inspired by, and can be practiced through, several interventions developed previously by Epstein, including a system of assessment and corrective body contacts called Network Spinal Analysis (NSA); an integrated 12-step healing program called The Twelve Stages of Healing; and a system of exercises that focuses attention, directs breathing, and creates energy awareness called Somato-Respiratory Integration (SRI). Basically, ROH is a metamodel that can include NSA and SRI, but ROH's greater power is the transcendence of any particular discipline. Success in ROH is not about symptom relief. Rather, success is the ability of the patient to apply the elements of ROH to effect lifestyle and health behavioral change (e.g., smoking cessation, etc.) and to take the novel perspective, first articulated by Jobst and colleagues,[4] that diseases can be viewed as indicators of what is going on in the individual's life and in society (i.e., "Diseases of Meaning" and "Diseases as a Manifestation of Health"), and thus be seen as a source of growth, understanding, and opportunity for greater awareness and as a catalyst for change.

Finally, ROH includes outcome assessments and clinical tools, including the Four Seasons of Wellbeing, the Triad of Change, and Energetic Intelligences (EIs). The Four Seasons of Wellbeing is an outcome measure used to assess an individual's readiness to change at any given moment in time. Practitioners trained in ROH learn to recognize these stages of readiness and direct interventions accordingly. The Triad of Change is a new and effective learning tool for teaching the

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fundamentals of health behavioral change. EIs are a means the ROH practitioner uses to assess the emotional reserves (resiliency), buffering, and willingness of patients to effect change in their lives. When applied in concert with NSA and SRI, these elements of ROH form a system of care that can be learned and applied by any health professional.

ROH is a model of health rather than a method. It is evidence-based, and it was slowly developed by Dr. Epstein during 25 years of clinical practice, research, and postgraduate teaching. Thousands of people have attended his transformational programs. A large cohort study by myself and colleagues, included analysis of 2818 patients under NSA care from 160 offices in the United States, Canada, Puerto Rico, and Australia.[5] Our results indicated that patients reported significant positive perceived change ($p < 0.000$) in all domains of health that were assessed. Effect sizes for these difference scores were all large (>0.9). These benefits of NSA are evident from as early as 1–3 months under care and appear to show continuing clinical improvements in the duration of care intervals studied, with no indication of a maximum clinical benefit.

Our research involved use of quality-of-life (QoL) surveys to assess NSA. There is an increasing trend in biomedical research to incorporate health-related QoL assessments.[6] Self-rated health (SRH), a formalized measure of subjective health, has been found to be an independent predictor of clinical outcome and mortality.[7] Even when numerous health status indicators are available, poor SRH is independently associated with increased mortality in different socioeconomic groups, in different age groups, in men and women, over time, and among persons with or without chronic illness.[8–12] Self-rated health also correlates with levels of circulating pro-inflammatory cytokines, which serve as biomarkers of general levels of stress (e.g., IL-1ß, IL-1ra, and TNFα). In a major study, poorer subjective health was associated with of higher levels of inflammatory cytokines in female subjects but not in males. Even when controlling for age, education, physical health, and diagnoses in multiple regression analyses, self-rated health was an independent and more robust predictor of cytokine levels than physician-rated health.[13]

A second series of papers on NSA by Schuster et al.[14,15] applied structural equation modeling to the data from our earlier[5] study to examine outcomes in relation to health-lifestyle practices and self-reported health and wellness. The final structural equation model indicated that individuals who underwent NSA successfully "reorganized" their self-reported health beliefs, practices, and behaviors along the lines of what is now the ROH Triad of Change. Namely, the benefits of care were distributed, meaning that health benefits of NSA were both direct and indirect. The direct effects of NSA on the health perception of the individual (perceptual) were significant and occurred across physical, mental/emotional, life-enjoyment and stress-related domains of health. There were also indirect effects of NSA care that led to positive changes in health behaviors (risk avoidance, healthy eating, food choice, and exercise). Although the direct effects of NSA on health belief were found to be the greatest, there was also a significant effect on patients who were making healthier lifestyle choices.[14,15] Across the population of 2818 subjects who underwent NSA care, self-reported changes in healthy lifestyle behavior included a 26% decrease in consumption of caffeine; an 8% reduction in smoking; and improvement in many healthy-lifestyle domains including a vegetarian diet (39% increase); consumption of vitamins (45% increase) and organic foods (46% increase); and use of regular exercise (40% increase); *t'ai chi*/yoga (20% increase), meditation (48% increase), and relaxation techniques (46% increase).[5]

Health lifestyle change must be part of health care reform. Nearly 1 in every 2 Americans has a chronic medical condition, defined as an illnesse that is prolonged, does not resolve spontaneously, and is rarely completely cured.[16] An estimated 90% of seniors have at least one chronic disease, and 77% of them have two or more chronic diseases.[17] Chronic diseases targeted by the CDC's National Center for Chronic Disease Prevention and Health Promotion are those illnesses that fit the broad definition of chronic disease and those that pose a significant burden in mortality, morbidity, and cost. Examples include chronic fatigue syndrome, rheumatoid arthritis, osteoarthritis, asthma, renal failure, diabetes, hepatitis, systemic lupus erythematosus, cardiovascular disease, some cancers, and osteoporosis. Although chronic diseases are among the most common and costly health problems (accounting for more than 60% of the nation's medical-care costs),[18] these diseases are also among the most preventable conditions. Adopting healthy behaviors, such as eating nutritious foods, being physically active, and avoiding tobacco use, can prevent or control the devastating effects of these diseases. The United States cannot address escalating health care costs effectively without addressing the prevention of chronic diseases. As indicated above, the NSA component of ROH has a significant influence on health lifestyle behavior and should be of help, if adopted broadly, in addressing the root causes and costs of treating chronic diseases.

## Health Care Reform

Policymakers and other stakeholders agree that health care costs must be controlled, but these people disagree on the best way to address the cost issues while ensuring access, fairness, efficiency, and quality. To highlight the problem, the World Health Organization ranked the U.S. health care system as highest in cost and responsiveness throughout the world, but the U.S. health care system ranks 37th in overall performance and 72nd among the 191 member nations surveyed in terms of the overall health of its citizens.[19,20] The Association of American Medical Colleges (AAMC) serves and leads the academic medicine community of medical schools, hospitals and health professionals' organizations in the United States. Recently, the AAMC and 14 other health professional groups issued statements to guide health care reform. At the top on their list of recommendations are increased access to high-quality, cost-effective, and patient-centered care through existing or new public and private health insurance options; greater emphasis on prevention and wellness; and stable funding for a health educational infrastructure to ensure well-educated and trained health professionals.[21] Clearly, implementing these changes would be a major first step in serious health care reform.

A distinguished panel headed by James S. Gordon, M.D., founder and director of the Center for Mind-Body Medicine, in Washington, D.C., prepared a far more comprehensive series of ten recommendations[22] emphasizing the need for:

1. A coherent, rational system of national health care to meet the needs of all Americans.

2. A new model of universal care grounded in prevention valued as highly as diagnosis/treatment, and in which self-care and mutual help are fundamental.
3. Greater implementation and study of integrative approaches.
4. A reduction of the financial barriers for training of health professionals.
5. Transformation of the population by focusing on the health of children.
6. A sane alternative to the costly and destructive system of dealing with medical malpractice;
7. Removing the influence of the private sector (insurance companies, pharmaceutical companies, etc.).
8. A change in the balance of research focus to include basic and new clinical research to support a new health care agenda (multiple outcomes, nutrition, mind–body and exercise approaches).
9. Reinstatement of ancient perspectives of health as promoting personal, emotional, social, and spiritual fulfillment.
10. Creation of a White House Office of Health and Wellness to ensure the "ongoing active engagement of our population in their own care and in shaping the kind of care that will most effectively, humanely, and economically meet all our needs." If enacted, these recommendations would provide long-term financial stability to the health care infrastructure and provide advancement in the health of the population.

### Impediments to Real Health Care Reform

Major health care reform has been considered in Canada but, in spite of strong evidence-based documentation and cost-effectiveness studies to the contrary, significant change and inclusion of complementary and alternative medicine (CAM) modalities such as chiropractic were never implemented into the Canadian single-payor system. Reports prepared in 1998 and 2000 by Ontario Health Economist Pran Manga, Ph.D., concluded that implementaing chiropractic could result in a potential savings to the Ontario health care system of as much as $380 million–$770 million per year; this extrapolated to a potential savings of $2 billion in Canadian dollars per year if implemented across all of Canada.[23,24] In a recent book written for the popular audience, *Squandering Billions: Health Care in Canada*, Bannerman and Nixdorf draw attention to the details the "Manga Report" and health-reform concepts of other prominent health economists.[25] We can learn a great deal from their recommendations. Accordingly, the 10 most common obstacles to overcome in implementing successful health care reform include the following concerns:

1. There is a need for patient awareness and accountability for maintaining a healthy lifestyle and balancing one's personal interests with those of society.
2. A reassessment of the basic reimbursement requirement only for "medically necessary services" is vital. Health is not the sole domain of the medical establishment, and health claims and access need to be integrated across all sectors of the economy.
3. When various services are being considered, governments need to understand the difference between "substitution" (shifting care from one sector to another, e.g., from primary care M.D.s to nurse–practitioners) and the typical bureaucratic interpretation of adding "additional" costs (i.e., services not now covered that would be covered over and above current costs).
4. Significant health care reform will require a "substation" of providers and services and not the "addition" of new services.
5. The bureaucracy and non–service-delivery-related infrastructure must be scrutinized and reduced at all levels. The noncompetitive environment must be improved. There is insufficient competition because of medical, dental, and pharmaceutical monopolies.
6. The modes of primary care delivery need to be vastly improved from the physician gatekeeper model to direct access to a variety of well-trained providers (e.g., chiropractors, nurse–practitioners, etc.).
7. Home care, convalescent hospitals, and small surgical centers should be dramatically expanded, each with the aim of providing adequate "substitution"[26] for more expensive acute care hospitals and trauma centers.
8. Pharmaceutical utilization and costs are out of control and need to be examined.
9. Dr. Manga stated that "good policies work if the leaders are prepared to be tough."[24] Frequently, this is not the case but will be an absolute requirement at all levels for health care reform to be successful.
10. "Progress gets lost in minutiae,"[24] said Dr. Manga. Searching for unanimous and even perfect solutions prevent any improvements from taking place. We need to get started now with a good (albeit not perfect) plan.

The benefits to society of systematically reorganizing the health care infrastructure are potentially enormous. I encourage all health care workers, policymakers, and citizens to read the Epstein, Senzon and Lemberger article in this issue (pp. 475–487) and consider the potential benefits that could be derived from a major shift in emphasis from the current restorative approach to a reorganizational healing perspective. I found that the best way to understand restorative healing was to review Table 2 of this article and then reflect on the triad of change model (shown in Fig. 2 of the article). Once I understood these principles, the potential for global world health offered by Reorganizational Healing became an exciting possibility.

Health economist Paul Zane Pilzer, author of *The Wellness Revolution*, summarized the situation well: "The sickness business is reactive. Despite its enormous size, people become customers only when they are stricken by and react to a specific condition or complaint. . . . the wellness business is proactive. People voluntarily become customers—to feel healthier, to reduce the effects of aging, and to avoid becoming customers of the sickness business. Everyone wants to be a customer of this earlier-stage approach to health."[27]

Moving forward, the real work begins once one makes the decision to shift focus from disease care to preventative care and, eventually, to reorganizational healing strategies. It seems clear that significant health care reform must focus on controlling the cost of health care while ensuring access, fairness, efficiency, and quality. The tools and techniques of ROH are not exclusive or restrictive and are being made available to all health professionals regardless of discipline. Research suggests

major changes in health lifestyle behavior are possible with the NSA component of ROH, and the additional ROH tools and outcome measures could benefit the massive re-educational task of teaching health behavioral change, patient awareness, and use of self-care and greater overall accountability of the citizens. A broadly tasked, fair and equitable system of health care delivery will better serve the health of all individuals, couples, families, communities, and nations.

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# Letters to the Editor

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## Network Spinal Analysis

Dear Editor:

There has been much debate about the objective basis of Network Spinal Analysis (NSA) and Network Spinal Analysis Care.[1–4] I and a number of my colleagues set out to study this. Our work during the last 10 years[5–10] has revealed some significant objective, repeatable, reliable, and measurable changes, which are the subject of a full paper being submitted for publication.* We believe that these findings have far-reaching implications for the future of health care development and for the development of Network Spinal Analysis Care as a discipline. For this reason, we believe it is important to alert the therapeutic and scientific community to our findings in this letter.

Our approach to Network Spinal Analysis has been to take an austere scientific and falsifiable view of the phenomena which arise in Network Spinal Analysis Care and in particular the emergence of the "NSA traveling and standing waves."[6,9,*] We sought, therefore, to measure and analyze surface electromyographic (sEMG) signals recorded during the NSA procedure. Over the past 10 years, we have taken the stand that sEMG signals recorded on the paraspinal muscles during the procedure provide a "window" through which we can view the central nervous system (CNS). The protocol—duly approved by the institutional review board of the University of Southern California, Los Angeles—consists of observing the cervical, thoracic, lumbar, and sacral sEMG signals when a subject is experiencing the NSA wave. This sensor deployment covers the cervical and sacral dural-vertebral attachments areas[11] that are sensitized during entrainment as well as additional areas that are interpolation points between the distal ends of the spine and that provide an insight into the overall motion of the spine. The specific features that we have observed on the sEMG signals recorded during NSA are: an improvement of the predictability of the sEMG signals as the subject goes from early to advanced levels of care[8]; an oscillation of the four signals in a standing-wave pattern[6,9,*]; and coherence among the various signals.[9,*] All of these phenomena point to some "organization" of the neuronal circuitry. What is closely related to the first feature is the fact that the mathematical models of the various signals, especially the cervical signal, are specific to the level of care in which they have been recorded.[9] More specifically, 12 baseline mathematical models are constructed and a switching logic based on least-squares prediction error consistently selects one, or two at the most, model(s), best fitting the data at a specific level of care and in a specific position of the subject (prone, supine, sitting). Probably the most important result is the dramatic improvement of the ability of the model selected by the switching logic to predict future outcomes[8] from early to advanced levels of care. This observation is corroborated by the increase of the mutual information between the past and the future of the bursts of sEMG activity from Level 1 to Level 3, as shown in Table 1.

In a few words, the "mutual information" (in bits per second) is a logarithmic measure of the amount of correlation between the past and the future[5]; evidently, should this correlation increase, the future will be more predictable from the past.

The objectively established fact that the signals become less random and more predictable can be interpreted to reveal a better "organization" of the neural circuitry at advanced levels of care. In the broader context, the coherent, standing-wave oscillation of the four signals reveals a better large-scale organization of the circuitry across the entire spine. The more complex wave pattern at Level 3 of care reveals a more-complex synaptic-strength pattern. It is an established mathematical fact that complex, yet predictable signals emanate from such nonlinear processes as attractors, which can be defined as stable, complex oscillatory patterns in dynamical systems.[12] The ability of the CNS to organize itself as an attractor, securing synchronization and coherence at a distance, has been shown to be ubiquitous in higher level cognitive processes.[13,14] Conversely, neurologic deficits are accompanied with lack of coherence/synchronization.[13] From this point of view, it is fair to assert that NSA provides some sort of "reorganization healing."

Table 1. Past/Future Mutual Information in sEMG Signals Recorded at Various points and at various Levels of Care[a]

| *Position along spine* | *Level 1 subject* | *Level 2 subject* | *Level 3 subject* |
|---|---|---|---|
| Cervical | 1.3465 | 2.1783 | 2.5804 |
| Thoracic | 1.0682 | 1.1324 | 2.2 |
| Lumbar | 0.9843 | 1.5855 | 1.5160 |
| Sacral | 1.7422 | 2.3117 | 4.3614 |

[a]Jonckheere E. Chaotic Modeling in Network Spinal Analysis. Mathematical classification of Levels 1,2,3 Patients. Online document at: http://exodus.usc/edu/CHAOS/nsa Accessed May 8, 2009.
sEMG, surface electromyographic.

*Jonckheere E, Lohsoonthorn P, Mahajan V, et al. On a standing wave Central Pattern Generator and the coherence problem. Biomed Signal Processing Control, submitted.

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## Probiotic Use and Clindamycin-Induced Hypercholesterolemia

Dear Editor:

Antibiotics are routinely used prior to arthroscopy to reduce the risk of infection. In patients allergic to penicillin who can not tolerate a cephalosporin, clindamycin is often used. Clindamycin is capable of eliminating anaerobic gastrointestinal flora such as bacteroides[1] that break down ingested cholesterol to products such as coprostanol that are excreted in the feces.[2] This unintended sterilization could lead to increased serum cholesterol levels, which could be of clinical significance if this elevation persisted unnoticed over a prolonged period of time. We detail an account of such a finding.

The preoperative baseline and postoperative clinical course is characterized for the case of clindamycin use as prophylaxis against an infection prior to right knee arthroscopy in a patient allergic to penicillin. Total serum cholesterol and its components as well as triglyceride assessments were tabulated at baseline and then postoperatively prior to and following a 1-week course of probiotic use.

A 46-year-old male allergic to penicillin, on no medications, and with no significant past medical history, had a lipid panel drawn as part of his annual physical examination on December 20, 2007 (Table 1). The following day he underwent a right knee arthroscopy and received 600 mg of clindamycin intravenously to minimize the risk of postoperative infection. A 2 cm×2 cm erythematous area was noted on postoperative day 2 just lateral to an entry site of the scope and was believed to be consistent with a cellulitis. A 10-day course of clindamycin was prescribed at 300 mg four times daily by mouth and the rash resolved. On February 6, 2008, as part of a workup for an elevated mean corpuscular volume (MCV = 100.2), a lipid panel was ordered. The conclusion of the work up for the elevated MCV was that, given that it was long standing (14 years) and that the patient was never anemic, this was a benign hereditary pattern. However, the lipid panel obtained on February 6, 2008 was now abnormal, showing marked increases in the total cholesterol, high density lipoprotein (HDL), and low density lipoprotein (LDL) calculated, despite no change in diet and minimal change in activity level. Because laboratory error was suspected, the lipid panel was repeated on February 11, 12, and 19, but while levels were lower they remained markedly elevated compared to baseline. Given the suspicion that clindamycin may have changed the flora in the gastrointestinal tract,[1] a probiotic acidophilus was taken daily by mouth for 1 week. A repeat lipid panel on February 27 showed a return to baseline values.

ORIGINAL RESEARCH

# Improvement in Attention in Patients Undergoing Network Spinal Analysis: A Case Series Using Objective Measures of Attention

*Yannick Pauli D.C.*[1]

**ABSTRACT**

**Objective –** Anecdotal preliminary evidence suggests that chiropractic care may be of benefits for individuals suffering from ADHD. This case series presents the improvement in attention experienced by 9 adult patients undergoing Network Spinal Analysis.

**Methods** – Nine adult patients are presented (4 male, 5 female) with a mean age of 40.4 years (range 22 – 58 years old). All patients were evaluated with the Test of Variable of Attention (TOVA) before receiving Network Spinal Analyis (NSA) care and at 2 months into care. The nine patients received level 1 NSA care for two months, as taught by the Association for Network Care. Neurospinal integrity was evaluated with palpation, as well as surface electromyography. Cognitive process of attention was objectively evaluated using a continuous performance test, the Test of Variables of Attention (TOVA).

**Results:** We evaluated our patient cohort before and after Network care using sEMG and variables from the continuous performance test (TOVA). Before care, all patients had an abnormal ADHD score with a mean of -3.74 (range: - 8.54 to - 1.89). After 2 months of care, all patients had a significant change in ADHD score (p=0.08) and 88% completely normalized the ADHD score. 77% and 66% of patients experienced significant change in reaction time and variability score, respectively. All patients experienced a significant reduction in sEMG pattern of activation (p=0.08). We discuss possible mechanisms by which spinal care may have enhanced the function of the prefrontal cortex, thereby resulting in improved attentional capacities

**Conclusion** – In this case series the nine adult patients experienced significant improvement in attention, as measured by objective outcomes, after receiving two months of Network Spinal Analysis. The progress documented in this report suggests that NSA care may positively affect the brain by creating plastic changes in the prefrontal cortex and other cortical and subcortical areas serving as neural substrate for the cognitive process of attention. These findings may be of importance for individuals suffering from attention deficit. Further research into this area is greatly needed.

**Key words**: *chiropractic, attention, Network Spinal Analysis, thalamocortical oscillations, subluxation*

## Introduction

Attention is the cognitive process of selectively concentrating on one thing, while ignoring other things.[1] In 1890, American psychologist and philosopher William James wrote:

"*Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneous possible objects or train of thoughts. Focalisation, concentration, of consciousness are its essence.*"[2]

Despite this seemingly simple description, more than a century of research and the fact that attention is one of the most studied domains in psychology and neuroscience, a clear understanding and a uniformly accepted definition of the word are yet to emerge.[3] Attention has been defined in many ways and various subcategories have been created to further precise the concept [4] (see table 1). Gerschwind defined attention as the ability to maintain a coherent line of thought or action [5].

Despite those considerations, the nature of attention remains elusive. This is not surprising since attention is not a unitary faculty. Rather, it is a diversified faculty of the human cognitive system that is subserved by multiple interrelated attentional networks in the brain and manifests itself in a

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variety of types and at different levels in almost every aspects of human behaviour, from perception and motor control to working memory, skill acquisition, response selection and consciousness.[6] Some authors even hypothesize that attention plays an important role in consciousness [7].

**Table 1 : Subcategories of attention** (from Palmese [4])

1. Focused attention – the ability to focus one's consciousness on an object
2. Sustained attention – the ability to maintain the focus on the object
3. Selective attention – the ability to sustain attention in the presence of distracters.
4. Alternating attention – the ability to change mental set
5. Divided attention – the ability to simultaneously process two pieces of information at once.

If the theoretical underpinnings of attention are vast, clinically, attention has relevance to various domains since it is implicated in various disorders. The most common one is attention deficit / hyperactivity disorders (ADHD). Epidemiological studies suggest that between 3-10% of children and 1-6% of adult population in the United States suffers from ADHD [8]. The worldwide prevalence of ADHD is between 3% and 9% [9].

Deficit in attention is not only related to poor concentration. It can have devastating consequences on the daily functioning of individuals it affects. Individuals suffering from ADHD have been found to suffer from significant risk related to daily living (see table 2).

**Table 2 : Increased behavioral risks in patients suffering from ADHD (adapted from Barkley [10])**

- Having at least four or more serious accidents – three times the risk
- Having traumas requiring sutures or hospitalisations – twice the risk
- ADHD young adults have four time as many car accidents as controls
- Having two or more car crashes – seven times the risk
- Being at fault in accidents – four times the risk
- Receive four times more citations (esp. speeding and failing to obey stop signals)
- Increased risk of cigarette, alcohol or marijuana use – 2-3 times the risk
- Greater difficulty managing money and credit
- Failing a grade, being suspended or expelled from school – three times the risk
- Greater risk of not finishing school
- Greater risk of unprotected sex, teen pregnancy and acquiring sexually transmitted disease
- Greater risk of changing job or likelihood of being fired
- Increased likelihood of divorce

Disorder of attention can also be found in traumatic brain injuries, which affect 2 million individual every year in the United States [4]. Attention problem has also been linked to neurodegenerative disorders, such as dementia [52], Alzheimer's disease[53] and Parkinson's disease [52]. The neuroanatomy and neurophysiology of attention, as it relates to prefrontal cortex is reviewed in the discussion portion of this article.

Limited evidence exist that chiropractic care may benefit individual suffering from ADHD. In a single subject research design, Giesen suggested that chiropractic care was associated with behavioural and motor hyperactivity improvement in five of seven children [11]. Bastecki reported the remission of ADHD symptoms of a five-year-old child receiving chiropractic care.[12] So far however, no studies have linked chiropractic care to changes in objectively measured attentional capabilities in adults. This case series represent the first study of the changes experienced by adult patient receiving NSA utilizing objective measure of attention.

## Methods

*Technique - Network Spinal Analysis*

Network Spinal Analysis (NSA) is an evidenced based approach to wellness and body awareness, developed by Donald M. Epstein, DC [13].

NSA evolved from subluxation-based, vitalistic chiropractic into a system of specific low force spinal applications designed to enhance the cognitive and precognitive awareness of an individual's spinal structure, body tension patterns, and the development of unique Somatopsychic and Respiratory waves of skeletal motor activity purported to assist in improved self-organization of the nervous system [14].

NSA care is delivered through a series of three levels of care. Each level has specific outcome and low force contact applications (see table 3). Low force contacts are taken at areas related to or adjacent of spinal-dural attachment. Those areas are known in NSA as Spinal Gateways. The application of force is guided by a clinical priority system called the Phasing System (see table 4).

**Table 3 : Levels of Care in NSA and related anticipated outcomes**

***Level 1*** – entrainment of respiratory motion with spinal motion (respiratory wave), release of tension from spinal stability subsystems, reduction of parameters of spinal cord tension.

***Level 2*** – resolution of dominant spinal defense patterns, development and refinement of the Somatopsychic wave (entrainment of two vertebral oscillators)

***Advanced care*** – absence of defense posture, development of the third (thoracic oscillator).

**Table 4 : NSA's Phasing system**

Phase 1 - Sacrum or occiput
Phase 2 - C1 or C5
Phase 3 - sacral apex or ilium
Phase 4 - C2 or C3
Phase 5 - Scaral apex/C2 or Coccyx/C5

Based on research done with post-traumatic stress disorder (PTST) patients demonstrating decreased blood flow and activation of prefrontal cortex (especially on the right hemisphere) and activation of limbic structures (see for example Shin [15]), Network Spinal Analysis hypothesizes that repeated life stressful events in the face of inappropriate coping strategies result in progressive dys-activation of prefrontal cortical areas and activation of limbic system. Dys-activation of the prefrontal cortex is hypothesized to impair the brain's ability to pay attention to the body's internal processes, resulting in reduced body awareness and decreased ability to access internal healing resources

Since previous research has demonstrated that prefrontal cortical areas (especially in the right hemisphere) are part of a neural network subserving the cognitive process of attention (see neuroanatomy of attention in the discussion), we were interested in knowing whether NSA care could influence attentional capabilities in adults.

*Clinical Features*

During a three months period (March – May 2006), all new patients presenting to our wellness centre reporting a complaint of attention problems (either as a chief complaint or as an additional complaint) on our health intake questionnaire were given the possibility to enter our study. Out of a panel of 57 new patients, 10 patients reported suffering from attentional difficulties (17.54%). Three patients had attention deficit as a chief complaint, seven as additional complaints. One patient declined to participate in the study because she would not be able to comply with the 2 months of care due to moving away. Therefore, nine patients (4 male, 5 females) with a mean age of 40.4 years (range 22-58) participated in our study. Patient characteristics are presented in table 5.

All patients were also evaluated for neurospinal integrity using Epstein's model of neurospinal subsystems. Palpation was used to assess tone and compliance of the active and passive subsystem. Paraspinal surface electromyography and thermography was used to assess neural control system.

Since this type of palpation has never been tested for validity of reliability, in this study, we used surface electromyography (Insight Subluxation Station – Millenium, Chiropractic Leadership Alliance) as our main outcome for neurospinal integrity. Static paraspinal surface electromyography using Insight Subluxation Station has recently been shown to have excellent intra- and inter-examiner reliability.

**Table 5 : Patient characteristics**

| *Subject* | *Age* | *Gender* | *Presenting complaint* |
|---|---|---|---|
| 1 | 29 | M | Spinal pain |
| 2 | 47 | F | Digestive/Gastrointestinal |
| 3 | 47 | F | Migraine headaches |
| 4 | 34 | F | Concentration/memory problems |
| 5 | 58 | M | Concentration difficulties |
| 6 | 27 | M | Medically diagnosed ADHD |
| 7 | 49 | F | Fibromyalgia |
| 8 | 50 | F | Whiplash / Traumatic Brain injury |
| 9 | 22 | M | Fatigue / anxiety |

All patients also underwent chiropractic functional neurological evaluation of the neuraxis, as taught by the Carrick Institute for Graduate Studies. Examination included sensory, motor, balance and oculomotor function assessment.

All patients were evaluated using the visual portion of the Test of Variable of Attention (TOVA). The TOVA is 22.5 minutes objective, standardized, visual continuous performance test of attention. It is a non-language based computerized test requiring no right-left discrimination and has negligible practice effect. The TOVA has been shown to have good sensitivity and specificity in discriminating ADHD from normal control individuals [16].

During the test, one of two easily discriminated visual stimuli is presented for 100 msec every 2 seconds. The designated target is presented randomly on 22.5% of the trials during the first half of the test and randomly on 77.5% of the trials during the second half. These two test conditions examine attentional variables under the usual stimulus infrequent mode (first half of the test) and impulsivity in the more provocative stimulus frequent conditions (second half of the test). Subject press a microswitch as quick as they can when the designated target appear but ignore the non-target. A 2.5 minutes practice session is administered to insure the subject understand the instructions. Measures of performance on the TOVA include:

1. Errors of Omission, failure to respond to the designated target, are interpreted as a measure of inattention.
2. Errors of Commission, inappropriate response to the non-target stimulus, are interpreted as a measure of impulsivity or failure of inhibition.
3. Mean Correct Response Time, the average latency of correct response, is interpreted as a measure of processing and response time.
4. Standard Deviation Reaction Time, computed as the square root of the average squared deviations from the mean, is a measure of variability or consistency.
5. ADHD score, represent an average score test result.

Results on TOVA subcategories are presented as T Score. A score of over 85 is considered normal. The TOVA also

compute an average score test result, called ADHD Score. An ADHD score of –1.80 or more positive is considered normal.

*Intervention*

As participants in the study, all patients agreed to refrain from seeking other types of care, unless medically necessary, during the duration of the study. They also agreed not to make any changes to their lifestyle routine (exercise, nutrition, …) during the study.

All patients were seen twice a week for two months, and cared for with Network Spinal Analysis level 1. At each visit the patient was entrained as deemed necessary by the chiropractor using NSA Phasing system. All patients claimed they respected those guidelines. During the study, one patient seeked emergency medical care for a wrist sprain due to a fall. She was given a wrist splint and took anti-inflammatory medications for three days.

A first re-evaluation was done at one month (8 visits) to evaluate neurospinal progress to care. No reassessment of attention was performed at this first re-evaluation. After 2 months of care (16 visits), all patient were again re-evaluated. A TOVA was repeated at the second re-evaluation to assess for possible changes in attentional capabilities. For each patient, the pre- and post- TOVA were done at the same time of the day (in the morning)

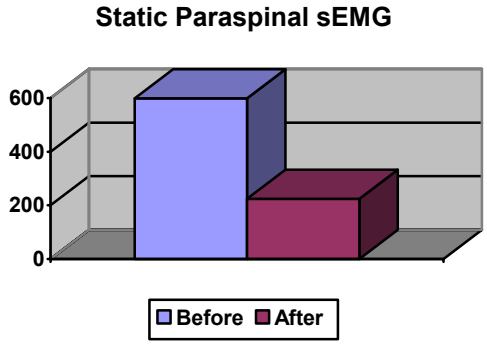
During the first two months of care, all patients experienced full development of the respiratory wave. This phenomenon, unique to NSA care, is observed as a deep, ample breath starting from the pelvis and travelling to the occipital areas. It is considered to be the expression of the breath entraining to spinal motion, and is associated with a reduction in spinal tension parameters and improved quality of life [17].

**Results**

*Static paraspinal surface electromyography (sEMG)*

Average sEMG for the nine patients before care was 599. Average sEMG score for the nine patients was 224 after care. All patients experienced reduction in the sEMG pattern of activation. Statistical analysis of individual change using non-parametric test (Mann-Whitney test) demonstrated that this change was significant (p=0.08). Before and After sEMG Changes are shown in Table 6.

**Table 6**




*Test of Variable of Attention*

As outcome measures of attention, we used five elements from the Test of Variables of Attention: ADHD score; omission errors; commission errors; reaction time; and variability.

*ADHD Score / Overall TOVA*

Using the ADHD score, which represents an overall measure of performance on the TOVA, all patients demonstrated significant impairment in attention on the visual portion of the TOVA. Average ADHD score for the nine patients before care was – 3.74 (range – 8.54 to – 1.89), well below normal (normal = -1.80 or more positive). All patients had at least two significant changes out of the five possible. The average number of change was 3.33 out of five (range 2 – 4). The ADHD score represented the most changes since 9 out of nine patients (100%) had a significant change. It was followed by reaction time (7 out of nine patients; 77%) and variability (6 out of nine patients; 66%).

All patients experienced significant change in ADHD score. All patients tested but one (patient 4) normalized their ADHD score after two months of care. After two month of chiropractic care, the average ADHD Score was +0.213. It is of interest that the patient who did not normalize her ADHD score (patient) was then referred to her medical doctor for complementary lab work and was subsequently diagnosed as suffering from severe hypothyroid disease.

According to TOVA interpretation, a change in ADHD Score is considered clinically significant if it reaches 0.5. The average change from – 3.74 to + 0.213 therefore represents a strong clinically significant change. Statistical analysis revealed the change to be significant (p=0.008). Individual pre and post result in ADHD Score are shown in table 7.

*Errors of omission*

Four patients had abnormal omission score before care. Four out of nine patients (44%) had a significant improvement in omission; but only one of the patients with abnormal omission experienced improvement. Statistical analysis demonstrated that change was not significant (p=0.173)

*Errors of commission*

Three patients had abnormal commission score before care. Four out of nine patients (44%) had a significant improvement in commission score; the three patients with an abnormal score normalized after two month of care. Statistical analysis demonstrated that the change was not significant. (p=0.86)

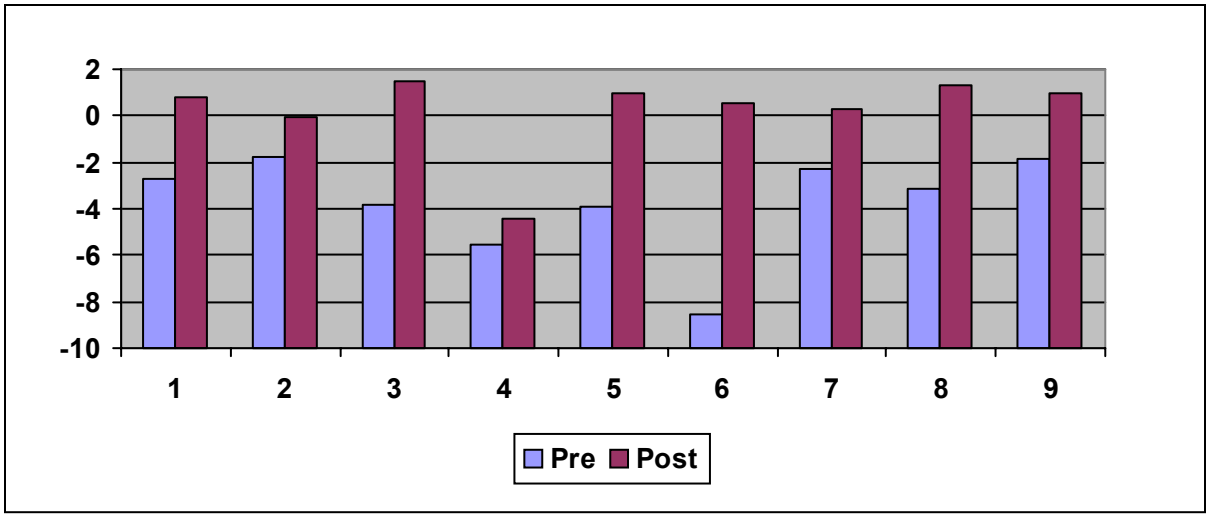
*Reaction time*

Two patients had abnormal reaction time before care. Seven out of nine patients (77%) had a significant improvement in reaction time; the two patients with abnormal reaction time normalized. Statistical analysis demonstrated that the change was significant (p=0.008)

*Variability*

Five patients had abnormal variability before care. Six patients out of nine (66%) had a significant improvement in variability; out of the five patients with abnormal variability, three normalized, one was significantly improved and the last one demonstrated no significant change. Statistical analysis demonstrated that the change was significant (p=0.035). Individual pre and post result in omission, commission, reaction time and variability are shown in table 8.

**Table 7 Individual Pre and Post ADHD Scores**




We were interested in knowing whether there were any correlation between the Pre sEMG score and the five variables on the Pre TOVA, as well as post sEMG score and the five variables of the Post TOVA. Statistical analysis of correlation was realized using Spearman's rho. No significant correlations were found between the various variables. We did not perform this analysis using other variables of neurospinal integrity (such as palpation of the active and passive subsystem) or neurological deficits from the neurological functional evaluation.

**Discussion**

*Neuroanatomy of Attention*

Recent advances in the neurosciences have suggested that there exist multiple attentional networks in the brain, each of which subserves a different type of attention [18]. Therefore, attention is neither the property of a single brain area nor is it a collective function of the brain working as a whole [7].

One of the most accepted and supported models of attention is the one proposed by Posner and Petersen [19]. In that model, it is proposed that the sources of attention form a specific system of anatomical areas which can be subdivided into three networks that carry out the function of *alerting*, *orienting* and *executive control* [6].

Alerting involves a change in the internal state to become ready. It is an important source of attention in the sense that maintaining an adequate level of alertness is critical for optimal performance.

Orienting involves selectively focusing on one or a few items out of many candidate inputs.

Executive control of attention is related to monitoring and resolving conflicts in the presence of competing information.

It is often required in higher cognitive operations including planning and decision-making. Neuroimaging and neuropathological studies have suggested that those three functions are carried out by specific brain regions. Those are shown in table 9.

In addition to those brain regions, recent evidence accumulated from the neuroimaging study of ADHD and other neuropsychiatric suggest that the cerebellum, most especially the vermal region of the cerebellum is involved in the neural circuitry of attention. In one study, Gottwald and colleagues demonstrated that patients with focal cerebellar lesions had clear impairment in attention and working memory, especially divided attention, ie in the executive control of attention [22]. Townsend and colleagues suggested that the cerebellum plays a role in attentional network, serving as an antecedent structure providing relatively unspecific effects on different components. In that view, the frontal cortex could only perform its attentional tasks in an optimal way if inputs from the cerebellum are unimpaired. Therefore, the cerebellum provides a mechanism predicting internal conditions necessary for a particular motor or mental operation, and then setting the corresponding conditions.[23] In their paper, Townsend and colleagues write:

"The cerebellum prepares internal conditions […] by repositioning sensory receptors; by altering cerebral blood flow levels; by enhancing neural signal to noise; by enhancing neural responsiveness in hippocampus, thalamus and superior colliculus; by modulating motor control systems." [23]

The role of the cerebellum is discussed further below under possible mechanisms of action of chiropractic care.

*Possible Mechanisms of Action: Stress Hormones*

Stress has been implicated clinically in the pathogenesis of mental illness. The medial prefrontal cortex has an important role in mediating responses to stressful situations. It does so by modulating the hypothalamic-pituitary-adrenal (HPA) axis [24]. Animal studies have demonstrated that stress impacts the brain by altering the morphology of prefrontal cortical dendrites [25]. One study demonstrated that those morphological changes predicted impaired attentional set-shift [26]. Research has also shown that those changes are potentially reversible.

One interesting finding by Sullivan and Gratton is that unilateral lesions of the right medial prefrontal cortex abolished the stress-induced secretion of glucocorticoids. Animals with those lesions failed to interpret sensory inputs related to stress and failed to integrate this with neuroendocrine responses [27]. This sounds very similar to a reduction in bodily sensations awareness. Network Spinal Analyis has for a long time hypothesized that patients under stress tended to suffer from reduced body awareness (also called alexysomia). One objective of NSA care is to increase body awareness of the patient. We may hypothesize that the reduced attentional ability seen in our patient is not only directed toward the external environment, but also toward the internal environment. By improving attention, NSA care may well also improve the patient's ability to pay attention to his or her internal milieu.

In one study of healthy aging adults, it was demonstrated that relaxation response training improved attention on a simple attention task [28]. The relaxation response is a mind-body intervention that counteracts the harmful effects of stress. One pilot study of NSA care suggested a decrease in electrodermal activity, a measure of sympathetic activation. It was suggested that NSA care had a "sympathetic quieting effect" [29].

**Table 8. Pre and post T scores in omission, commission, reaction time and variability**

| Subject | Omission | | Commission | | Reaction time | | Variabilty | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| 1 | 85 | **100** | 96 | 101 | 102 | **117** | 82 | **100** |
| 2 | 108 | 108 | 100 | 98 | 103 | 110 | 72 | **98** |
| 3 | 103 | 108 | 82 | **100** | 87 | **121** | 85 | **106** |
| 4 | <40 | <40 | 108 | 105 | 86 | 93 | 47 | **59** |
| 5 | 78 | *61* | 77 | **119** | 96 | **117** | 46 | **100** |
| 6 | 76 | 76 | 52 | **113** | 66 | **109** | <40 | **104** |
| 7 | 77 | **108** | 94 | 100 | 97 | **110** | 93 | 87 |
| 8 | 97 | **107** | 114 | *100* | 71 | **111** | 74 | 68 |
| 9 | 83 | **108** | 95 | **118** | 96 | **110** | 93 | 93 |

**Black** = significant positive change ; *italic* = significant negative change

This study, with many anecdotal reports from patients experiencing NSA care, may suggest that NSA triggers physiological changes similar to the relaxation response. One mechanism for improved attention may therefore be that NSA care triggers a relaxation response within patients, allowing for attenuation of negative effects of stress and potential reversal of dendritic spine losses in prefrontal cortical areas, with concomitant improvement in attention.

**Table 9 : Neuroanatomy of attention (compiled from Wang [6], Fan [20] and Perry [21])**

| Function | Attention subcategory | Possible neural substrates |
|---|---|---|
| *Alerting* | sustained attention | Frontal and parietal regions, especially of the right hemisphere |
| *Orienting* | selective attention | Superior and inferion parietal lobe, frontal eye field, superior colliculus, and thalamus (pulvinar and reticular nuclei) |
| Executive control | divided attention | Midline frontal areas (anterior cingulated gyrus) and dosrsolateral prefrontal cortex |

*Possible Mechanisms of Action: Activation of Spino-Cerebellar Pathways*

A growing number of studies suggest that attention deficit/ hyperactivity disorder (ADHD) is a disorder involving deficit in central executive functions [30]. The relationship between the cerebellum, the basal ganglia and the prefrontal regions with regards to higher cognitive functions has also been recently studied [31]. Growing evidence suggests that AHDH [32] and other neuropsychiatric disorders such as schizophrenia [33] involve a

dysfunction of a cerebello-thalamo-prefrontal neural loop. Studies have suggested that the cerebellum is not only affected in its function, but also in its size. For example, Berquin, using a morphometric MRI study, demonstrated that right-handed ADHD boys had a 8.5% reduction in volume of the vermis, the central aspect of the cerebellum [32]. Connections between the cerebellum with prefrontal associative areas has lead some researchers to suggests that the vermis may act as a "coprocessor" which enhance speed and efficiency in attention and executive functions [34]. In fact, at least one fMRI study has demonstrated increased blood flow in the vermis during a shift-attention task [35]. Moreover, it has been shown that patients with cerebellar lesions have shifting attention deficits [36].

It is notable to realize that the vermal region of the cerebellum is part of what is called the *spinocerebellum*. This structure receives its main afferent information from the head and proximal and midline structures of the body, especially the spine and postural musculature [37].

The concept of diaschisis may bring some light to the relationship between cerebellar dysfunction and prefrontal dysfunction. Diaschisis is defined as a functional depression of brain function at a structurally intact site remote from, but functionally related to, an area of brain lesion. Diaschisis is a well-recognized phenomenon in strokes. For example, crossed cerebellar diaschisis (CCD) is a matched depression of blood flow and metabolism in the cerebellar hemisphere contralateral to a focal, supratentorial lesion and is a well-recognized phenomenon following cerebral infarction. The most likely mechanism underlying CCD is the interruption of the corticopontocerebellar connections by the infarct causing deafferentation and transneural metabolic depression of the contralateral cerebellar hemisphere [38].

We propose that prefrontal dysfunction leading to altered attentional capabilities seen in our patients is related to a diaschetic mechanism involving the cerebellum, and more specifically the vermal region of the cerebellum. However, in those cases, the cerebellar dysfunction is not due to a "hard" lesion, but is itself a diaschetic consequence of dys-afferentiation from spinal structures. The latter being most likely due to vertebral subluxations or other postural imbalances, combined with other causes from improper lifestyle.

Based on the previous considerations, it may possible that the entrainment of respiration to spinal motion (called the Respiratory wave) mobilizes the entire spinal system; thereby provide a tremendous amount of activation of joint mechanoreceptors and muscle spindle. This then results in activation of spinocerebellar tracts to the vermis of the cerebellum. Such increase in afferentiation provides increased activation of neural pathways, which is known to stabilize unstable neurons.

Increased neuronal stability of the vermis may then be translated, as hypothethized by Townsend [23] (see above), in better function of prefrontal areas. Proprioceptive stimulation is known to impact brain function. For example, Muller demonstrated that pathologic cognitive processes caused by traumatic brain injury could be improved by proprioceptive stimulation [39]. Using cortical physiological mapping, Carrick demonstrated that chiropractic adjustment increased cortical activity on the side contralateral to the adjustment [40].

*Possible Mechanisms of Action: Synchronization of Thalamocortical Oscillations and Temporal Binding*

A specific feature of brain function is the presence of brain waves. Those waves oscillate at various frequencies, depending on the functional state of the brain. Oscillatory activity is an emerging property of the thalamocortical system [41].

In the waking state, the brain oscillates at fast rate, called gamma oscillations. Interestingly, research has shown that gamma activity is associated with attentiveness [42,43] and focused arousal [44]. It has also been proposed that synchronization in the gamma frequency range is related to cognitive processing and important for temporal binding of sensory stimuli [45].

Thalamocortical neurons (TC) possess a large set of intrinsic currents that enable them to contribute to the various oscillatory activities and/ or to mediate some of them. They display fast oscillations (around 40Hz, generally between 30-80Hz) [46]. Those fast oscillations are due to their intrinsic properties, as well as synaptic inputs. Those inputs arise mainly from ascending sensory pathways (medial lemniscus, optic tract, brachius of the inferior colliculus and brachum conjectivum) and from brainstem modulatory system; as well, they are also influenced by corticothalamic integration [41].

Of more interest for the chiropractor is that the oscillatory nature of TC neurons is also dependent on prethalamic relay stations such as the deep cerebellar nuclei, and that it has been shown that lesions of the brachium conjectivum changes the oscillatory frequency of TC neurons [46]. Of importance is the fact that Pinault demonstrated that, although oscillatory frequencies persisted after transection of, for example, the capsule, they could no more be recorded after lesions of the dorsal columns [47], leading the author to conclude that TC neurons oscillations represented mainly excitatory potentials of prethalamic origin.

Based on similar mechanisms as proposed in the previous section, we suggest that proper activation of dorsal column circuitry is essential for optimal excitation of TC neurons. Afferentiation from pre-thalamic structures, combined with the intrinsic nature of TC neurons, serve as the basis for the existence of fast (gamma) oscillation. Those gamma oscillations are necessary for proper temporal binding of sensory information, optimal cognitive processing, focused arousal and attentiveness.

On the other hand, improper afferentiation of TC neurons via dorsal colums due to vertebral subluxations or other types of postural imbalances, may result in altered oscillatory frequencies of the TC network. Combined with other environmental factors, this can result in altered neuronal functions subserving attention and other cognitive processes, especially of the right hemisphere. This leads to a potential functional dysconnection syndrome [48].

The Respiratory wave that patients develop under NSA care may serve as a self-generated, rhythmic mechanism that stabilize and restore proper TC neurons oscillations, via direct activation of dorsal column pathways and indirect activation of deep cerebellar nuclei. Improper integration of TC oscillatory loops has been termed thalamocortical dysrhythmia syndrome and has been suggested as a prominent feature of certain neuropsychiatric disorders, including ADHD [49,50]. The interested reader is directed to the excellent textbook "*Neurobehavioral disorders of childhood*" [51] by Melillo and Leisman for a more complete review of those concepts. Other alternative explanations cannot be disregarded.

**Limitations of the Study**

The observational nature of this case series precludes us from definitive conclusions and from drawing conclusions as to cause and effects relationship. Small sample size and lack of blinding are notable limitations of this report. Since we had no control group, nor randomisation process, we cannot exclude that alternative variables may explain our results. However, it has been shown that TOVA testing does not result in learning effect; in fact, quite the contrary is true. Therefore, we can already exclude testing learning effect as a variable in the observed improvement.

**Conclusion**

In this study, about 18% of patients seeking chiropractic care had attention deficit as identified by a continuous performance test. This number is definitely higher that the expected percentage of adults suffering from attention deficit in the general population (1-6%). This bias could be explained by the fact that our clinic is known to take care of individuals suffering from those types of disorders.

Our sample was small and statistical analysis failed to demonstrate any correlation between neurospinal integrity, as measured by surface electromyography, and improvement in the various parameters of attention. Further studies will need to include greater sample size and expand the conceptualization of neurospinal integrity to other parameters such as static palpation, motion palpation and other diagnostic instruments (not just sEMG), as well as neurological deficits evidenced by functional neurological evaluation to determine if any correlations do exist.

Within the limitations of the study, the clinical progress experienced by the patients suggest that two months of care with Network Spinal Analysis may positively affect the brain of adults by creating plastic changes in the prefrontal cortex and other cortical and subcortical areas serving as neural substrate for the cognitive process of attention. The observations documented in this case series provide preliminary evidence that NSA care may improve, and even normalize, attentional abilities of some adult individuals. These findings may be of importance for individuals suffering from attention deficit. Further research into this exciting area is greatly needed in the form of well designed clinical trials.

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CASE STUDY

# Quality of Life Improvements and Spontaneous Lifestyle Changes in a Patient Undergoing Subluxation-Centered Chiropractic Care: A Case Study

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**ABSTRACT**

**Purpose of study:** This case study is to report the improvement in quality of life experienced by a patient undergoing subluxation-centered chiropractic care.

**Clinical features:** A 36 year old male presented with primary health concerns of stress, eye pain and left leg pain of 14 years duration radiating to the foot and secondary complaints of gastritis, ulcers, nervousness, depression, lack of concentration and general loss of interest in daily life. The patient also smokes, does not exercise, eats a sub-optimal diet and rated his family and friends support, as well as job satisfaction as sufficient.

**Intervention and Outcomes:** We discuss the various analyses employed to evaluate vertebral subluxations, including paraspinal surface electromyography and thermography. Adjustive care included a combination of Network Spinal Analysis, Torque Release Technique and diversified structural adjustments to correct vertebral subluxations over a six month period. We used visual analog scales, open-ended questions and selected items from the Self-Rated Health and Wellness Instrument to monitor health changes, as well as the positive improvements in quality of life as perceived by the patient himself.

**Conclusion:** This case study demonstrates that the correction of vertebral subluxations over an 11 month period was associated with significant improvements in the quality of life of the patient.

**Key words:** *chiropractic care, vertebral subluxation, quality of-life, wellness, Network Spinal Analysis (NSA), Torque Release Technique (TRT)*

## Introduction

The purpose of chiropractic is to optimize the health of the person who seeks our care. This professional objective is primarily realized through the correction of vertebral subluxation.[1]

The notion that the correction of vertebral subluxation is associated with improvements in quality of life has been anecdotely reported by chiropractors for a long time, but has remained ignored in the scientific literature. Only recently has this idea been tested and published.[2,8,9] Other studies are presently underway to further test the hypothesis that long-term correction of vertebral subluxation results in improvements of health and well-being.[3, 4, 5, 10]

Intrinsic in the chiropractic paradigm of health is the notion that the correction of nerve interference and restoration of neural integrity is an essential component of health maintenance and enhancement.[1]

In recent years, it has become evident that the professional objective of health optimization involves a different paradigm than that of disease diagnosis and treatment. The chiropractic profession has recognized the need to not only document the effect of subluxation-centered chiropractic care on health and wellness, but also the need to develop new outcome measures which are better fitted to assess the health changes experienced by patients undergoing non-medical healing interventions.[10]

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The Self-Rated Health and Wellness Instrument is such an instrument that seems to have the potential to assess the impact of care on health and wellness [2].

Although the correction of nerve interference has been hypothesized by chiropractors to be an important component in the enhancement of health and wellness, it is obviously not the only factor. Recent research has shown that health and well-being are multifaceted and include such concepts as psychological factors (empathy, self-esteem, personal control, …), social factors (family and friends support), spiritual factors (sense of coherence).[6] This is expressed in the World Health Organization definition of health as being a "state of optimal physical, mental and social well-being, and not merely the absence of disease or infirmity."[11] Although many researchers have brought some light on the issue of what health is, no authoratative definition of this concept has been achieved at this time.

It can consequently be affirmed with a high degree of certainty that the correction of vertebral subluxation is not, in and of itself, a sufficient intervention to allow a person to achieve "total health." One very interesting hypothesis, however, is that patients under chiropractic care tend, as their subluxations reduce, to spontaneously take up lifestyle changes or health-enhancing activities. It has been said in traditional chiropractic philosophy that a healthy person makes healthier choices. The hypothesis that subluxation correction chiropractic care may promote positive lifestyle choices has been suggested by many practitioners but has only recently been documented more objectively.[2,10] Based on anecdotal clinical evidence, our personal experience tends to corroborate this hypothesis.

This case report documents the self-rated quality of life improvements experienced, and spontaneous lifestyle changes undertaken, by a 36 year old male undergoing subluxation-centered chiropractic care in an office setting, over an 11 month period. We discuss the various outcome measures used to monitor health and well-being, as well as the progress made by the patient throughout his care.

**Interventions**

Analysis and adjustive procedures utilized in the management of this case were based mainly on four different chiropractic systems: Network Spinal Analysis, Torque Release Technique, Thompson Technique and Diversified structural adjusting. Elements of the various systems were selected as deemed appropriate by the author at various times in the evaluation and management of the case. Although no attempts were made to follow the specific protocol taught by any of the systems employed, the patient was managed from a tonal model of chiropractic.[12] Tonal models tend to see the spine and nerve system as a functional, dynamic unit. Particular attention is placed on vertebral motor segments receiving dural attachment which, when subluxated, are hypothesized to place the central nervous system under abnormal mechanical tension. The latter is thought to alter the tone of the nervous system and, consequently, its integrity.

Network Spinal Analysis (NSA), developed by Donald Epstein, D.C., was originally a system of classifying, prioritizing, and adjusting vertebral subluxations.[7] In recent years, NSA has evolved into an approach to wellness that applies low force touch contacts to cue the nervous system to develop new strategies for living and healing. An other objective of NSA care is to trigger two "healing" waves which, when they develop, help improve spinal and neural integrity, adaptability and significantly advance wellness and quality of life.[13] Once the type of subluxation has been identified, a priority system of adjusting is initiated. This sequencing of adjustments is termed the Phasing system. Care is advanced through a series of Levels. Level 1 was used in the management of our patient.

Torque Release Technique (TRT), developed by Jay Holder, D.C, is a model and technique that was developed out of human population research involving subluxation-centered chiropractic in a residential addiction treatment facility [14]. TRT uses various indicators of vertebral subluxations and also prioritizes their correction into a system called Non/Linear Testing Priorities. The correction of vertebral subluxation is made through the use of an adjusting device, called Integrator. The Integrator possesses a pre-cocking, pressure sensitive tip with an automatic release mechanism. Its features also include a torque and recoil component.[15]

Thompson technique, developed by Clay Thompson, D.C., is both a system of analysis and adjustive procedures. The analysis relies heavily on prone leg length analysis and the correction is often performed on a special table made of segmental drop pieces that facilitates the adjustment.[16]

Diversified structural adjustive procedures include a variety of high velocity, low amplitude chiropractic maneuvers designed to bring an articulation past its physiological barrier and into its paraphysiological space.

**Case Study**

*History*

A 36 years old male Peruvian presented with health concerns of stress, headaches, eye pain and 14 years left leg pain radiating to the foot with subjective loss of strength and sensation. Secondary health concerns included gastritis, ulcers, nervousness, depression, lack of concentration and general loss of interest in daily life. Patient had sought medical care, which helped manage the pain of gastrointestinal complaints. There was still however residual abdominal discomfort, gas, and bloating. He reported that the aforementioned symptoms were interfering with his work, family and social life.

The patient also had a history of alcoholism with several bouts of severe binge drinking which resulted in falls. During his binge drinking, he was also involved in several fistfights. The patient also mentions having been struck by a car 9 years earlier, with no further details. There is no history of hospitalization or surgery. Medications have been used in the past for gastrointestinal complaints. Presently, the patient self-medicates with unspecified over-the-counter pain killers on a regular basis. The patient has been smoking half a pack of cigarettes per week for the last 15 years. There is no physical activity (regular exercise) reported. Diet is sub-optimal with daily consumption of coffee, sugar-loaded sodas, fried food and dairy products. The patient is at the present time not using

any health-enhancing modalities (e.g. yoga, spiritual practice, healthy food choices). On a 4-points scale (poor, sufficient, good, excellent), family and friends support, as well as job satisfaction are reported as sufficient. Physical and mental health are perceived as poor.

*Examination*

On postural analysis the patient presents a slight left occipital tilt, right low shoulder and hip. Cervical rotation is slightly decreased bilaterally. Static muscle palpation reveals significant tightness of the suboccipital muscles, left trapezius and lumbar paravertebral musculature. A ½ cm left functional short leg was present in the prone, leg extended position which is indicative of either a neuromuscular contraction of the extensor muscles of the lower spine and pelvis or pelvic malposition.

With the patient prone and legs in the extended position, head rotation to the left resulted in lengthening of the short leg, a finding called Left Cervical Syndrome in Thompson analysis.[16] This phenomenon is indicative of a cervical vertebral subluxation. It is thought to be due to activation of the bulbo-reticular inhibitory area upon head rotation which results in a relaxation of the lower spine and pelvic girdle musculature. Upon bringing the extended legs into a flexed position, the short leg lengthens, a phenomenon referred to as Positive Left Derefield in Thompson. This corresponds to an ilium in which the posterior superior iliac spine has moved posteriorly and inferiorly (PI ilium).

Motion palpation reveals restriction of the left sacroiliac articulation, upper cervical complex (C1-C2 principally) as well as several fixations of the thoracic spine. Torque release analysis revealed positive pressure test for left lateral coccyx and right lateral atlas. A pressure test is considered positive when a short leg momentarily lengthens after a suspected subluxated vertebral segment is challenged (pushed) with a specific vector line.[18]

Network Spinal Analysis revealed heel tension of 4/5, defined as an increased in the resistance to ankle dorsiflexion. This phenomenon is thought to be associated with the presence of adverse mechanical cord tension. There is also bilateral adduction stress. Adduction stress is revealed by an increase resistance to hip adduction and is considered indicative of a second or third cervical motor segment involvement. The latter is also confirmed by the presence of a z-flick , which is a brief inferior-superior oscillatory motion of the legs upon bilateral head rotation.[19]

Complementary exams included lateral and AP lumbar, and AP, AP Open Mouth and lateral cervical x-rays, as well as paraspinal surface electromyography and thermal scans (using Insight 7000 Subluxation Station). Surface EMG is a scanning procedure employing hand-held electrodes which are placed over the skin of muscle tissue. It is used to collect and record electrical potential associated with muscle activity. The muscular activity of various spinal segments are then analyzed by a software program and compared to a normative database. The program then provides a read-out consisting of standard deviations form the normative data. The program also offers a comparative analysis of left and right side of the spine, which reveal muscular imbalances. Surface EMG, as recorded with the Insight 7000, has been shown to be an objective measure of change in the assessment of the patient's progress.[17]

Thermal scan analysis is a measurement of infrared heat emission from the skin. In normal individuals, paraspinal thermal scan should be symmetrical from side-to-side. Thermal asymmetries indicate abnormal autonomic regulation associated with vertebral subluxation. Heat emission is also recorded, compared to a database and, as for the surface EMG, displayed graphically in the form of different colored bars representing standard deviations from the normative data.

Cervical x-rays reveal moderate loss of the cervical curve with no significant degenerative changes. Lumbar views are unremarkable.

Surface electromyography reveals overall moderate dysponesis. Dysponesis is a reversible pathophysiological state consisting of misdirected neurophysiologic reactions, consisting mainly of covert errors in action potential output from the motor and premotor areas.[20] Those are expressed by a specific pattern of paravertebral muscle facilitation. Thermal scans revealed severe dysautonomia in the form of sympathetic hyperactivity.

*Chiropractic Care*

Based on the examination findings, it was determined that the patient was suffering from vertebral subluxation of C1-C2, left SI and adverse mechanical cord tension (with point of critical tension at C2 and lateral coccyx). Compensatory restrictions are present in the mid-thoracic spine. The patient was placed on an initial care plan with an adjusting schedule of 3 times per week for 2 months, twice per week for 2 months and once a week for 2 months.

Adjustive care consisted, in various sequence and timing, of Network Spinal Analysis low force touch contacts, Torque Release Technique Integrator instrument, pelvic drop piece adjusting and Diversified structural high velocity, low amplitude adjustments to the aforementioned vertebral subluxations. Thermal and sEMG scan re-evaluations were performed at 4 weeks (12 visits), 8 weeks (24 visits), 14 weeks (36 visits), 26 weeks (52 visits) and 42 weeks (56 visits). After week 26, the schedule was spaced by constantly adding one additional week to reach monthly visits. Scans are to be taken every three months to monitor the patient's neural integrity.

*Outcomes Measures and Evolution – See Appendix I*

Measure of quality improvement consisted of self-reported health changes and quality of life improvements including:

A. Subjective changes taken during re-evaluations at 12, 24, 36 and 50 visits, which consisted of:

    a. Three 10 cm Visual Analog Scale (0%-100%) asking to evaluate percentage of improvement in:
        1. Primary health concern(s)
        2. Secondary health concern(s)
        3. Overall health

b. Four open-ended questions, which asked:
    1. What changes have you experienced in your *symptoms*?
    2. What changes have you experienced in *yourself*?
    3. What else has changed *in your life* since you started chiropractic care?
    4. What activity can you do now that you could not do before?

B. On visit 24, to select and comment on, from a list of 24 items, those bodily systems, functions or life activities, in which the patient felt improvement had occurred.

C. On visit 36 and 50, retrospective survey of selected questions from the Self-Rated Health and Wellness Instrument [2] in Mental/Emotional State, Life enjoyment, Stress Evaluation and Overall Quality of Life.

D. Narrative letter submitted by the patient.

*Changes in Health Concern and Overall Health*

After the 6 months period, the patient experienced a (self-rated) 95% improvement in left leg pain, headaches and eye pain. The improvement was gradual with 30% after 12 visits, 50% after 24 visits and 60% after 36 visits (see Appendix I). It is interesting to note the "plateauing" effect of symptom changes between week 8 and 14, and then the marked amelioration to 95% after week 14.

This is possibly associated with the first awareness of a full, deep Respiratory Wave, a clinical phenomenon unique to Network Spinal Analysis that the patient experienced on week 15 of care. This phenomenon consists of a deep, harmonious full-spine "wave" of respiration that resembles a profound sigh. Epstein [7] has noted that the greatest change of vertebral subluxation indicators occurs in patients experiencing the Respiratory Wave. It has been shown that greater levels of self-reported wellness are reported by patients with an early awareness of the breath (respiratory wave).[10] It is not known however if this can be extrapolated to symptom changes as well. A similar pattern seems to be present in secondary health concerns and, to a much lesser extent, overall health.

However, the influence of external, unrecognized factors is also possible. There also seems to be a temporal correlation between improvement in health concerns and objective changes as measured by sEMG. Surface EMG pattern demonstrated no specific trend toward changes within the first 14 weeks of care. The first month of care showed decrease in global muscle facilitation (decrease of the dysponetic pattern).

The second month of care showed increase in facilitation. Whether this is due to internal factors such as internal pattern of dissipation specific to this individual (our own personal clinical anecdotal experience showed that about 20% of patients had an increase in muscle facilitation within the first month prior to a significant decrease) or to external factors such as increase in overall stress, is not known. The overall pattern decreases again in the third month of care. Thereafter, the overall changes stabilized, with a slight further improvement. From week 14 on, we may hypothesize that the stabilization of the overall pattern on sEMG correlates to the resolution of vertebral subluxation pattern, a resolution that allowed for greater nerve system integrity and enhanced healing, which is expressed as maximal reduction of health concerns. (See Appendix II)

Re-evaluation at 42 weeks revealed a stabilization in thermal and sEMG scan and it was decided, in concert with the patient, that his wellness schedule consisted of monthly visits, unless severe physical, chemical or emotional stress occurred. The thermal scan pattern showed a different trend with a rapid decrease in dysautonomia within the first two months to a point of normalcy at 14 weeks.

Improvement in secondary health concerns include decrease in stress levels, nervousness, lack of concentration, irritability and apathy, as well normalization of digestive function. He perceived his overall health to be improved 100% at six months.

**Discussion**

The present case study warrants discussion of a certain number of points. First, chiropractic care was presented from a subluxation-centered perspective. This means that we did not purport to diagnose or treat diseases or conditions. In consequence we approached the patient from a psycho-social paradigm rather than a biomedical one. This is reflected in the history, examination and outcome measures used throughout care. This also explains why no traditional allopathic orthopedic or neurological exam were performed since, in our opinion, they do not provide information on vertebral subluxations. This approach allowed us to discover a patient whose health concerns affected him not only physically, but also in his work, family and social life, as revealed by the initial history. Extending our history to include such a more psycho-social type of questioning revealed that the patient perceived his social support system (family and friends) and job satisfaction as sufficient, and his physical and mental health as poor.

The outcome measures utilized revealed that throughout care the patient did not only improve physically, but also in his overall quality of life, with for example less family-related and work-related stress. He went from feeling "terrible" or "unhappy" with his personal life, his job, himself, and his life as a whole to being "mostly satisfied". It is important to note the significance of positive changes in mental/ emotional state since it has been suggested that this category carries the biggest weight toward the feeling of "wellness" (defined as patient self-reported health).[10]

After 6 months of care, the patient was physically pain-free, did not have to use medications, had his hearing improved, more concentration and more energy to work (which is probably also related to an increase in productivity). Also important is the self-reported improvement in his family and social life, where he notes positive changes in his character, relationship with others and outlook on life. This suggests that by undergoing chiropractic care, the patient also indirectly improved the quality of life of the people around him. The societal implications of vertebral subluxation corrections have been investigated elsewhere.[21,22]

Secondly, the reduction of vertebral subluxations was evidenced by a significant decrease in dysponetic pattern demonstrated by overall decrease in muscle activity. Such a decrease in muscle activity has already been demonstrated in other types of adjustive care.[17] In this case, the same is also true of the thermal scan pattern. Those changes are of significance because our basic assumption was that our purpose was to optimize our patient's health, through the correction of vertebral subluxations. Our hypothesis for accepting our patient under care was that his quality of life was negatively impacted by the presence of vertebral subluxations and that reduction of vertebral subluxation would result in greater quality of life.

The improvement in surface EMG and thermal scan patterns demonstrate that the pattern of vertebral subluxation was indeed successfully managed. If his quality of life had improved, but the pattern of vertebral subluxation had not reduced, we would have had to conclude that the former was a consequence of variables not related to the latter. This is not the case. Although we cannot definitely exclude the influence of other variables, the correlation between subluxation reduction and improved quality of life make a good case for a causative relationship. Various other studies have also suggested that the improvement in neural integrity is temporally associated with improvement of overall quality of life. [2, 3, 9, 10]

Thirdly, the patient made a certain number of spontaneous lifestyle changes while under chiropractic care. Such changes include spontaneous smoking cessation, listening to classical music, start of regular exercise, relaxation and breathing exercises, as well as better nutritional choices. It is important to point out that we never told the patient to undertake such changes. We only provided resources and guidance to fulfill his newly discovered interests. It could be argued that those lifestyle changes, rather than chiropractic care, were the variable responsible for improved wellness. Healthy lifestyle does in fact promote wellness but, as the Network study suggests,[10] the chiropractic intervention weighted twice as much as a healthy lifestyle in promoting a sense of wellness. That same study also suggested that Network Spinal Analysis care did not only contribute directly to self-rated health and perceived wellness, but also indirectly by promoting positive lifestyle choices.[10] Whether this is due to enhancement in neural integrity or to the overall "office experience" is not known.

**Conclusion**

We have reported on the improvements in quality of life and spontaneous lifestyle changes experienced by our patient.
We used, as outcomes, instruments that were either derived from scientifically tested and accepted outcome measures (such as the visual analog scales), variation of instrument presently under investigation (survey derived from Self-Rated Health and Wellness Instrument[2] ), as well as measures whose values have not, to the author's knowledge, been formally investigated in the scientific literature (such as the open-ended questions and narrative letter). However, as naïve as the employed outcome measures might have been, they suggest that this individual has experienced positive changes in his physical, mental, social state as well as overall quality of life.

Those changes are temporally related to the correction of vertebral subluxations (as demonstrated by sEMG and Thermal analysis). Although it is difficult to ascertain to which extent those changes are attributable to the correction of vertebral subluxations only – as other potentially unrecognized variables might also have had an influence – the previous chronicity of the health concerns strengthens the notion that the positive changes are, in fact, a consequence of chiropractic intervention. If one thing is certain, in the author's mind, is that this individual has, as a result of his encounter with chiropractic and a chiropractor, experienced remarkable changes in his quality of life and in his lifestyle. The commitment of the patient to his plan of care has been, in the author's opinion, essential to the success encountered.

Although no overall generalizations can be drawn from a single case study, we hope that this report will stimulate the writing of other cases that look at the changes in health, wellness and quality of life beyond the patients presenting complaints.

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# Appendix I

Percentage Improvement reported on Visual Analog Scale (VAS):

| Visits (weeks) | 12 (4) | 24 (8) | 36 (14) | 50 (26) |
|---|---|---|---|---|
| Primary Health Concern | 30% | 50% | 60% | 95% |
| Secondary Health Concern | 50% | 50% | 60% | 95% |
| Overall Health | 50% | 50% | 80% | 100% |

***Open-ended questions***

**What changes have you experienced in your *symptoms*?**

"No more leg pain nor headaches" [12 & 24 visits]
"I have overcome my stress, nervousness, lack of concentration, loss of interest, irritability and apathy" [36 visits]

**What changes have you experienced in *yourself*?**

"spiritual, physical and mental changes" [12 visits]
"more interest in life" [24 visits]
"general change; changes in all aspects of myself" [36 & 50 visits]

**What else has changed *in your life* since you started chiropractic care?**

"I think everything has changed" [12 visits]
"My character" [24 visits]
"My relationships with others" [36 visits]
"I look at life with more optimism" [50 visits]

**What activity can you do now that you could not do before?**

"I was doing everything wrong, now I have improved" [12 visits]
"I was doing everything halfway, now I do things better" [24 visits]
[nothing reported at 36 visits]
"Concentrate when I read" [50 visits.]

**Positive Changes in Functions at 24 visits.**

Of the 24 questions, the patient reports positive changes in the following:

| ***Body system(s) or function(s) improved*** | ***Patient's comment*** |
|---|---|
| Sleep | I am well-rested (after sleeping) |
| Stress level or ability to handle stress | Better |
| Energy Level | I can work more |
| Athletic Ability | I have more resistance |
| Skin Appearance | Better (told by people around me) |
| Digestion | It is fine now |
| Flexibility | Better |

**Retrospective self-rated survey**

1. Mental/Emotional State

Rate the following questions on a frequency scale of 1-5
1= never; 2= rarely; 3= occasionally; 4= regularly; 5= constantly

| | PRE CARE | NOW | # VISITS |
|---|---|---|---|
| 1. If pain is present, how distressed are you about it | 5 | 2 | 36 |
| 2. Presence of negative or critical feelings about yourself | 5 | 2 | 50 |
| 3. Experience of moodiness or temper or angry outbursts | 5 | 2 | 36 |
| 4. Experience of depression or lack of interest | 5 | 1 | 36 |
| 5. Being overly worried about small things | 5 | 1 | 50 |
| 6. Difficulty thinking or concentrating or indecisiveness | 5 | 2 | 50 |
| 7. Experience of vague fears or anxiety | 5 | 3 | 36 |
| 8. Being fidgety or restless; difficulty sitting still | 5 | 2 | 50 |
| 9. Difficulty falling or staying asleep | 1 | 1 | 36 |
| 10. Experience of recurring thoughts or dreams | N/a | N/a | 50 |

N/a = No answer

2. Stress Evaluation

Evaluate your stress relative to the following, with
1= none; 2=slight; 3=moderate; 4= pronounced; 5=extensive

| | PRE CARE | NOW | # VISITS |
|---|---|---|---|
| 1. Family | 4 | 2 | 36 |
| 2. Health | 4 | 1 | 36 |
| 3. Work | 4 | 2 | 36 |
| 4. General Well-being | 4 | 1 | 36 |
| 5. Coping with daily problems | 4 | 2 | 36 |

3. Life Enjoyment

Rate the following questions on a degree scale of 1-5, with
1= not at all; 2= slight; 3=moderate; 4=considerable; 5=extensive

| | PRE CARE | NOW | # VISITS |
|---|---|---|---|
| 1. Openness to guidance by your “inner voice/feelings” | N/a | N/a | 50 |
| 2. Experience of relaxation or ease or well-being | 1 | 4 | 36 |
| 3. Presence of positive feelings about yourself | 2 | 4 | 50 |
| 4. Interest in maintaining a healthy lifestyle | 3 | 5 | 36 |
| 5. Feeling of being open and aware/connected when relating to others | 1 | 3 | 36 |
| 6. Level of confidence in your ability to deal with adversity | 1 | 3 | 36 |
| 7. Level of compassion for, and acceptance of, others | N/a | N/a | 50 |
| 8. Incidence of feelings of joy and or happiness | 2 | 4 | 36 |
| 9. Level of satisfaction with your sex life | 3 | 4 | 50 |
| 10 Time devoted to things you enjoy | 2 | 4 | 50 |

4. Overall Quality of Life

Evaluate your feelings relative to the quality of your life, with
1= terrible; 2= unhappy; 3=mostly dissatisfied; 4= mixed; 5=mostly satisfied; 6=pleased; 7=delighted

| | PRE CARE | NOW | # VISITS |
|---|---|---|---|
| 1. Your personal life | 1 | 5 | 36 |
| 2. Your wife/husband (significant other) | N/a (single) | N/a | 36 |
| 3. Your job | 2 | 5 | 36 |
| 4. Your co-workers | 4 | 5 | 50 |
| 5. Your handling of problems in your life | 1 | 5 | 50 |
| 6. Your physical appearance – the way you look to others | 1 | 5 | 50 |
| 7. Your self | 2 | 5 | 36 |
| 8. The extent to which you can adjust to changes in your life | 1 | 5 | 36 |
| 9. Your life as a whole | 2 | 5 | 50 |
| 10. The extent to which your life has been what you want it to be | N/a | N/a | 50 |

**Narrative Letter**

In his narrative letter the patient relates his history of health problems and some of the improvements in his symptoms.
He also states:

"The benefits that I am experiencing today are the following:

1. I have no more pain at all
2. I have stopped taking medications
3. I spontaneously stopped to smoke (I find it unpleasant)
4. I listen to classical music (something I never did before)
5. My hearing has improved (despite the lesion I have in my right tympani)
6. I can concentrate better when I read.
7. I have more energy to work.
8. My social and family relationships have improved.

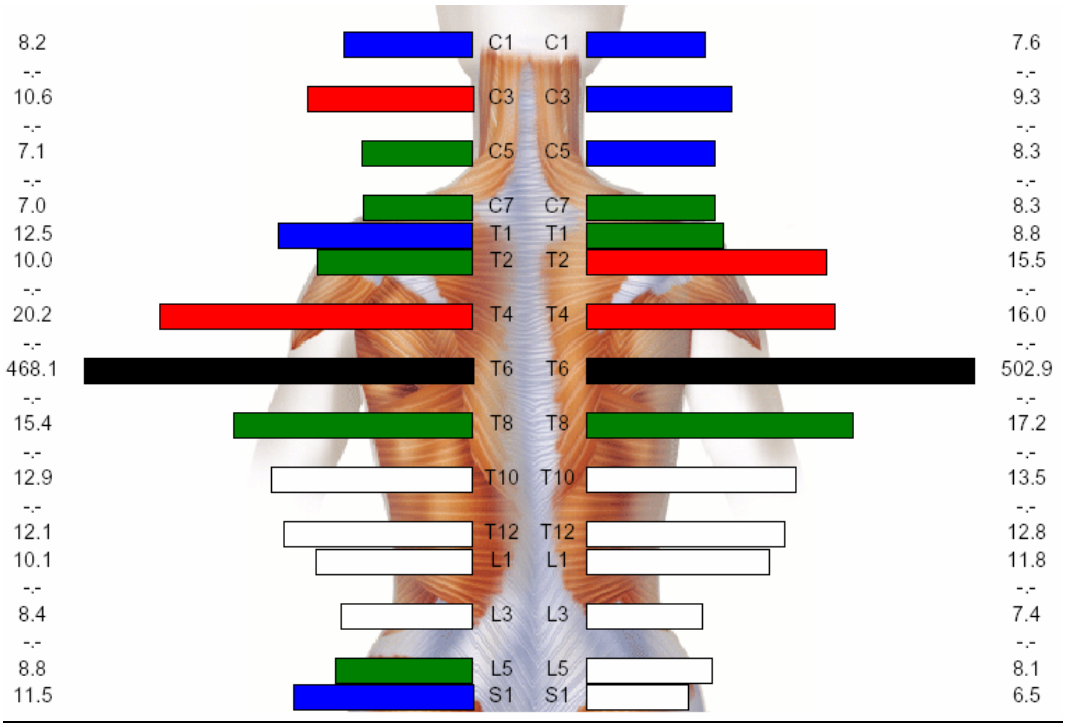
Today, I am learning to:

1. Feed myself properly
2. Practice regular exercise
3. Practice relaxation and breathing exercises.

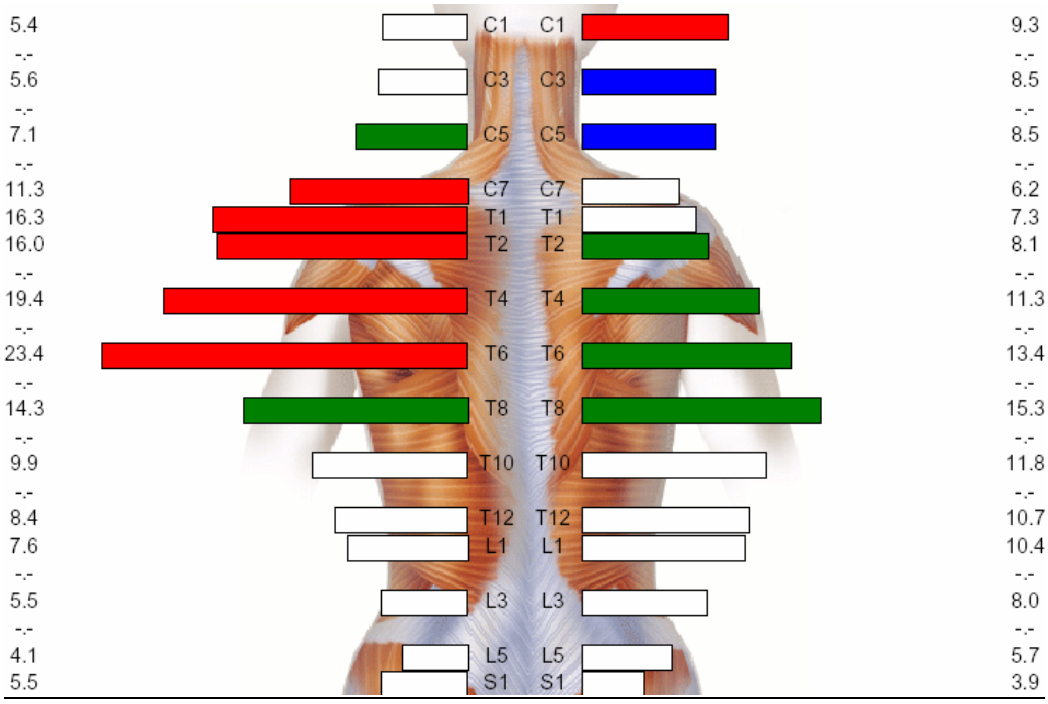
In summary, I am learning to live a different lifestyle.
I know that I have still much to learn and improve; but I am convinced that I am on the right track, success is in my own hands"

**Appendix II**

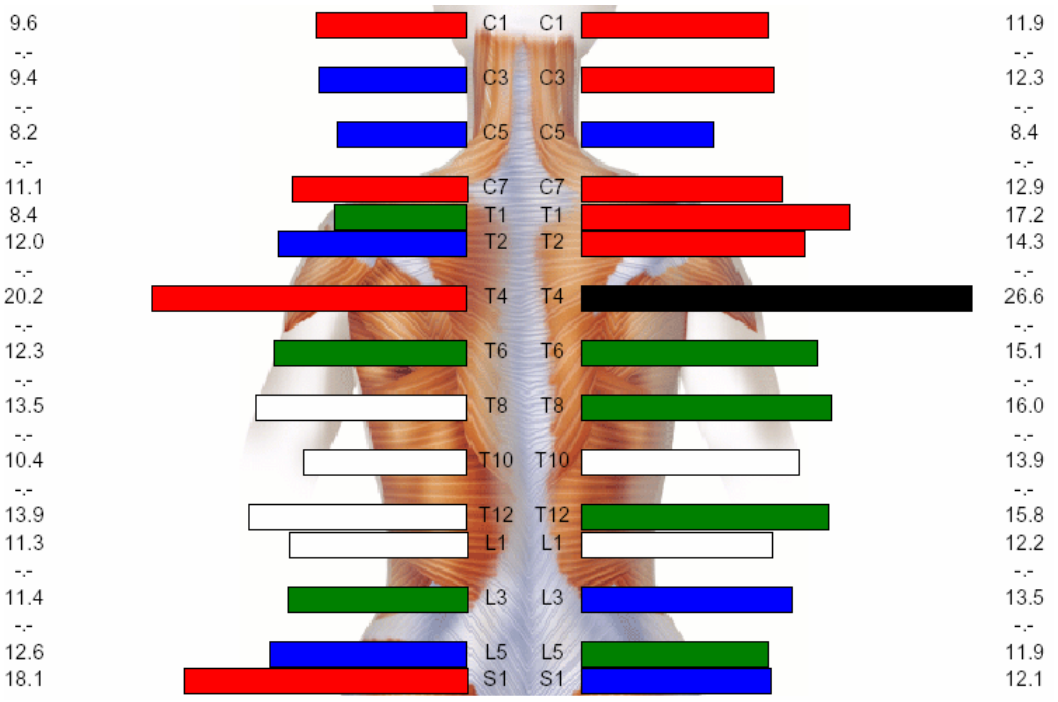
## sEMG Scan 1



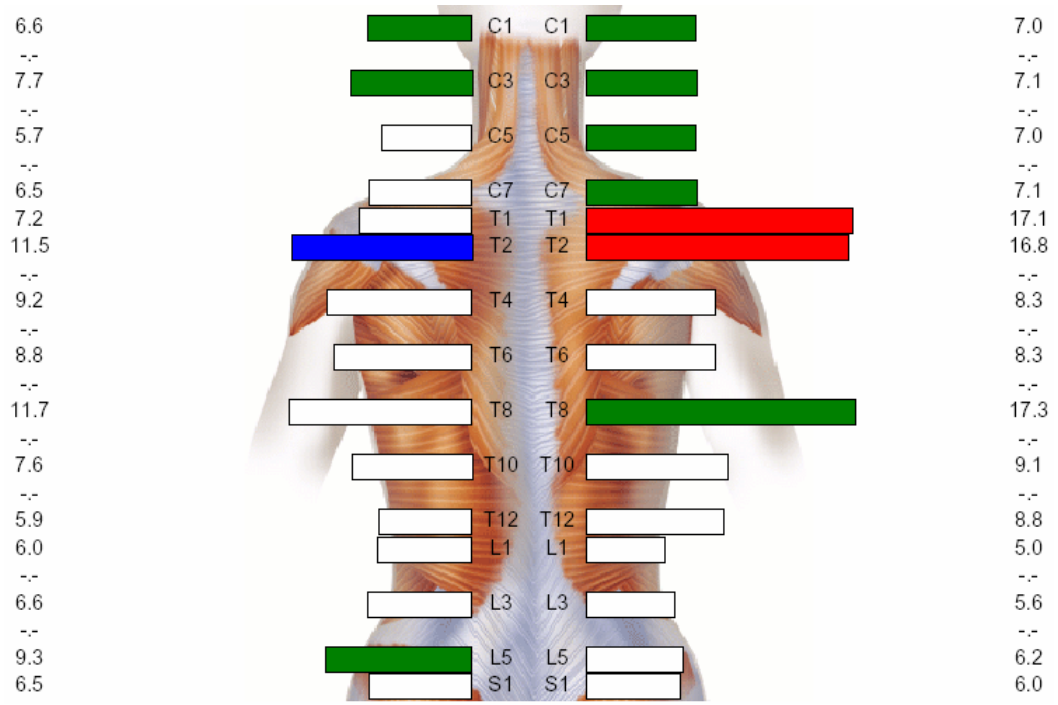

## sEMG Scan 2 – One Month Into Care



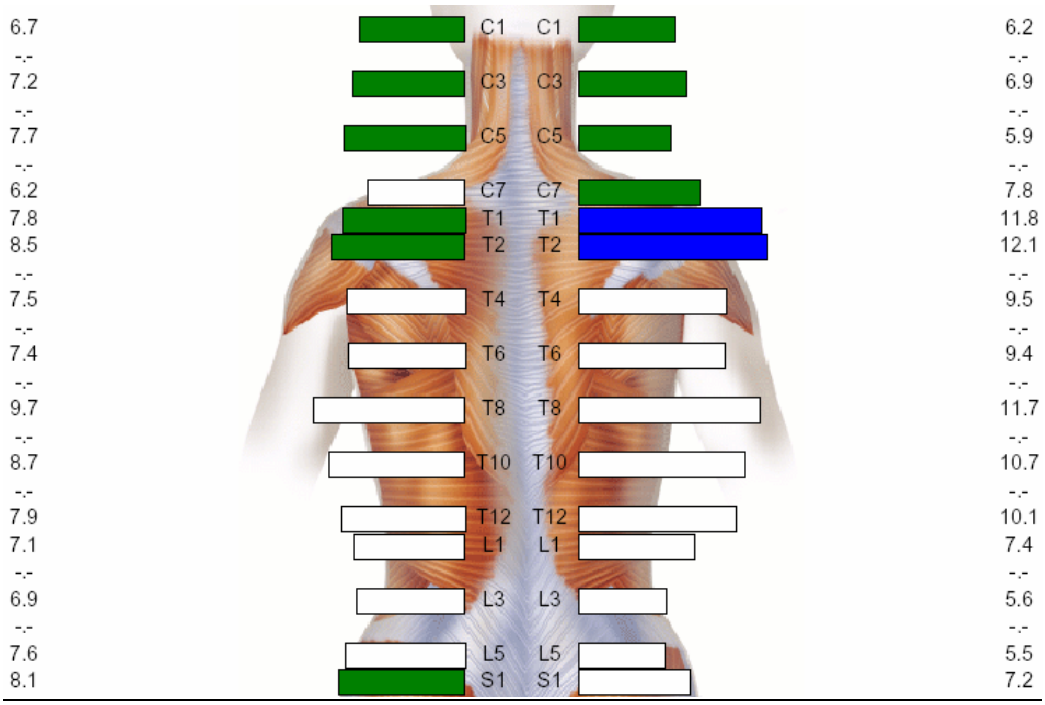
## sEMG Scan 3 – 2 Months Into Care



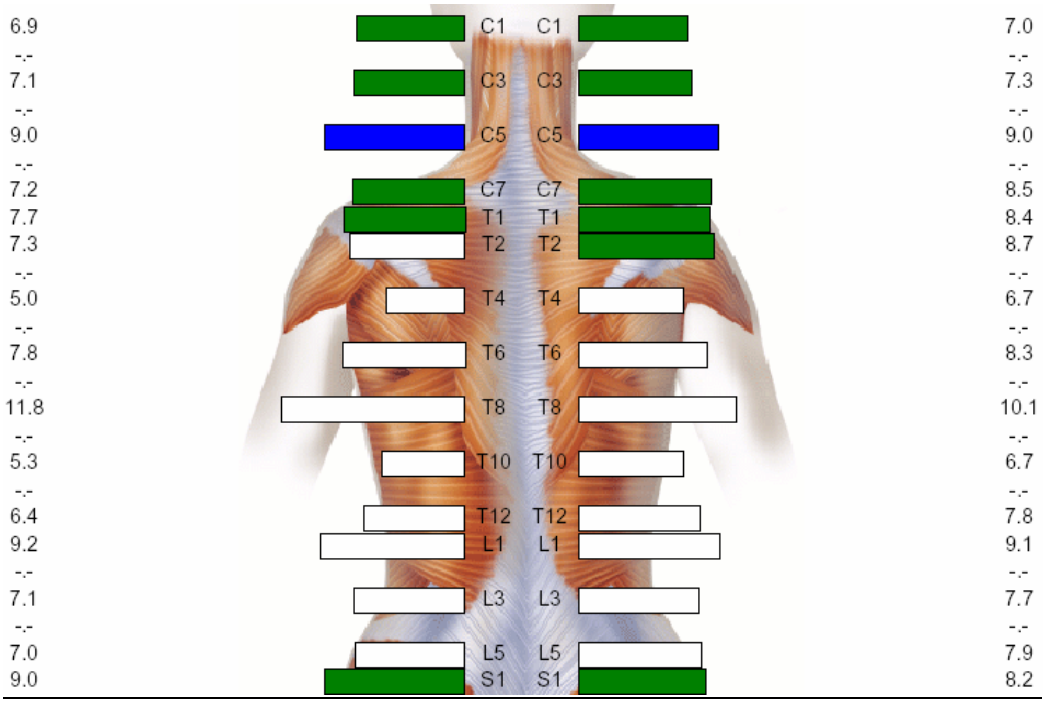

## sEMG Scan 4 – 3 Months Into Care



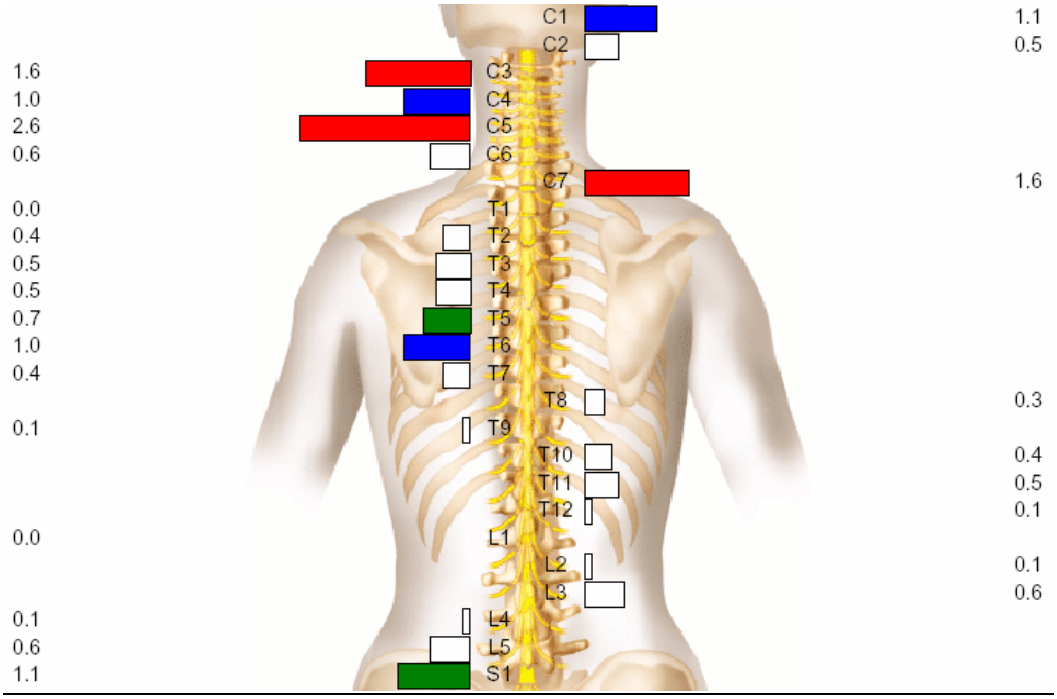
## sEMG Scan 5 – 8 Months Into Care



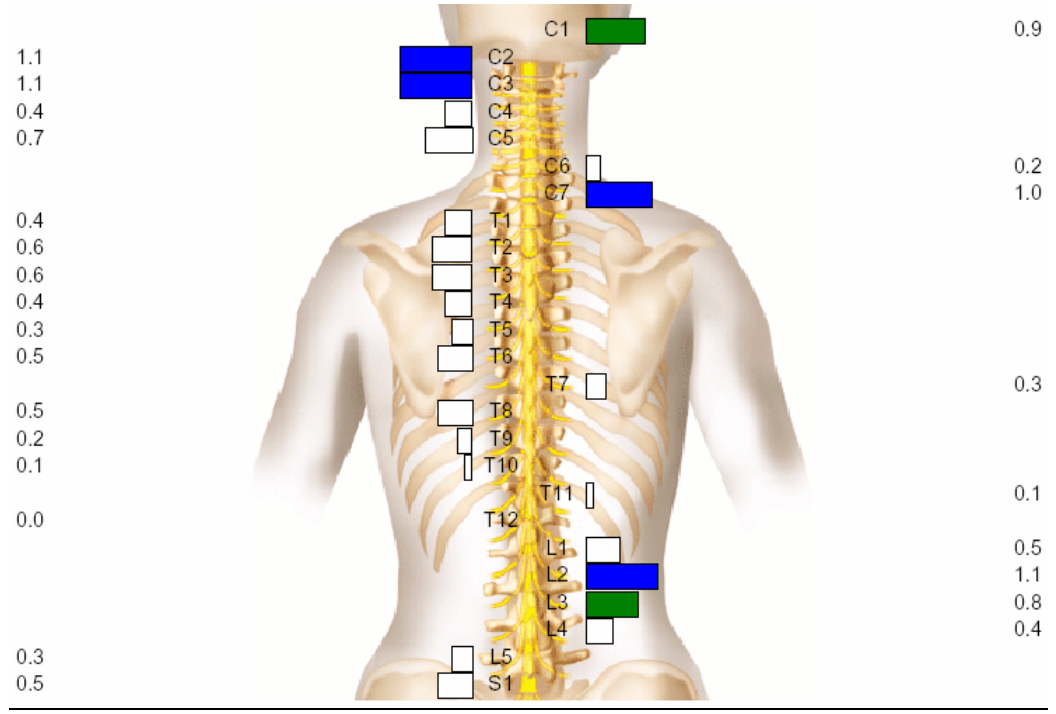

## sEMG Scan 6 – 11 Months Into Care



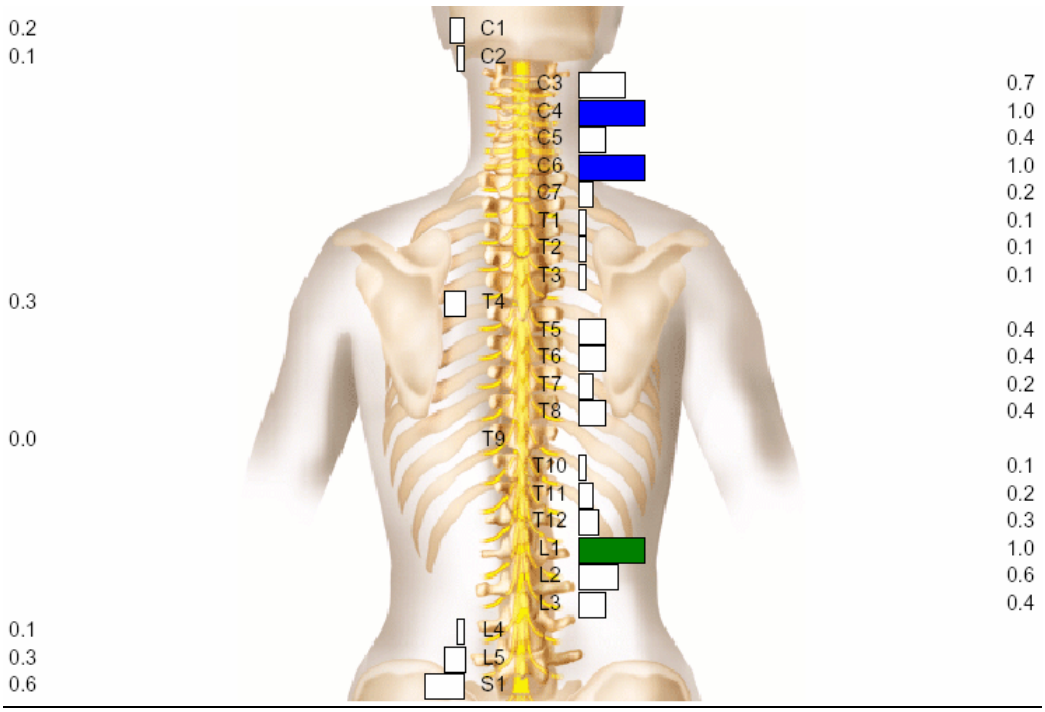
# Thermal Scan 1



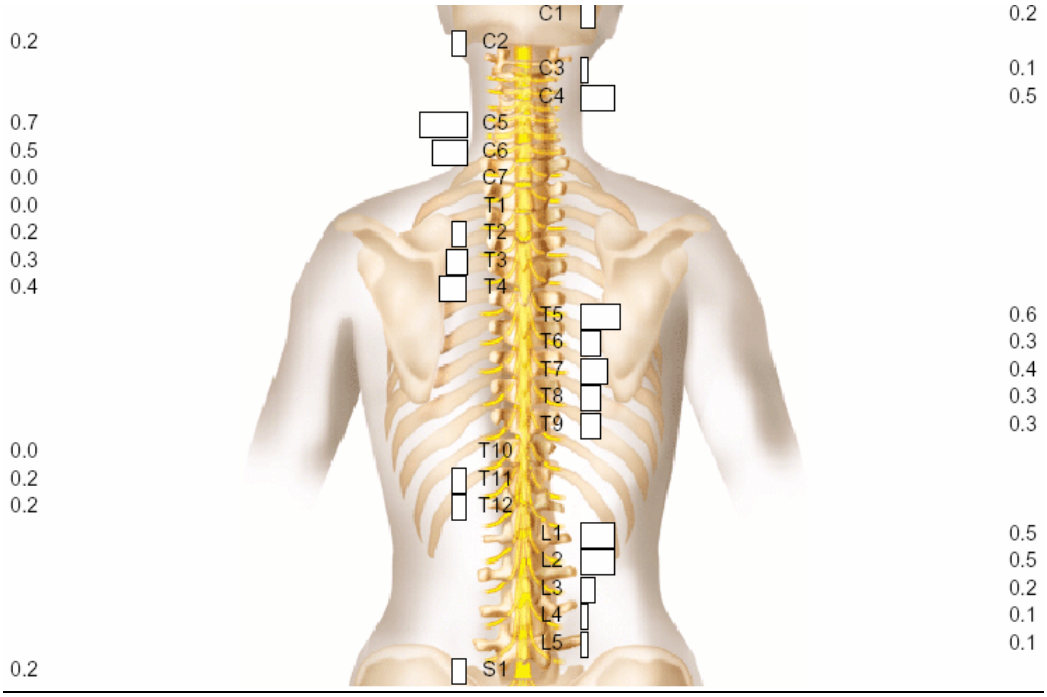

# Thermal Scan 2 – One Month Into Care



# Thermal Scan 3 – 2 Months Into Care




# Thermal Scan 4 – 3 Months Into Care



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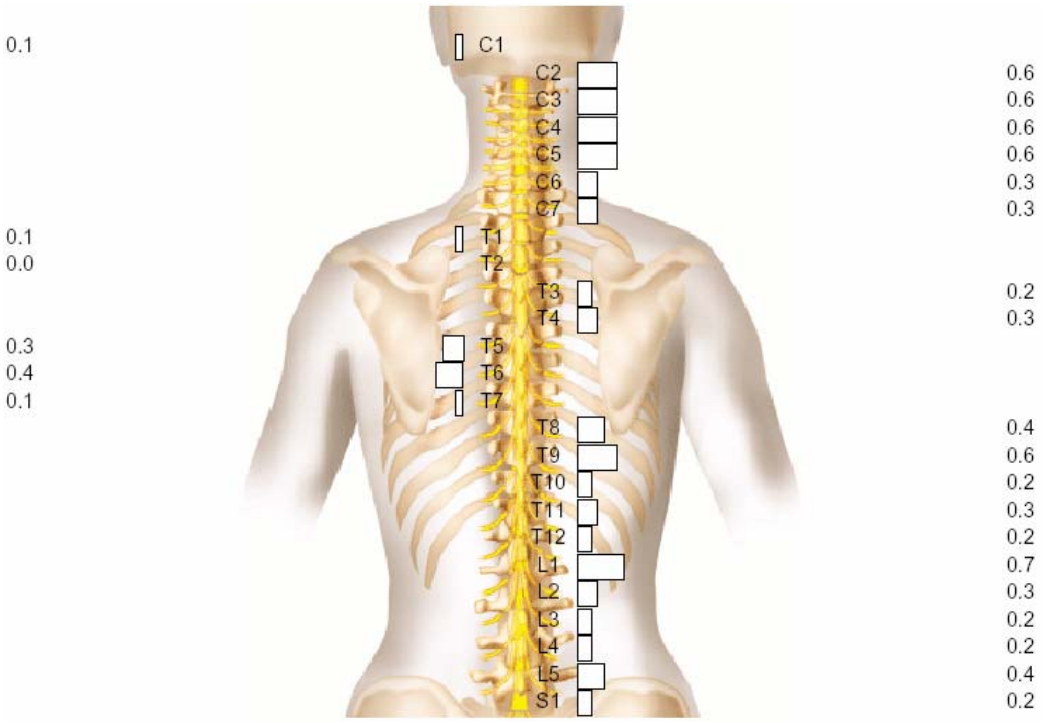
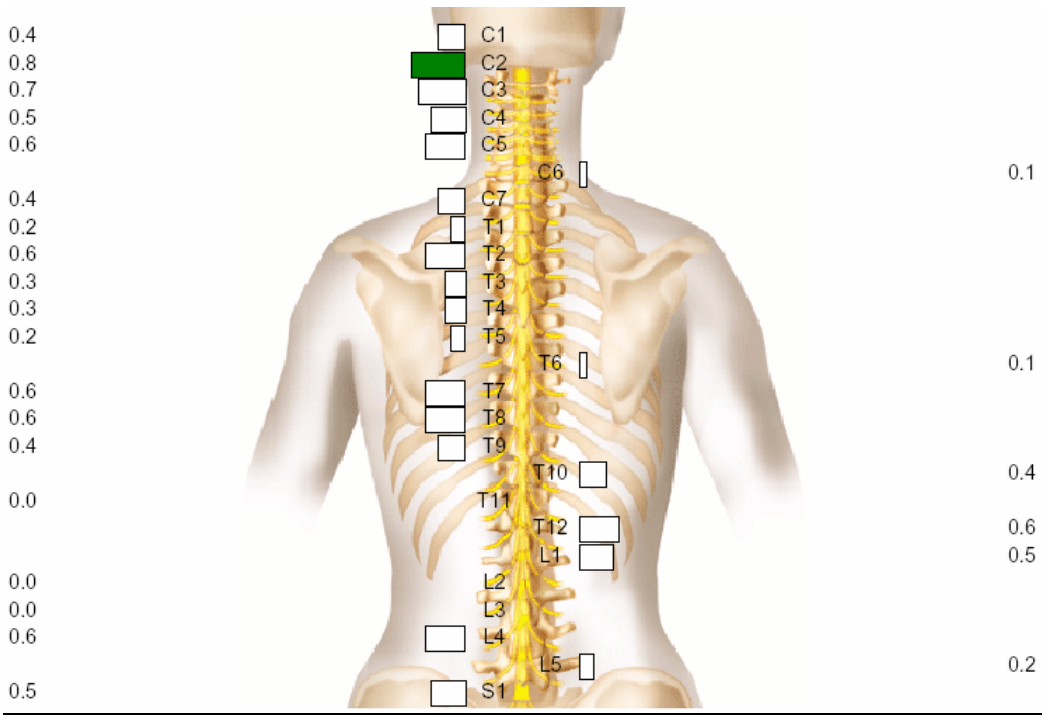



## Thermal Scan 6 – 11 Months Into Care



CASE STUDY

# Chiropractic Care of a Battered Woman: A Case Study

*Leslie Bedell, DC*[†]

**ABSTRACT**

**Objective**: This case study documents the chiropractic care of a battered woman struggling with Intimate Partner Violence (IPV). Chiropractic offers battered women a unique service, it is the only profession trained and licensed to detect and correct vertebral subluxations. The relationship between the stresses of abuse and vertebral subluxation, as well as the subsequent changes during chiropractic care, are described.

**Clinical Features**: A Caucasian, 23-year old female presented with headaches, neck pain, and upper back pain. The initial complaint noted sharp, knife-like pains into the medial scapular borders, worse on the right side. Tingling extended into the right hand, most severe in the 2nd, 3rd, and 4th fingers.

**Chiropractic care and outcome**: Protocols of both Torque Release and Activator techniques were utilized to evaluate vertebral subluxations. Subjective quality of life issues were evaluated through a Network Spinal Analysis (NSA) Health Status Questionnaire. After commencing chiropractic care, this woman suffered a cervical spine hyper-extension/hyper-flexion type injury from an automobile accident. For the first 30 days after, adjustments were applied twice weekly. Acute exacerbations of symptoms unrelated to the original complaints were displayed and progress became irregular. During the next 60 days, there were various unexplained falls and severe flare-ups of painful symptoms, and she finally admitted to being battered by her husband. Referrals to counselors and programs dealing with domestic violence were provided. Once the physical battering stopped, consistent progress was noted in both clinical symptoms and quality of life issues.

**Conclusion:** As a battered woman must receive emotional and social support to improve her situation, it is important for chiropractors to recognize the "red flags" of IPV. Chiropractors re-evaluate regularly for changes in vertebral subluxation patterns and can recognize inconsistent responses. They may also be the first caregivers to offer a vitalistic approach; considering a woman's physical, chemical, and emotional quality of life; a perspective that offers significant connection and trust. This article serves as a foundation on the topic of IPV and chiropractic, for use in both communities.

**Key words**: *chiropractic, vertebral subluxation, adjustment, Activator technique, Torque Release Technique, Network Spinal Analysis (NSA), battered woman, Intimate Partner Violence*

## Introduction

Intimate partner violence (IPV), previously termed "domestic violence," is defined by the Centers for Disease Control (CDC) as "intentional emotional and/or physical abuse by ex-spouse, boyfriend/girlfriend, ex-boyfriend/ex-girlfriend, or date."[1]

IPV is the most frequent type of violence committed against women,[2] affecting 2 million women each year in the U.S., and includes all races, ages, incomes, and religions.[3] Included in intimate partner violence is battering, where the abuser uses acts of violence and a series of behaviors, including intimidation, threats, psychological abuse and isolation to coerce and to control the other person. The violence may not happen often, but it remains as a hidden (and constant) terrorizing factor.[4] Battered women who are injured by ongoing partner abuse account for the highest percentage of U.S. emergency room visits, approximately 22-35%.[5] Cultural awareness of this social issue has increased since 1987, when the first Domestic Violence Awareness Month was observed that October, it is now an annual event. Also begun in 1987 was the first national toll-free hotline.[6]

Battered women suffer from symptoms such as depression, anxiety, a sense of being detached from their bodies and numb to the physical world, nightmares, and flashbacks of violent episodes. The syndrome characterized by these symptoms is 'post-traumatic stress disorder' (PTSD).[7] PTSD does not allow women to function well, think clearly, or prepare for their futures. Their bodies are constantly living in a state of "Fight or Flight", described by Hans Selye,[8] and many times the symp-

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toms that a woman seeks help for are magnified by the extent of abuse in her life. Their symptomatic profile can include: chronic pain with taut and tender muscle fibers in the head, neck and upper back region, sleeping disorders, and digestive complaints. In addition to these symptoms, victims of intimate partner violence will often reveal 'red flags' that can alert health care practitioners to a battering situation. These indicators may also contribute to the inconsistent or stalled progress of subluxation correction that a battered woman may demonstrate. Eleven red flags, developed from clinical experience, are listed in Table 1.

Statistics indicate that a woman is more likely to discuss her abusive relationship with her doctor than other professionals.[9] As a trusting relationship is established between the chiropractor and the practice member, the battered woman may verbalize the truth about her life situation and be open to resources that are available to help her improve her situation.

Bruises and broken bones are not often a part of the clinical picture, however statistics report that verbal and emotional abuse can be just as damaging as physical abuse.[10] Research by noteworthy scientist Candace Pert, Ph.D indicates that emotional stresses are able to influence neurochemistry: "Our research suggests that the usual picture of the limbic system should be extended to include the spinal cord, for a third area enriched with neuropeptide receptors is the dorsal horn of the spinal cord."[11] The changes in neurochemistry triggered by emotional stresses may contribute to vertebral subluxations, and confirms the mind/body connection the developer of chiropractic, B.J. Palmer, termed the "mental impulse" many years ago. Accordingly, emotional issues such as a woman's feelings of insecurity, fears of danger to herself or her children, helplessness to change her situation, and loss of self-esteem are as essential for chiropractors to note, as are life-style issues such as diet, exercise and postural stresses.

**The Case Report**

A 23-year old Caucasian female presented with headaches, neck pain, and sharp, knife-like pains into her upper back region most pronounced along the medial scapular border on the right side. There was tingling into the right hand, most severe in the 2nd, 3rd, and 4th fingers. Torque Release technique was utilized as the primary approach for analysis and care, Activator technique was utilized secondarily for correlation and application of adjustments. The initial evaluation includes observation of prone leg length discrepancies, termed functional leg length inequality in Torque Release and Pelvic Deficiency in Activator technique. Unequal leg length is described as the expression of the body's fixated pattern that lacks adaptability and indicates lateral or posterior rotated subluxation.

Dr. Jay Holder, developer of the Torque Release Technique, describes the definition of a subluxation as: "A condition of one or more spinal segments that have lost their ability to move freely or completely throughout their range of motion and that physically interfere with the spinal cord and or spinal nerves and their function."

Holder's perspective recognizes that all vertebrates have a brain reward system utilizing opiate receptor sites, and the vertebral subluxation complex is the hallmark insult of the vertebrate's ability to express a state of well-being to its fullest potential. Therefore, Torque Release Technique views the subluxation as a "separation from wholeness." Holder describes the causes of subluxation as an:

"Imbalance between external incoming forces and internal resistive forces, often an exaggerated perception of stress causing an inappropriately excessive internal resistive response. The categories of one cause include 1) physical (trauma, thermal, electromagnetic, gravity), 2) chemical (nutritional, toxic, mood altering), 3) mental (perceived threats of stress, emotional), and 4) genetic."

The principles of the Torque Release Technique model are based on the original precepts and findings put forth in the two textbooks written by R.W. Stephenson, *The Chiropractic Textbook* and *The Art of Chiropractic.*[12]

**Torque Release Technique Indicators[13]**

In addition to functional leg length inequality, Torque Release technique utilizes the following findings as indicators to determine location of subluxations:

Palpation – The process of gathering information through touch. There are four types:

1. Scanning palpation
2. Tissue palpation
3. Intersegmental palpation
4. Motion palpation

The cranio-spinal meningeal functional unit is evaluated as a whole to observe energy imbalances including abnormal heat or cold. Vertebral segments are checked for rotational movement as well as anterior and posterior misalignments.

**Abductor Tendency/Adductor Resistance:**

A muscle which upon contraction draws apart and away from the median plane of the body, e.g. the action of the tensor fascia lata. The tendency of one or both legs to remain in abduction and resist being moved into adduction or together indicates C2 subluxation – usually on the side of greater resistance. The

**Table 1. Bedell's Clinical Red Flags include:**

1. hypersensitivity to touch including jumpiness and muscle twitching
2. vague descriptions of injuries related to acute exacerbations of symptoms
3. somato-emotional releases during chiropractic care including tears
4. financial concerns about treatment in spite of adequate family income
5. minimization of life stresses and their relationship to symptoms
6. obsessive need to find a physical answer that can be the cause of symptoms
7. over-concern about scheduling appointments and having to check in with her partner
8. irrational explanations of missed appointments
9. eye deviation/facial stress during questioning about injuries
10. changes subject frequently when asked about her relationship with her partner
11. over-emphasize positive character trait of partner

resistance in graded on a 0-5 scale with 0=no resistance and 5=maximum resistance to movement.

**Foot Flare (Inversion/Eversion):**

Toe-in or Toe-out – can be right, left or both observed in the prone position; indicates torsion/distortion/tension in the spinal cord and meninges. This is associated with anterior rotation of spinal segments with dural attachments.

Sphenoid, Occiput, C1,C2,C5, Sacrum (S2,3,4), and Coccyx anterior rotation is associated with traction of the meninges. Occiput has dural attachment around the entire foramen magnum.

**Foot pronation/supination:**

The foot resists against direction of supination and/or pronation and indicates a problem with the position of the trochanter. The resistance is rated on a 0-5 scale as above.

**Heel tension (Achilles):**

Indicates spinal cord torsion/distortion/tension and any subluxation, posteriority, superiority, or inferiority. Spinal cord tension at C2, C5, Sacrum, and coccyx is most likely. Resistance is rated on a 0-5 scale.

**Abnormal breathing patterns:**

Observation of patient's breathing pattern, looking for slow, rhythmic, and full movement occurring in a wave throughout the entire spine. Normal breathing is not compartmentalized. An observable decrease or incomplete movement accesses movement throughout the Cranio-Spinal meningeal functional unit.

**Inappropriate Sustained Patterns of Paraspinal Contractions**
Positive Jump sign, myoirritability, and EMG changes.

**Congestive Tissue Tone:**

Observation of abnormal fullness or congestion primarily in non-muscle tissue: over the subcutaneous tissue, over anterior neck muscles and the kidney area. Indicates trapped dominant patterns as a sequela to toxic chemicals, drugs, etc.

**Postural faults (standing, sitting, prone):**

Indicates stuck inappropriate pattern of spatial gravitational adaptation.

**Cervical syndrome test:**

A screening test for posterior rotation of C1 or C5, with or without laterality. A leg length inequality (short leg) is required prior to this test being performed. Evaluate in a prone position. The side that is down when head is turned and legs even is the side of posterior rotation. The legs must remain even to the exact millimeter and not lengthen or shorten again after a few seconds.

**Bilateral Cervical Syndrome Test:**

When the short leg changes back and forth to long and short as the head is turned from left to right and back again. In other words, the legs remain uneven. Repeat this action several times to verify that the legs are switching back and forth. A finger pressure test should be done first at coccyx, then occiput, C5, atlas, or T6. The posterior contact on the spinous process, the tubercle, or E.O.P. with a line of drive inferior to superior, and posterior to anterior will cause the legs to remain even, thus determining which segment to adjust with the instrument. Also pressure test for right or left torque.

**Derifield Test:**

The screening test for +D reveals the pubic subluxation, posterior-inferior ilium or opposite side AS ilium. The screening test for –D reveals an AI sacral base.

**Abnormal heat/energy radiation from the body:**

Utilizes heat-sensing instruments such as the Thermograph or neurocalometer. Testing documents sympathetic dysfunction.

Torque Release Technique is distinct from Activator technique in that it is described as "non-linear." The same segments are never adjusted in the same vector or in the same order any three visits in a row, and only 1,2, or 3 segments are adjusted on any one visit. Leg testing and pressure testing are utilized to determine the subluxation, the presence of torque, and the line of correction. The practice member is encouraged to allow time to process the changes in their body following the adjustment.

**Indicators and Care Relevant to This Case**

This woman's initial chiropractic examination, utilizing the previously described indicators, revealed postural distortions of a head tilt to the right with the right ear and shoulder lower than the left. The head was carried forward of the normal gravitational line by 1 ½ inches and a loss of normal kyphosis was evident in the upper dorsal region. Palpation revealed painful trigger points and taut and tender muscle fibers along both medial scapular borders from the levels of T4-sacrum with the right side demonstrating the most pain. Congestive tissue tone was evident over the right upper dorsal region as well as the left flank. A one-inch left leg discrepancy was displayed, which will be referred to as a "pelvic deficiency." Leg length became equal with her head rotated to the right side, indicating a positive cervical syndrome on the left side and subluxation of one of the cervical vertebrae. A gentle force with finger pressure was directed into the 1st and 2nd cervical vertebrae on the left side, alternating clockwise and counterclockwise rotational movements, to determine if leg length equality could be obtained. Following the clockwise force at the first cervical vertebra, the leg lengths became equal (balanced), indicating ease of tension in the dural attachments along the left side of the spinal column and correction of the vertebral subluxation.

An adjustment (specific force applied to a vertebra to release the flow of vital life force along the nerve pathway) was given utilizing the Integrator instrument. This instrument was developed by Dr. Holder for use with Torque Release Technique. It is a spring-loaded, hand-held instrument, which delivers a force utilizing torque and recoil at 1/10,000 sec., similar to a toggle-recoil manual adjustment.[14] The instrument is set with a preloaded tension so that when held lightly against the skin, the specific force is delivered in an exact line of drive to correct the misaligned vertebrae. In this case, the correction was made at the level of C1, from left to right, with a right torque. A similar

evaluation was performed along the medial sacral border on the left side. A noticeable evening of the legs was noted after applying a light finger pressure medially at the 1st sacral level, also indicating subluxation. The integrator instrument was pre-set and a specific force (adjustment) was applied medially, from left to right, at the 1st sacral level.

Levels of disability were self-rated in work and personal activities by completing Vernon-Mior (neck) and Oswestry (low back) scales. Visual Analogue assessment was also utilized as a means of monitoring the subjective symptoms. Findings are outlined in Table 2 and Table 3.

When questioned about personal stresses, the woman listed both work stress (working long hours at cleaning houses) and personal stress (live-in boyfriend). Her boyfriend worked for his father and the auto accident involved the father's vehicle, or both were stressful situations.A Health Status Questionnaire from Network Spinal Analysis was completed. The survey rates physical and mental/emotional stress evaluation, life enjoyment and overall quality of life on a 1-5 scale, with 5 indicating the highest rating.

A reduction in both objective and subjective findings occurred after the first month of care and the visit frequency was reduced to once weekly. A subluxation pattern continued to be evident, including acute exacerbations of painful symptomatology and taut, tender muscle fibers in the cervical, thoracic, and lumbosacral regions.

While planning a small wedding and marrying two months later, the woman missed several appointments during this time and stated, "I have the flu." Approximately one month after returning from her honeymoon, she returned to my office with increased painful symptoms in her neck and shoulder blade as well as paraesthesia into her right hand. Over the next 3 months, she was seen sporadically with several cancellations and vague excuses for her missed appointments. On one instance, she cited a "bad fall in the bathtub" and displayed a significant increase in her symptoms, including many tender muscle fibers during palpation. She was unable to make eye contact with me when I inquired about the details of her injury. One month later, she re-appeared in my office for treatment after another bout with "the flu" and stated, "My neck, mid-back and rib cage hurt so bad that I had to roll out of bed." Once again, she avoided eye contact when relating her symptoms.

It was at this point, that I felt she was being battered. The "Red Flags" were all evident (see Table 1).

**The Moment of Truth and Ultimate Trust**

For a health care provider to successfully help battered women, they must be aware of the distinct communication patterns of this population. To document this appropriately, the following section is written in a more narrative style.

The moment of truth had arrived. The battered woman took an opportunity to trust me with her feelings - her emotional state as well as her physical state. While she lay prone on the adjusting table, I gently shared I could provide resources to help with whatever she was going through in her life that was causing her so much stress and pain, that was interrupting her full recovery. I related how much emotional stress affects our bodies and how much tension and stress I felt in her body. At that time she began sobbing and shared some of the suffering she was experiencing from her husband's abusive behaviors. I validated her by honoring her emotions while palpating her spine, and let her cry. I emphasized how valuable of a person she was, that she was deserving of respect, honor, and dignity, and provided her with the name of a counselor who helps women who are in abusive relationships. I told her she could call 9-1-1 if she was ever in danger. I was careful not to say negative things about her husband.

She began to keep her regular appointments of once weekly and established more eye contact with me. The symptoms remained consistent on both subjective and objective assessments. Two months passed until she appeared with a black eye and bruised face, falling into my arms in tears. I had built up enough trust in our relationship that she felt safe enough to let me see her bruises. I had not judged either her or her husband for all the past abuses. She admitted that she needed help and I advised her to contact the local law enforcement officers who deal with domestic violence. I gave her the name of an Advocate who could help her. I also told her about classes available for

**Table 2 - Vernon-Mior and Oswestry Scales**
(numbers show percentage of inability to perform everyday personal and work activities)

| Date | Vernon-Mior | Oswestry |
|---|---|---|
| 9-13-00 | 48 | 34 |
| 9-16-00 | 46 | 44 |
| 9-23-00 | 32 | 28 |
| 10-23-00 | 8 | 6 |
| 11-25-00 | 6 | 2 |
| 12-20-00 | 2 | 0 |
| 2-16-01 | 4 | 4 |
| 4-12-01 | 18 | 14 |
| 5-11-01 | 14 | 12 |
| 6-11-01 | 14 | 4 |
| 7-12-01 | 10 | 8 |
| 8-09-01 | 14 | 6 |
| 9-13-01 | 6 | 0 |
| 10-25-01 | 14 | 10 |
| 11-30-01 | 8 | 4 |

**Table 3 – Visual Analogue Scale**
(numbers indicate level of total physical discomfort on scale of 1-100 with 100 being maximum pain and discomfort)

| Date | Scale Reading |
|---|---|
| 6-16-00 | 60 |
| 9-23-00 | 25 |
| 10-5-00 | 25 |
| 10-23-00 | 42 |
| 11-25-00 | 14 |
| 12-20-00 | 15 |
| 2-16-01 | 10 |
| 4-12-01 | 48 |
| 5-11-01 | 44 |
| 6-11-01 | 35 |
| 7-12-01 | 29 |
| 8-9-01 | 26 |
| 9-13-01 | 24 |
| 11-30-01 | 24 |

education and support to empower her. She was finally ready to risk the changes and followed through with my advice.

It had taken nearly a year for her to "come clean." Chiropractic care allowed her nervous system to reduce subluxations and included safety, gentleness, respect, and education. The empowerment associated with a clear spine and healthy nervous system was reflected in her life; old destructive behaviors were cleared and new constructive behaviors were chosen, allowing her to admit the painful truths of her life and build up courage to change the situation. I also encouraged her to begin a self-care program at home with scheduled hot baths, yoga and stretching, breathing exercises, and provided positive affirmation tapes to play when she was feeling stressed. Remarkably, it was only a couple months following this monumental office visit that her symptoms began to stabilize and she elected to continue with her wellness care.

A year after beginning chiropractic care, a follow-up NSA Health Status Questionnaire was completed, rating current quality of life. Nearly all of the areas of mental/emotional and physical stress factors that had previously rated as 4 or 5 (maximum) were reduced to 1 and 2 (minimal). Also, the areas of life enjoyment increased from 1 and 2 up to 3, 4 and 5, and overall quality of life also significantly increased. She is still attending classes, she is still with her husband who attends regular counseling sessions with her, and she is not allowing herself to be abused any longer.

**Discussion**

This case describes a subluxated battered woman who successfully broke the cycle of abuse in her life after the application of chiropractic care. Chiropractic offers battered women the benefits of: specific adjustments for vertebral subluxations, education on the chiropractic lifestyle, and resource support for changing destructive lifestyles and relationships that are robbing them of life. It should be noted that "low force" chiropractic techniques were utilized in this case. Clinical findings indicate that because of many battered women's life experiences, they can be more sensitive to physical "force" and do not relax during high-force osseous-type adjustments. Battered women also need more nurturing, as many of their questions and concerns involve their tremendous need for trust and safety. A chiropractor that has good listening skills can establish a tone of confidence and security.

When chiropractors create an environment where a battered woman feels safe enough to get in touch with her pain and non conscious beliefs, she can begin to trust herself to make healing changes, from her nervous system to her life. A battered woman has learned to survive in a constant state of stress. Her body is engaged in some degree of a "fight-or-flight" response at all times in preparation for the next verbal, emotional, or physical attack. The cortical releasing factor (CRF) secreted by the hypothalamus, stimulates production of ACTH that causes adrenalin to be released by the adrenal glands. This has been shown to happen whether the attack is real or perceived. This cycle can lead to adrenal exhaustion, as well as depression. Over time this highly reactive state takes a toll on the organs of the body. At the annual meeting of the American Psychosomatic Society in Monterey, California on March 13, 2001, it was reported that an unhappy marriage can break a woman's heart, figuratively, and literally.[15] Current work in the fields of psychoneuroimmunology and brain chemistry show the effects of emotional stress in decreasing wellness. *In Molecules of Emotion*, Candace Pert. Ph.D., explains that "CRF is the peptide of negative expectations, since it may have been stimulated by negative experiences in childhood," and "When emotions are expressed – which is to say that the biochemicals that are the substrate of emotion are flowing freely – all systems are united and made whole. When emotions are repressed, denied, not allowed to be whatever they may be, our network pathways get blocked, stopping the flow of the vital feel-good, unifying chemicals that run both our biology and our behavior."[16]

There is no record of previous literature in chiropractic research documenting the relationship between intimate partner violence and subluxation patterns. This article offers to establish a foundation and promote discourse. Research from the *International J. of Alternative and Complementary Medicine* includes a study that discusses chronic pelvic pain in women who have a history of sexual and/or physical abuse. The author emphasizes the importance of helping these individuals "learn all the necessary steps on how to achieve empowerment and to regain power and control over one's body."[17]

Chiropractic literature does include discussions on the relationship of stresses causing dis-ease. R.W. Stephenson states in *The Chiropractic Textbook* that "Dis-ease was a failure of organisms to adapt optimally to internal and external stressors because of loss of contact with the inherent organizing principle, or innate intelligence, found in every living organism."[18] And recent studies show the relationship of chiropractic care to the reduction of the effects of emotional stress.[19] Dr. Donald Epstein, the developer of Network Spinal Analysis, discusses an "emotional motor system" that has the ability to project from the prefrontal cortex and caudal brainstem into the spinal cord. It establishes sensory and motor levels in the caudal brain stem and spinal cord, influences the sympathetic and parasympathetic systems, results in independent movements of the extremities (axial and proximal body movements), establishes specific emotional behaviors, and triggers mechanisms of rhythmical and other spinal reflexes. In his book *The Twelve Stages of Healing*, he provides exercises that integrate breath, touch, and movement in order to provide a mirror to the bodymind and emotional/physical connections.[20]

**Conclusion**

Women in abusive relationships have attained what has been described as "learned helplessness." They have learned to survive but have little hope for improvement in their quality of life. The benefits associated with chiropractic care, including improvements in physical and emotional state, can help these women engage in constructive choices that break the cycle of abuse and make positive changes in their lives.

Intimate Partner Violence is a significant social problem. The chronic nature of abuse adds expenses to an overburdened health care system, as well as the economic impact of lost productivity and creativity of battered women.

The effectiveness of chiropractic care in helping IPV victims to successfully respond to stress and make improvements in

their life situations has never been formally studied. Additional factors to be evaluated are the decreases in medical expenses due to reduced emergency room visits, and the economic impact on business as these women become healthier and more productive. Funding is necessary to proceed with future studies that can evaluate chiropractic's cost effectiveness, safety, and benefits, as applied to the topic of Intimate Partner Violence, and support for funding will be pursued.

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# Wellness Lifestyles II: Modeling the Dynamic of Wellness, Health Lifestyle Practices, and Network Spinal Analysis™

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## ABSTRACT

**Objective:** Empirical application of a theoretical framework linking use of Network Spinal Analysis™ (NSA; a holistic, wellness-oriented form of complementary and alternative medicine [CAM]), health lifestyle practices, and self-reported health and wellness.

**Design:** Cross-sectional self-administered survey study.

**Respondents:** Two thousand five hundred and ninety-six (2596) patients from 156 offices of doctors who were members of the Association for Network Chiropractic (currently titled Association for Network Care); estimated response rate was 69%.

**Measures:** Exogenous variables entered into the structural equation model include gender, age, education, income, marital status, ailments, life change, and trauma. A wellness construct consisted of calculated difference scores between two referents, "presently" and "before Network" care, for self-reported items representing wellness domains of physical state, mental-emotional state, stress evaluation, and life enjoyment. Positive reported change in nine items assembled into dietary practices, health practices, and health risk dimensions serve as indicators of the construct of changes in health lifestyle practices. The NSA care construct consisted of duration of care in months, awareness of energy and awareness of breathing since beginning Network care.

**Results:** Of the exogenous variables only gender, age, and education remain in the final parsimonious structural equation model in these data. Reported wellness benefits accrue to individuals along a direct path from both self-reported positive lifestyle change (0.22), and from NSA care (0.43). The path (0.65) from NSA care to positive health lifestyle changes indicates that NSA care also has an indirect effect on wellness through changes in health lifestyle practices.

**Conclusions:** The Structural Equation model tested in these analyses lends support to our theoretical framework linking wellness, health lifestyles, and CAM. This study provides further evidence that our measurements of health and wellness are particularly appropriate for investigating wellness-oriented CAM. There is a positive relationship between the experience of NSA care and self-reported improvements in wellness as well as self-reported changes in lifestyle practices. NSA care users tend toward the practice of a positive health lifestyle, which also has a direct effect on reported improvements in wellness. These empirical links are discussed relative to the sociodemographic characteristics of this population and show that use of NSA care is an aspect of a wellness lifestyle.

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## INTRODUCTION

Wellness has become a popular concept that has been applied by the mass media to fitness and self-help products and services, by work-site wellness/health promotion programs (Sorensen et al., 1998), and biomedical research incorporating health-related quality-of-life assessments (WHOQOL Group, 1998). In addition, mounting evidence and popular wisdom have established a firm link between health lifestyle practices and quality of life, as well as specific health outcomes. This research is based on our theoretical framework that proposes dynamic linkages among wellness, health lifestyles, and complementary and alternative medicine (CAM) (Schuster et al., pp. 349–356). Within our framework, use of CAM, along with typical health lifestyle practices, for the pursuit of wellness is an aspect of what we have termed "wellness lifestyles." In the context of the present study, the application of this framework highlights both the importance of broader wellness outcomes for assessing effectiveness, as well as the influence of CAM on health lifestyle practices. CAM use, in addition to any direct benefits, may also promote positive health beliefs and behaviors that may then in turn effect improvements in perceived wellness.

CAM modalities vary widely in scope of practice, healing objectives, and individual motivations for use, thus making problematic the study of CAM as a homogenous entity (Cassidy, 1995; Goldstein, 2000). We therefore restricted the present investigation to one particular type of practice within CAM known previously as Network Chiropractic and, since 1995, as Network Spinal Analysis™ (NSA) (Epstein, 1996, 1998, 1999) and practiced by certified practitioners. NSA represents many of the values common to CAM practices and systems including "high-level wellness," "the interpenetration of mind, body and spirit," holism/individualism, self-healing, vitalism, the body as a bioenergetic system, and a focus on the natural/ecologic context (Micozzi, 1996; Goldstein, 1999, 2000).

NSA arose out of a school of thought within chiropractic that embraces the original, vitalistic principles of the field and that recognizes an "innate intelligence" that coordinates all functions of the body via the nervous system. The original tenets of chiropractic held that mechanical disturbances in the spine and nervous system could affect the optimum functioning of this innate intelligence, thus interfering with the overall health and well-being of the individual. Growing out of this philosophy, NSA distinguishes its scope of practice from the other school of thought in chiropractic that developed in the 1970s that is based on the palliation of musculoskeletal conditions in accordance with a biomedical or "treatment" model (Koren, 1999; Redwood, 1996).

NSA has further developed into a low force spinal application (i.e., light touches to specific spinal regions) to enhance the cognitive and precognitive awareness of an individual's spinal structures, body tension patterns, and the development of unique "somatopsychic" and "respiratory" waves of skeletal motor activity purported to assist in improved self-organization of an individual's spine and nervous system. When practiced by chiropractors this approach addresses mechanical disturbances in the nervous system and assists the body in developing self-regulating processes to remedy spinal mechanical tension regardless of symptomatology. When practiced as a wellness discipline, it does not have the objective of remedying any condition or returning a patient to a previous minimum standard of health. Rather, the objectives of NSA, as wellness care, are concerned with promoting an individual's innate capacity to self-regulate their own spinal and neural physiology and thus contribute to an individual's overall wellness. Use of NSA, as a holistic, wellness-oriented CAM modality, is likely to reflect a wellness-orientation among users; thus, it is an ideal arena for testing CAM use as an aspect of a wellness lifestyle.

The goal of this study was to present a model derived from our theoretical framework that demonstrates the operationalization of wellness as an integrated construct, and explores wellness lifestyles by illustrating the dynamic influential processes across NSA, health lifestyle practices, and self-reported health and wellness. More specifically, we investigate whether aspects of NSA care, as an example of an holistic form of CAM, may influence individual improvements in health lifestyle practices, and how much those improvements effect self-reported health and wellness benefits, in addition to any direct wellness benefits of NSA care. In order to isolate these basic dynamics, social structural influences impacting these processes, such as gender, age, socioeconomic status (income and education), and marital status, as well as specific life challenges that represent stressors were included as statistical controls. This theoretical model represents an integrated collection of constructs and hypotheses about the possibility of a wellness lifestyle that are tested simultaneously in our data.

## METHODS

### *Sample characteristics*

The data used in this study are from a cross-sectional, self-reported survey of patients under Network Chiropractic in 1994 (Epstein, 1996). Surveys were sent to all 330 practitioners registered as members of the Association for Network Chiropractic (ANC); 9 practitioners were not actively practicing, leaving 321, with 156 practitioner offices responding by administering surveys to their patients, yielding a practitioner response rate of 49%.

Patients were sampled according to the following inclusion criteria: (1) 18 years of age or older and (2) under care for 1 month or more as of the survey date on the clinical assumption that the cumulative benefits would then be as-

sessable. Practitioners were instructed to sample all practice members (patients) unless there were more than 100 in the practice. If it was not possible to administer the survey to all patients, practitioners were asked to sample all those who visited the practice on a given day(s).

In a study of this size, using a census design, it is difficult to ascertain the size of the patient population accurately, therefore, we estimated the response rate. During the study period we conducted further systematic data collection to determine the average size of a Network practice. In two practitioner samples, the median was determined to be 40 practice members. The sample was estimated to be somewhere between 3972–4221 patients. This estimate was based on exclusion of practice members 18 years of age and under (5%–7%), those within 1 month of care (15%–17%), and adjusting for the number of patients from 12.4% of practices who had 100 patients or more and who therefore randomly sub-sampled their patients. This gave an estimated response rate of 67%–71% (Blanks et al., 1997). The final analyses for this study are based upon the 2596 respondents for whom complete data were available.

Sample sociodemographic characteristics are consistent with other CAM surveys (Table 1), with a predominance being women (73%), middle-aged (43 ± 11 years), approximately one third postgraduate-educated (37%), and with a median personal income in the $25,000–35,000 range (62% less than $40,000 per year). Approximately one half of respondents were married.

Fifty-five percent (55%) of respondents reported persistent ailments, and 47% reported a significant life change (in either marital status, residence, or occupation) since beginning Network care. Respondents were asked to rate the degree of physical, emotional, and chemical trauma (if any) they had ever experienced. A summary measure combining these three items revealed that only 13% felt they had never experienced any trauma. On this constructed scale, the average score was 6.0 (± 3.5, scale of 0–12). The average duration of NSA care was 21 ± 27 months. Seventy-eight (78%) of respondents indicated that they were aware of energy or rhythmic spontaneous movement in their body (a physiologic response unique to individuals undergoing NSA care), and 81% reported that they were more aware of their breathing since receiving NSA care.

### *Measurement of latent constructs*

*Wellness.* As reported in our earlier paper (Blanks et al., 1997), an instrument appropriate for measuring health and wellness broadly was developed for this survey. Confirmatory factor analyses further supported the earlier reliability studies which indicated four distinct domains within the overall Self-Rated Health and Wellness (SRHW Version 1.0) instrument, including the wellness themes of physical state, mental/emotional state, stress evaluation, and life enjoyment. Individual items were developed in close consultation with practitioners and patients regarding experiences with NSA care, and included adaptations from existing instruments as well as original constructions. The item format was developed to explicitly elicit self-perceived changes in wellness since beginning NSA care by asking respondents to rate their level of health and wellness both "presently" and "before Network." This approach goes beyond retrospective recall (e.g., patient medical histories) to provide the individual's self-aware evaluation of differences before they received Network care, and makes clear the cognitive standard of comparison for present wellness which is missing in health ratings that ask only for current status.

The mean for these four self-rated health domain scales "presently" were approximately 67% of the maximum possible score, while the mean for ratings retrospectively recalled "before Network" were approximately 50% of maximum (the midpoint in the possible range). This study utilizes the calculated difference scores between the respondents' "presently" and "before Network" perceptions within each wellness item (theoretical range −1.00 to 1.00 with 0 indicating no difference in score; see Table 1). The average difference for the stress evaluation scale was +0.20, indicating approximately 20% higher perceived score presently (range, −0.60 to 1.00). The perceived difference in the mental/emotional state and life enjoyment scales was about +0.17 (range −0.50 to 0.94, and −0.86 to 0.77 respectively), while on average physical state was rated at approximately +0.15 (range, −0.32 to 0.77).

To illuminate the relevance of these numbers further, Table 1 includes effect sizes for each domain, which represent the magnitude of clinical or meaningful variation. Calculation of effects sizes compares the mean sample difference in individuals' scores "presently" to the amount of deviation across the scores of all respondents "before Network" (that is, the normal range of the majority of individuals' initial scores) (Cohen, 1977). Effect sizes of 0.20 are considered small, 0.50 moderate, and 0.80 large; thus, the range of 0.91–1.15 across the separate scales indicates that a large positive clinical outcome had occurred within all domains. The items assembled into these four themes or constructs serve as indicators of the latent or more conceptually abstract construct of wellness.

*Health lifestyle change.* A lifestyle change index was developed that measured a broad range of health behaviors identifying a healthy lifestyle. In this study, the latent construct is based on perceived change in these practices, and thus represents an individual's health lifestyle while under NSA care. Nine items were selected for inclusion in the lifestyle index, representing three distinct areas of health behavior: dietary practices, health practices, and health risky behaviors. The dietary practices dimension included three items: use of health food/vitamin supplements, organic food/whole grain consumption, and vegetarian diet. The health practices dimension included four items: regular ex-

Table 1. Frequencies for Variables Entered into the Model ($n$ = 2596)

| | | *Percent (%)* | |
|---|---|---|---|
| Exogenous Variables | | | |
| Age (42.9 ± 10.9 years) | 18–28 | 8.1 | |
| | 29–35 | 16.3 | |
| | 36–42 | 27.8 | |
| | 43–49 | 24.8 | |
| | 50–56 | 12.0 | |
| | 57–63 | 6.0 | |
| | 64+ | 5.2 | |
| Male | | 26.8 | |
| Married | | 49.8 | |
| Education (postgraduate) | | 36.6 | |
| Income <$40,000 per year | | 62.3 | |
| Life Challenges | | | |
| Persistent Ailments | | 54.7 | |
| Significant Life Changes | | 46.8 | |
| Trauma (no trauma, 0, most extensive 12) | | 6.0 ± 3.5 | |
| NSA Care | | | |
| Awareness of Energy | | 78.2 | |
| Awareness of Breathing | | 81.1 | |
| Time in NSA care (21 ± 27 months) | | | |
| | 0–3 mo | 14.8 | |
| | 3–6 mo | 11.8 | |
| | 6–12 mo | 15.7 | |
| | 12–24 mo | 28.9 | |
| | 24–36 mo | 13.6 | |
| | 36–48 mo | 6.3 | |
| | 48+ mo | 9.5 | |
| | *Mean* | *SD* | |
| Health Lifestyle Changes (Positive Change, Range 0–1) | | | |
| Healthy risk dimension | | | |
| Smoking | 0.08 | 0.26 | |
| Coffee consumption | 0.26 | 0.44 | |
| Dietary practices dimension | | | |
| Vegetarian diet | 0.39 | 0.49 | |
| Vitamin consumption | 0.45 | 0.50 | |
| Organic food consumption | 0.46 | 0.50 | |
| Health Practices Dimension | | | |
| Regular exercise | 0.40 | 0.49 | |
| *Tai Chi*/yoga | 0.20 | 0.40 | |
| Meditation | 0.48 | 0.50 | |
| Relaxation techniques | 0.46 | 0.50 | |
| | *Mean sample difference (Presently–before network care)* | *SD* | *Effect size* |
| Wellness (Range −1–+1) | | | |
| Physical state—Mean of Items | 0.15 | 0.26 | 0.94 |
| Mental-emotional state—Mean of Items | 0.17 | 0.16 | 0.91 |
| Stress evaluation—Mean of Items | 0.20 | 0.20 | 0.98 |
| Life enjoyment—Mean of Items | 0.17 | 0.16 | 1.15 |

SD, standard deviation.

ercise, relaxation/self-hypnosis, meditation/prayer, and *tai chi*/yoga. The two items included in the health risky dimension included smoking and caffeine consumption. Beef consumption was initially included in this dimension but was deleted because it was too highly correlated with vegetarian diet in the dietary practice dimension. While these items do not encompass the totality of health behaviors assessed in the literature, they were selected based on the pre-

dominance of evidence that suggests consistent correlation between use (or avoidance) and bio-psycho-social health. Preliminary factor analysis showed items loaded on three factors that were consistent with the three constructed dimensions. The lifestyle index containing all nine items, showed internal reliability ($\alpha = 0.766$).

Survey respondents were asked to report the extent of change "at present" in each lifestyle item on a scale of $-3$ to $+3$, with $-3$ reflecting the greatest decrease in the particular behavior, 0 = no change in behavior, and $+3$ reflecting the greatest increase in the behavior. Because there were positive and negative lifestyle items, the items were then recoded as a dichotomous variable to reflect "positive lifestyle change." If respondents reported an increase in what was considered a health beneficial behavior, such as exercise, the value for positive lifestyle change was coded as a 1 for that item (see Table 1 for distribution of each item). Only 8% of respondents reported a positive change in smoking behavior, with approximately one fourth to one half of respondents reporting positive changes in the other eight behaviors. The items assembled into the dietary practices, health practices, and health risk dimensions serve as indicators of the latent construct of health lifestyle change.

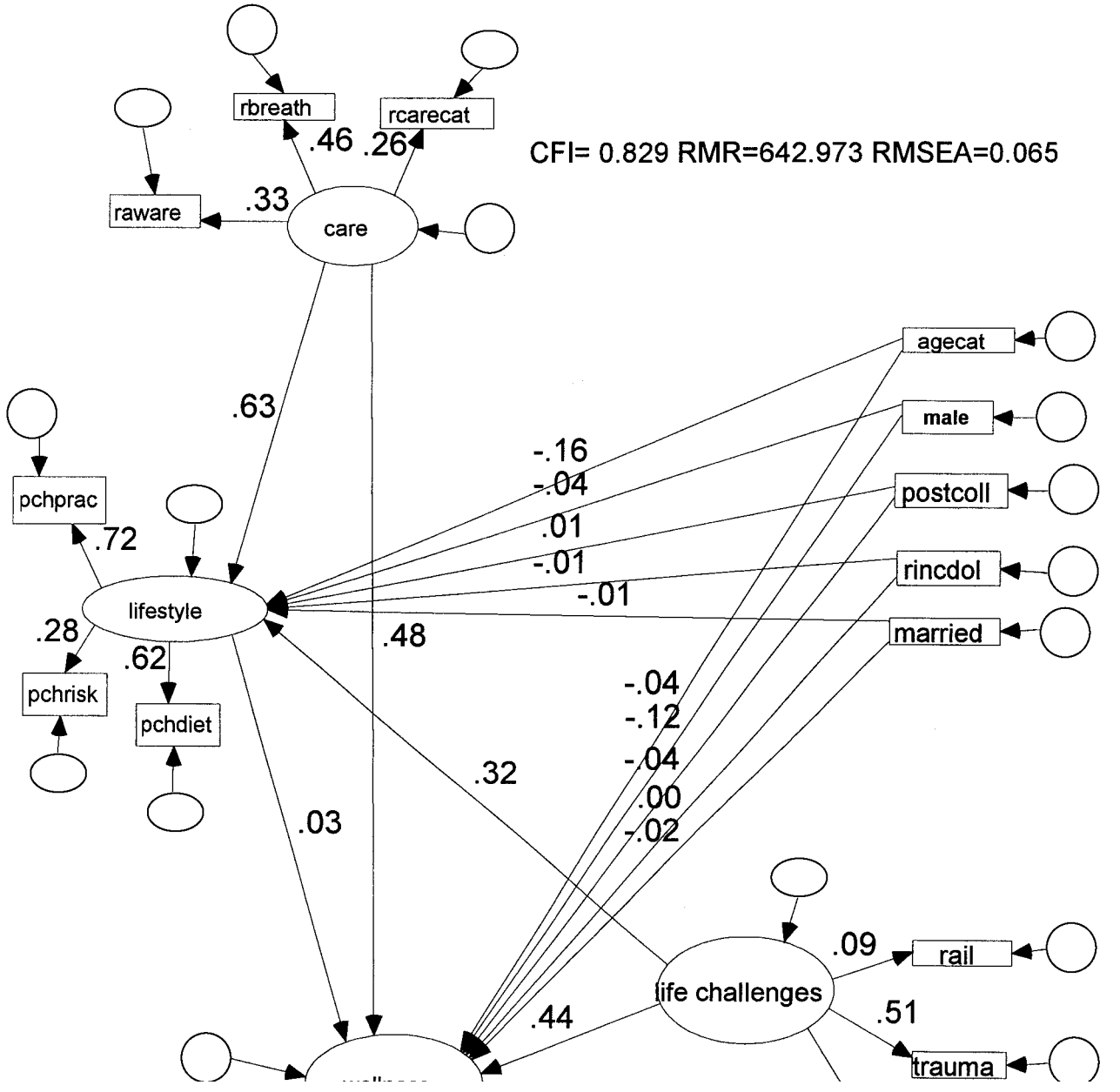
*NSA care.* The latent construct representing the experience of Network care was indicated by three variables: length of time in care (categorized in months), whether or not the individual is presently more aware of energy or rhythmic spontaneous movement in his or her body, and more aware of his or her breathing. Duration of care is considered indicative of a commitment to the long-term health promotion objectives of Network care. The last two items represent a respondent's experience of NSA care as the somatopsychic and respiratory waves (physiologic responses unique to this form of care), and are considered essential clinical indicators of progress by practitioners. Further elaboration of the unique physical responses experienced by recipients, the clinical objectives and the theoretical, biophysiologic mechanisms underlying this form of care can be found in Epstein (1996, 1998, 1999).

*Exogenous variables.* Exogenous concepts represent other known influences on the constructs (wellness, lifestyles, NSA care) that are included in the analyses in order to statistically control their impact, thus randomizing their influence and isolating the independent effects among the constructs in our theoretical model. Several variables reflecting the concept of life challenges were included. The presence of persistent ailments was a single item assessed dichotomously (present or not), and included in the model in order to account for the influence of chronic conditions. Measurement of significant life changes was a dichotomous item indicating a change in marital status, occupation, or residence since beginning care because stressful life events are known to influence health. Also included was a summary item establishing the degree of physical, emotional, and chemical trauma experienced by the respondent that ranged from 0 to 12. Sociodemographic variables, specifically gender, age (categorical), marital status (dichotomous married/not), postcollege education (dichotomous yes/no), and income (in dollars, midpoint of range), were included in the model since these social categories are known associates of health outcomes.

### *Analyses*

Analyses of the data using SPSS (version 9.0 SPSS, Inc., Chicago, IL) and AMOS (version 4.0 SPSS, Inc.) were conducted in several phases, with univariate and bivariate analyses first, followed by confirmatory factor analyses of the latent variables, and concluding with the building and testing of the model itself. "The primary purpose of structural equation modeling [(SEM)] is the testing of causal theories using nonexperimental data" (Martin, 1987). SEM is a sophisticated form of regression analysis that compares the estimated (co)variances under the specified model to those that are observed (Bollen, 1989). Various relationships are thus simultaneously tested (Hoyle and Smith, 1994) through a combination of factor analysis and regression techniques. The model actually consists of two models: a measurement model and a structural model. The measurement model reflects the relationships between the observed variables and the hypothesized constructs (latent variables of wellness, lifestyle, care). The structural model consists of all of the simultaneous relationships among these latent variables, which are then regressed on all variables hypothesized to be causal precedents of those variables. This is an iterative process that begins with an initial theoretical model, which is then tested against the data and modified based on statistical conventions but within the constraints of the initial theoretical framework.

There are several indices that can be used to test how well a proposed model fits a given data set. In the current study, the root mean square residual (RMR) and the comparative fit index (CFI; Bentler, 1980, 1999) were selected as the main fit indices for reasons of sample size and number of parameters. The root mean square error of approximation (RMSEA; Steiger, 1990) was used as the main measure of parsimony. Parsimony means the simplest explanation is preferred; for example, the fewest paths necessary to satisfy both the theoretical model and a given data set. Parsimony and fit were greatly improved for the reduced model (CFI of 0.938 and RMR of 0.025, and RMSEA of 0.052 compared to CFI = 0.829 RMR = 642.973 RMSEA = 0.065 for the initial model). Therefore, the reduced model was considered a more accurate representation of the nature of the relationships between characteristics of individual respondents, their health lifestyle practices, their experience of NSA care, and their perceived difference in wellness domains since beginning NSA care.


CFI= 0.829 RMR=642.973 RMSEA=0.065
rbreath
rcarecat
.46
.26
raware
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care
.63
agecat
male
postcoll
rincdol
married
-.16
-.04
.01
-.01
-.01
pchprac
.72
lifestyle
.28
.62
.48
pchrisk
pchdiet
-.04
-.12
-.04
.00
-.02
.32
.03
.09
rail
life challenges
.51
.44
trauma

**FIG. 1.** (*cont'd*)

Key to Construct and Variable Labels

Ovals = hypothesized constructs
Rectangles = measured/observed variables (sets of variables)
Circles = measurement error

Exogenous Variables

agecat: age in categories (see Table 1)
male = 1
postcoll: postcollege education = 1
rincdol: income in dollars, midpoint of range ($15, $30, $40, $50, $60 thousand)
married: married = 1

LIFE CHALLENGES = Life Challenges Construct:

rail: presence of persistent ailments = 1
trauma: degree of physical, emotional, chemical trauma 0–12
siglife: change in marital status, occupation, or residence = 1

CARE = NSA Care Construct:

rcarecat: length of time in care categorized in months
rbreath: presently more aware of energy = 1
raware: presently more aware of breathing = 1

LIFESTYLE = Health Lifestyle Change Construct:

pchdiet: positive change in dietary practices = 1
pchrisk: positive change in health risky behavior = 1
pchprac: positive change in health practices = 1

WELLNESS construct:

dfstrs: differences scores in stress evaluation items
dfphys: differences scores in physical state items
dfemos: differences scores in mental/emotional state items
dfenjs: differences scores in life enjoyment items

relative contribution of different variables in the model are denoted by the standardized regression (path) coefficients corresponding to arrows in the model, which were statistically significant ($p < 0.05$). For a detailed explanation about how to read path coefficients see Bollen and Long (1993).

Inspection of Figure 2 shows the importance of the remaining individual sociodemographic characteristics. The coefficient of −0.06 between gender and Wellness indicates that females report slightly greater differences in wellness scores than males, while the coefficient of −0.17 for the path from gender to NSA care suggests that females in this sample have been receiving NSA care longer than males and are more likely to report the clinical indicators of progress. There is not a significant association between gender and changes in health lifestyles. Individuals in older age categories are less likely than younger individuals to report positive changes in health lifestyles (−0.14), and show weaker indicators of NSA care experience (−0.12), while age does not appear to influence perceived differences in wellness. A postcollege level of education was an important contributor to perceived wellness (−0.05), but not health lifestyles or NSA care.

In the final model, reported wellness benefits accrue to individuals along a direct path from both self-reported positive lifestyle change (0.22), and from NSA care (0.43). Note that NSA care directly contributes more than health lifestyles to self-reported improvements in wellness by a factor of 2:1. In addition, the path (0.65) from NSA care to positive health lifestyle changes provides evidence that these individuals are likely to have also effected positive changes in their health-related lifestyle practices (which, in turn, impacts wellness) during the time they received NSA care. Thus, NSA care contributes both directly and indirectly (through lifestyle) to self-reported wellness.

## DISCUSSION

This study represents the first empirical application of our theoretical framework which proposes dynamic links among wellness, health lifestyle practices, and an holistic form of CAM (Schuster et al., pp. 349–356), in this case, Network Spinal Analysis.™ We utilized SEM to investigate relationships among these constructs, and found evidence that health lifestyle practices influence wellness, and NSA impacts wellness both directly, and indirectly through influence on health lifestyles practices. These complex interrelationships, then, indicate that use of NSA as a wellness-oriented CAM modality is an aspect of a wellness lifestyle.

The results of our investigation also provide evidence that positive health and wellness can be operationalized and utilized to comprehensively investigate the benefits associated with holistic CAM modalities. The confirmatory factor analyses strengthen the conclusions from our earlier reliability studies that these survey items meaningfully capture four coherent wellness themes as well as an overall integrated wellness construct. The retrospective recall approach taps into explicitly referenced individual self-perceptions; the breadth of these items taps into multiple domains of health, and the statistical strategy integrates the domains into an unconstrained generalized self-perception of health we have termed wellness (Schuster et al., pp. 349–356). With this we were able to detect positive change in an already well population. We anticipate that the current revision of our SRHW instrument will more fully address each of the domains of health (physical, mental, social, and spiritual), as well as other known precursors to health (e.g., positive and negative aspects of the immediate social environment of interpersonal relationships) to yield yet more informative results.

This study demonstrates several major findings. A positive relationship between NSA experience and self-reported wellness was supported by these analyses. Self-reported positive changes in health lifestyle practices also influenced wellness. NSA experience had a direct impact on positive changes in health lifestyle practices. Finally, our results illustrate the relative importance of the sociodemographic factors of age, gender, and education on these interrelationships.

The substantial path coefficient linking NSA care and

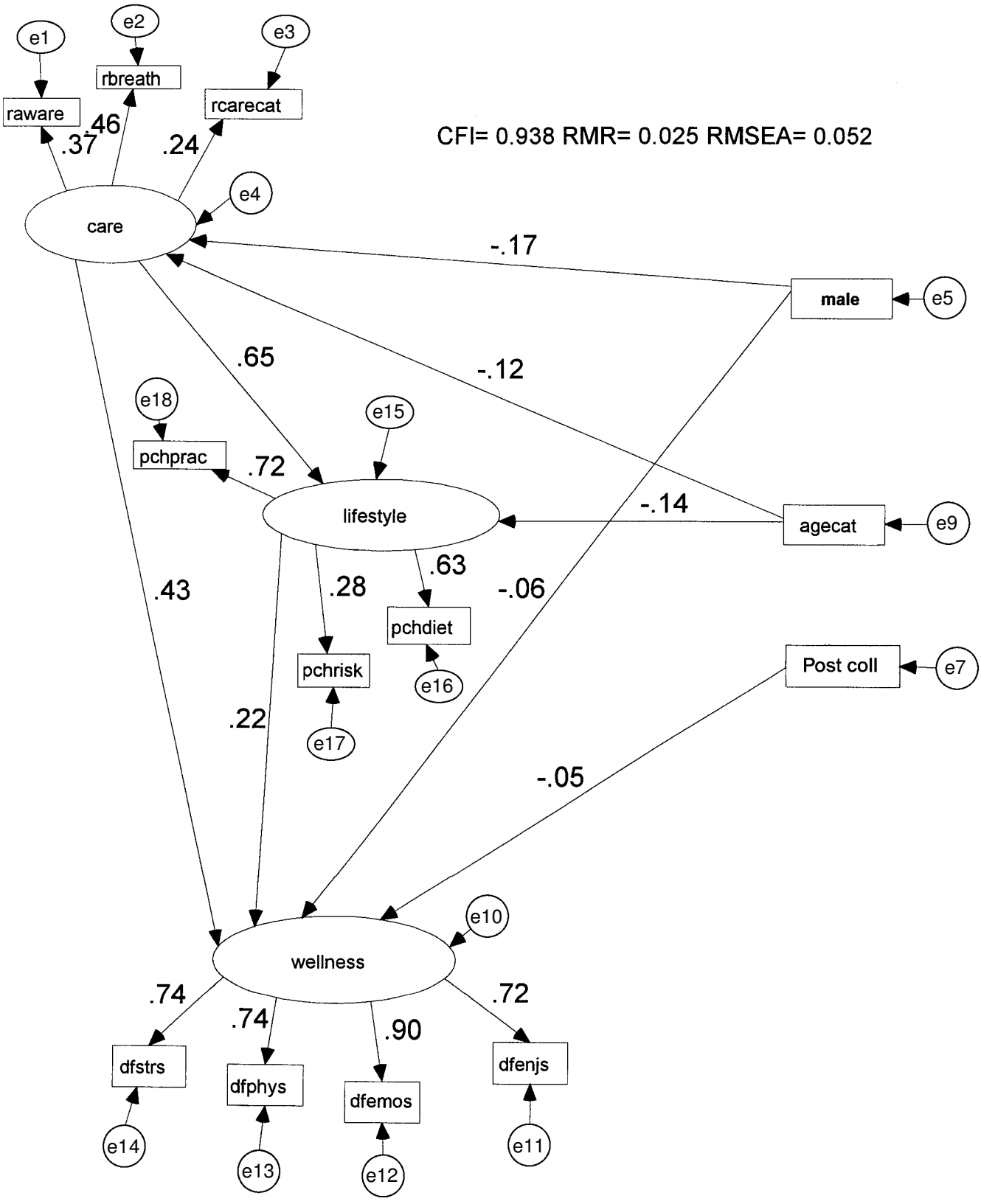


**FIG. 2.** Reduced final structural equation model. (See facing page.)

**FIG. 2.** (*cont'd*)

Key to Construct and Variable Labels

Ovals = hypothesized constructs
Rectangles = measured/observed variables (sets of variables)
Circles = measurement error

Exogenous Variables

agecat: age in categories (see Table 1)
male = 1
postcoll: postcollege education = 1
rincdol: income in dollars, midpoint of range ($15, $30, $40, $50, $60 thousand)

CARE NSA = Care Construct:

rcarecat: length of time in care categorized in months
rbreath: presently more aware of energy = 1
raware: presently more aware of breathing = 1

LIFESTYLE = Health Lifestyle Change Construct:

pchdiet: positive change in dietary practices = 1
pchrisk: positive change in health risky behavior = 1
pchprac: positive change in health practices = 1

WELLNESS construct:

dfstrs: differences scores in stress evaluation items
dfphys: differences scores in physical state items
dfemos: differences scores in mental/emotional state items
dfenjs: differences scores in life enjoyment items

wellness represents the independent influence of NSA care while statistically controlling for other known contributors to wellness, and thus increases confidence that the relationship is not caused by some extraneous associated influence. These results augment the findings of our earlier investigation (Blanks et al., 1997), which showed a significant bivariate association between length of time in care and a summated scale of self-perceived differences in wellness items during NSA care.

Another noteworthy finding is that self-reported positive changes in health lifestyle practices influence wellness. While popular wisdom may suggest this, few empirical studies have provided evidence of such a linkage. While the magnitude of the effect is only half that of the impact of NSA on wellness, it represents the direct, independent effect of positive lifestyle changes on wellness. This result may be unique to this population currently participating in NSA, but is further evidence that use of wellness-oriented CAM may be part of a wellness lifestyle.

Particularly important is the impact of NSA experience on positive changes in health lifestyle practices. NSA care itself is not administered with this objective in mind (see Epstein, 1996), and most practitioners are not trained or practicing as lifestyle or nutrition experts during individual sessions. The mechanism by which NSA care promotes a greater sense of wellness and healthier lifestyle choices is unknown. Individuals may be making positive lifestyle choices based on common health beliefs or values that likewise may self-select them to this type of care. The value of health and wellness as an end itself (see Schuster, et al., pp. 349–356) may be part of our culture's growing focus on individual responsibility for health, which may influence the use of NSA and other CAM modalities. Nevertheless, the significance of NSA (and perhaps other CAM) users engaging in health promoting practices and avoiding health risks without specific patient education programs or urging by the practitioner represents a potential milestone to public health/lifestyles research. Regardless of the specific causal relationships between health lifestyles and CAM use, our findings support the concept of a wellness lifestyle.

Our theoretical framework (Schuster, et al., pp. 349–356) proposed several variables affecting the dynamics among the constructs that were dropped in the final model because they made statistically inconsequential contributions and were not central to the overall theoretical framework. Nevertheless, their exclusion in the final model is informative. Changes in marital status, job, and residence have been shown to be intense life stressors, so it is notable that significant life changes, as well as degree of trauma, did not affect wellness in the final reduced model, perhaps suggesting that NSA care has stress-buffering effects. That is, NSA care is associated with higher levels of wellness in which individuals perceive themselves able to meet life challenges and thus do not experience them as stressful. Similarly, although we predicted that persistent ailments would impact changes in health lifestyles and wellness, neither of these paths remained in our final model for this population. This is an important finding, lending evidence to our conceptualization of wellness lifestyles, and of wellness as a different and perhaps independent construct than the absence of physical ailments.

While income is associated with duration in care, it did not remain in the final model as it is not as strong a predictor as education (with which it is correlated), which may be more closely associated with positive health lifestyles and pursuing wellness as an end in itself. Age also remained in the final model, suggesting the while older age does correspond to a lower likelihood of lifestyle changes, it is not predictive of wellness improvements. Gender also remained in the final model, effecting both NSA care experience and wellness. Marital status, highly correlated with gender, but not as strong a predictor, fell out of the model. One explanation for the effect of gender is that women are more likely to utilize health care than men (Verbrugge, 1985), and have different definitions of health (Kenney, 1992). Given the complex interrelationships among sociodemographic variables and latent constructs, we suggest that none can be understood independent of the others.

These findings must be interpreted within the constraints of cross-sectional data and SEM. Cross-sectional data are limited in their ability to explain causality because the data are constrained to a single timeframe. However, our retro-

spective recall method provides some measure of perceived differences in self-rated health and wellness while under care beyond that customarily provided in cross-sectional measures. Direct evidence of over-time changes in wellness and wellness lifestyles will require longitudinal data, which are vital next-steps in CAM research. While SEM is a powerful tool in the testing of complex causal theories, such as our wellness lifestyles framework, it represents a necessarily simplified approximation of reality. The results of SEM are subject to the accuracy of the basic theoretical assumptions, as well as the *a priori* assumptions regarding data requirements inherent to multivariate statistical analyses (Bollen, 1989).

The dynamics of a wellness lifestyle captured in this research are necessarily tied to the specialized study population of NSA users. As we suggested, given the diversity of techniques and philosophies subsumed under the umbrella of CAM, studies of effectiveness need to focus on a single modality in context. This particular population was selected on theoretical grounds (see Schuster et al., pp. 349–356), representing a wellness, holistically oriented CAM modality. Whether these wellness lifestyle dynamics operate within other such CAM modalities, other less holistic CAM modalities, or conventional medicine, is an important question for future research, which we believe must include refined measurement of health lifestyle practices and beliefs.

Further research using this model may assess the extent to which use of CAM in specific populations (e.g. the elderly, men, particular ethnic groups) may contribute to broad health outcomes. Wellness is a useful framework for outcomes research because not all use of CAM is for medical complaints alone, and the motivations for use must be factored into appropriate outcome assessments. Individual motivations and health beliefs could be more thoroughly investigated through the use of more qualitative or ethnographic research, as could the consequences of the relationship between the user and the practitioner on expectations and effectiveness of care. Such in-depth investigation would be highly useful in providing richer explanatory data, to further elucidate the processes linking wellness, lifestyles, and CAM in our theoretical framework. This information will be beneficial in refining the direction of the causal pathways of our theoretical framework.

We encourage further research using this framework and methodology, particularly using longitudinal designs, broader wellness and lifestyle measures, other CAM and conventional healing modalities, as well as more diverse sociodemographic representation, in order to clarify cause-effect relationships between CAM and the elements contributing to wellness and a wellness lifestyle. This application of our strategy for CAM research upholds the importance of broader wellness outcomes for assessing CAM effectiveness, the influence of CAM on health lifestyle practices, and the concept of wellness lifestyles.

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# Wellness Lifestyles I: A Theoretical Framework Linking Wellness, Health Lifestyles, and Complementary and Alternative Medicine

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## ABSTRACT

Scholarship concerning complementary and alternative medicine (CAM) practices within the United States could benefit from incorporating sociological perspectives into the development of a comprehensive research agenda. We review the literature on health and wellness emphasizing definitions and distinctions, the health lifestyles literature emphasizing issues of both life choices and life chances, and studies of CAM suggesting utilization as an aspect of a wellness lifestyle. This review forms the foundation of a new theoretical framework for CAM research based on the interrelationship of CAM with health promotion, wellness, and health lifestyles. To date, few studies have sought to bring these various elements together into a single, comprehensive model that would enable an assessment of the complexity of individual health and wellness in the context of CAM. We argue that attention to literatures on health measurement and health lifestyles are essential for exploring the effectiveness and continuing use of CAM.

## INTRODUCTION

Scholarship concerning complementary and alternative medicine (CAM) practices within the United States could benefit from incorporating sociological perspectives into the development of a theoretical framework for exploring effectiveness and continuing use. While work in medical anthropology seeks to understand medical pluralism and ethnomedical practices across the world, relatively little sociological research has focused on the "alternative" medical practices of Western industrialized nations. Currently these diverse practices, previously marginalized by the medical profession, are subsumed under the label complementary and alternative medicine (CAM). Understanding why individuals seek to use CAM practices and what benefits they experience must be understood in a broader social and economic context, including patterns of health behaviors related to the concept of lifestyle. Moreover, an understanding of various health behaviors and "health care" is contingent on how health is conceptualized. As we take seriously the idea that health is more than the absence of disease, we need to take into account health-promoting activities that are not specifically for the treatment of diseases and may be related to the concepts of wellness and "health lifestyle" (Cockerham, 2001).

Data in the original study by Eisenberg et al. (1993) suggested: "[A] full third of the respondents who used unconventional therapy in 1990 did not use it for any of their principal medical conditions." From this, they inferred that a substantial portion of "unconventional therapy is used for non-serious medical conditions, health promotion, or disease prevention." Others have also found this to be a moti-

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vation for use in some populations (Astin, 1998; Cassidy, 1998a, 1998b). This suggests a dynamic in CAM use that deserves more substantive inquiry distinct from the dominant research paradigm largely concerned with the effectiveness of CAM for chronic disease treatment or remediation of specific symptomatology.

The National Center for Complementary and Alternative Medicine's (NCCAM) Strategic Plan (2000) highlighted the potential of CAM as a means of combating certain diseases, especially cancer, human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDs), and other autoimmune or musculoskeletal ailments. Despite drawing associations between the public health movement and health-promoting paradigms associated with CAM, their research agenda focuses predominantly on the necessity for randomized, controlled, clinical trials (RCTs) to test the clinical efficacy of various CAM modalities. While this is a worthy objective, recent trends in medicine have begun to integrate concerns presented by some social science fields which suggest the need to recognize and measure health as a broader concept than the absence or presence of disease, and by methods more inclusive and naturalistic than RCTs.

As the dominant perspective in the U.S. health care system, biomedicine—a reductionist, allopathic (cure by opposites) approach—focuses on a cause, course, and cure model of healing. This perspective seeks to understand the effects of surgical or drug interventions on patients' disease severity, although some recent biomedical research incorporates disease-specific health-related quality-of-life outcome measures. In this paper we offer a less widely utilized perspective—the sociology of health and medicine—which is concerned with understanding the perceptual and social processes by which individuals and groups understand and experience health: physically, psychologically, functionally, socially, and spiritually. Dissatisfaction with conventional medical care is often cited as one reason that CAM is used so broadly in Western industrialized nations (Astin, 1998; Goldstein, 2000a). In addition, the various practices labeled as CAM often share some worldviews that represent an "alternative" to the precepts of modern biomedicine, which may account for their historic marginalization from the U.S. health care system and for their popularity with the public. Even considering that some Americans use these practices mainly for their chronic ailments, there is sufficient evidence that use of CAM may also be associated with a reconfigured notion of health care not just as disease care or prevention, but as wellness enhancement. Therefore, evaluating CAM solely by clinical biomedical research methods is limited, and could be enhanced using social science methods to investigate the subpopulations of users who are often seeking and benefiting from the broader emphasis on health and wellness embodied within CAM.

This paper presents a theoretical framework, or middle-range theory, for CAM research that emphasizes the interrelationship of CAM with health lifestyles, health promotion, and wellness. To date, few studies have sought to bring these elements together into a comprehensive model that enables assessment of individual health and wellness within the context of CAM. Given the variety of CAM modalities and users, measuring the effectiveness of CAM is not a simple process. Attention to the literatures on health measurement and health lifestyles are essential for understanding the continued and increasing use of CAM, and uncovering potential wellness motivations and benefits positioning CAM utilization as an aspect of what we term wellness lifestyles.

## HEALTH AND WELLNESS: DEFINITIONS AND DISTINCTIONS

Definitions of health are social constructions and fundamental aspects of the sociocultural and sociohistorical environment. Sociological approaches to defining health have recognized that individuals are not merely biological entities, but psychological and social beings—creative agents enmeshed in social, economic, political, religious, ethnic, age, and gender relations that influence how they perceive and enact their everyday lives. Correspondent with rising life expectancy over the last century, notions of health evolved from mere survival, to freedom from disease and disability, advancing to an emphasis on the individual's ability to function or perform daily activities, and more recently expanding to themes of well-being and quality of life.

The World Health Organization's (WHO) constitution defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (1948). Early criticism that this definition was not quantifiable (Last, 1988) has been proven wrong as investigators in diverse disciplines validated assessments across aspects of physical, mental, and social well-being. WHO (1986) clarified the definition of health further, noting that to reach a state of health "an individual or a group must be able to realize aspirations and satisfy needs, and to change or cope with the environment." Recent conceptualizations of health now include the ability to accommodate potential stresses or internal/external adaptive challenges. The current *Physician's Desk Reference* (*PDR*) *Medical Dictionary* (1995) describes health as: "A state characterized by anatomical, physiological, and psychological integrity, ability to perform personally valued family, work, and community roles; ability to deal with physical, biological, psychological and social stress; a feeling of well-being and freedom from the risk of disease and untimely death." Given these sources, clearly the biomedical as well as the social science community now acknowledges, theoretically if not empirically, the multifaceted and complex nature of health and well-being.

There is growing scientific acceptance of the "perceptual" nature of health, despite earlier claims of the inherent invalidity and unreliability of perceptions. Abundant stress and social support research shows the power of perception (Co-

hen et al., 1995; Kessler, 1992). Moreover, well-established epidemiologic findings highlight the overwhelming importance of self-rated perceptions of health as among the most powerful predictors of subsequent health outcomes (Idler and Kasl, 1991; Menec et al., 1999). In clinical medicine, patient "interviews" are integral to the diagnostic and treatment process; vital information, such as pain assessment, not only must rely on but is an individual perception. Clearly, individual perceptions tap into a rich source of health information distinct from physiologic and psychologic indicators. As some researchers note: "How can we sanctimoniously apply absolute standards of wellness in a relative world?" (Adams et al., 1997).

A consensus is developing that acknowledges that definitions of health include multiple domains, among them physical, psychological (mental, emotional, intellectual), social, and spiritual. Wellness is a higher order construct integrating these domains, and necessarily draws on the level of individual self-perception. Thus, we conceptualize wellness as the generalized self-perception of health. From this perspective, wellness is distinct from health-illness; an individual can deem themselves to be in an acceptable state of wellness whether they experience suboptimal "health" in any given domain or area of functioning (Greenberg, 1985). This view accommodates the idea of health as the ability to function and deal with internal/external stressors, as well as life quality among those with functional limitations, disabilities, or challenges (Kock, 2000). Because wellness is a generalized self-perception, the relative importance of each domain is unique within each individual, while incorporating the health values and beliefs of the surrounding social environment.

The measurement of health domains has gone beyond clinical instrumentation of physiologic states, pain, and symptom checklists. Reference books on broad measurements of health are now past their first editions (McDowell and Newell, 1996) as researchers seek to uncover aspects and determinants of health, wellness, and quality of life. Well-developed scales of physical functioning address personal and instrumental activities of daily living, and recent emphases on immunologic function stress the ability to deal with physiological threats. A recent review and synthesis identifies seven domains of psychologic well-being (Ryff and Keyes, 1995), and there exist numerous validated scales of mental status and depression. Evolving measurement dimensions of social well-being focus on adjustment in roles and relationships and involvement in the wider community (Keyes, 1998), while discussion continues regarding the definition and importance of spiritual health (Hawks et al., 1995).

The measurement of quality of life now includes numerous scales; however, these tend to be tailored to specific disease entities, disease/disability populations, or cross-cultural comparison (e.g., the developing WHO cross-cultural instrument [The WHOQOL Group, 1998]). Attention to the theoretical and empirical integration of these domains of health/quality of life remains lacking.

Many psychometric survey instruments are unsuitable for research on well populations and for purposes of assessing wellness improvements because of "ceiling" effects (Blanks et al., 1997). Adams et al. (1997) recently noted that: "[W]e do not yet possess all of the tools to fully describe and predict human health—in particular, positive health or wellness." Mackenbach et al. (1994) compared the determinants of excellent health (measured as the absence of health complaints and good self-assessments of health) with those of ill-health. They concluded that while the usual predictors apply to both (education, employment status, age, gender), such factors account for 2–3 times the variance in ill-health compared to excellent health. This suggests that the concept of positive health is empirically distinct from ill-health, and that we are only beginning to address the dynamics of wellness.

"Wellness" measurement tools have been limited to detecting disease risk factors or the lack thereof. As a result, even research on health promotion is still primarily about disease prevention. Lacking is attention to the broad system of health beliefs and values, ranging from self-perceptions to sociocultural definitions of health and health care, that activate health-related behaviors.

## HEALTH LIFESTYLES: LIFE CHOICES, LIFE CHANCES

The rise in "healthism" (Colquhoun, 1990; Crawford, 1980) and individual-oriented health policy is evident within the public health movement of the 1980s and 1990s that provoked initiatives by various national health agencies to highlight the need for improvement in individual health behaviors (Healthy People, 2000). This paralleled the rise of self-help/self-care books, fitness centers, and the natural health movement. The NCCAM strategic plan also frames the research agenda for CAM within this paradigm.

Much public health research focuses on morbidity and mortality associated with behavioral risk factors (such as smoking, excessive alcohol consumption, poor diet, lack of access to or use of preventive medical examinations, etc.) within a disease prevention framework. Public health research is often limited by its focus on individual health behaviors independent of their social context, reliance on biomedical indicators, and on targeting chronically ill populations. Cockerham et al., (1997) argue that research on health lifestyles is needed but that: "[M]easurement and analysis should not stop at the individual level but must be extended to consider collective patterns of health-related behavior that form health lifestyles . . . different lifestyles must be related to the social contexts in which they occur." Lifestyle as a sociological concept is related to social status, which is associated with modernity and consumerism (Weber, 1978), a sense of individuality (Simmel, 1950), class cul-

ture (Bourdieu, 1984), and lifestyle choices as a means of producing self-identity (Giddens, 1991). Lifestyle provides an important framework for analyzing the interplay between structure (social forces affecting individual's life chances) and agency (individual's life choices). Cockerham et al. (1997) argue that: "[T]oday's health lifestyles are recent postmodern phenomena most clearly visible in the culturally and economically empowered middle classes." The role of health lifestyles will be an important area of investigation for understanding orientations to certain health behaviors.

Recent studies suggest that the social environment affects the prevalence of health behaviors in various national or subgroup populations (Cockerham, 2001; Stahl et al., 2001). Studies in the United States and Germany suggest the practice of healthy living is associated with "modernity" and upward class mobility (Cockerham et al., 1988). Studies in Great Britain show certain class differences remain, but suggest that regardless of social position people tend to adopt health lifestyles within the limits of their social circumstances or structural characteristics such as age or gender (Dean, 1989; Ross and Bird, 1994). Generally, empirical research into global patterns of health lifestyles is lacking (Abel, 1991; Cockerham, 2001).

A significant debate in the lifestyles and health behaviors literature concerns the extent to which the practice of one particular health behavior may be related to the practice of other health-related behaviors (Norman, 1985). Most studies show a weak association among health behaviors suggesting that "engaging in one health behavior does not guarantee the practice of others" (Sobal et al., 1992). They conclude that "analysis of subpopulations that may have special patterns of health behavior relationships is also needed to target those groups for interventions." Along this line, Patterson et al. (1994) proposed a seven-category typology that grouped individuals by similarity of health behavior. Their findings suggest that most of the population have health behavior patterns that are multidimensional, neither completely health-promoting nor completely "hedonistic" or health-risky. They recommend that identifying "[H]ealth lifestyle groupings in U.S. adults and knowledge of past, current, and changing lifestyles may help us understand more about determinants of health lifestyles, the disease outcomes of these lifestyles, and the success of our national policies in helping people achieve healthier more productive lives in the year 2000 and beyond" (Patterson et al., 1994). Analysis of specific subgroups may give a more accurate picture of the practice of certain kinds of health lifestyles.

We add to this research framework the need to tie in health and wellness outcomes, not just disease outcomes, in order to identify the potential subgroups motivated by wellness promotion over disease prevention. Health is more than the absence of disease, so if we are to understand the reasons people practice certain lifestyles, we have to take into account wellness promotion as well as disease prevention. Few studies link the relationship between health behavior and positive health/wellness. One exception are worksite wellness studies in which behavioral modifications are used to help contribute to employee well-being and productivity, and even these studies tend to focus on reduction of mortality risks (Maes et al., 1998; Sorensen et al., 1998; Watt, 1998). There is a paucity of empirical research investigating the relationships among an individual's lifestyle choices, life chances, and self-perceived health and well-being. Health lifestyles, wellness, and the movement toward a broader definition of health should be explored within the context of CAM populations.

## COMPLEMENTARY AND ALTERNATIVE MEDICINE: WELLNESS LIFESTYLES

The utilization of CAM practices has been the subject of some study in the last decade. Eisenberg et al. (1993) conducted a landmark study showing that one third of Americans used at least 1 of 16 forms of "unconventional" therapy in 1990, with a total out-of-pocket expenditure of $13.7 billion. A follow-up in 1997 revealed that this trend had increased from 33.8% in 1990 to 42.1% in 1997, with total visits exceeding the total visits to all U.S. primary care physicians (Eisenberg et al., 1998). While these therapies were most frequently used for back problems, anxiety, depression, and headaches, one third of respondents in 1990 did not use them for a primary medical problem. In 1997, 58% of respondents stated they used alternative therapies partly to "prevent future illness from occurring or to maintain health and vitality" (Eisenberg, 1998).

The belief that maintaining balance and harmony will allow the body to cope with life-stressors, including disease, better is common to many CAM practices. While these practices are many and varied in scope of practice and methods of healing, there are certain shared underlying beliefs about the body and health that are often in direct opposition to the precepts of the dominant biomedical model (Micozzi, 1996; Goldstein, 2000a). The biomedical model maintains adherence to the Cartesian mind–body dualism, a mechanistic model of the body, and a reductionist notion of illness as centered solely in dysfunctional biological processes. On the other hand, concepts common to CAM include, "high-level wellness," "the interpenetration of mind, body and spirit," holism/individualism, self-healing, vitalism, the body as a bioenergetic system, and a focus on the natural/ecologic context (Goldstein, 2000a).

As a recently developed construct, CAM incorporates diverse and previously unaffiliated health care practices. While some point out the similarities between these practices in terms of philosophies and worldviews (Micozzi, 1996), Cassidy (1995) highlights their diversity and therefore the difficulty of grouping these practices together. Furthermore, Cassidy argues that it is important to categorize

these practices appropriately, otherwise assessment of their benefits or effectiveness would be ill founded. An important step in understanding the distinct contributions and benefits of the various CAM practices will be to recognize the "cultural" worldviews from which these healing practices draw their objectives. Moreover, while most CAM practices share a holistic, even vitalistic philosophy toward health, healing, and the body, the trend toward "integrative medicine" has led to the application of various CAM practices in a reductionist, treatment-oriented paradigm.

The various applications of CAM practices are paralleled by the variety of reasons people use these practices, which may be because of the method and philosophy of the approach or practitioner, or health beliefs of the individual patient (Astin, 1998). Some patients may use acupuncture, for example, as a therapy for low-back pain, while others may use it to enhance their overall health and wellness (Cassidy, 1998a, 1998b). These diverse orientations toward CAM make understanding the "health benefits" of these practices difficult, because there may be different motivations and benefits for different people. Long (2002) argues that the choice of outcome measures must match the desired outcomes of the user, and further that any such effects may arise not only from the techniques but also the philosophies of CAM modalities, as well as the user–practitioner relationship.

Wootton and Sparber (2001) reviewed a growing body of survey literature on CAM use, including national and regional population surveys, surveys of low-income groups, ethnic groups, children, and the elderly. They compared a number of national level surveys that confirm the findings of the earlier Harvard surveys that approximately 42% of Americans use CAM. Wootton and Sparber also compare sociodemographic characteristics across studies, concluding that while CAM users seem to be predominantly middle-aged and middle class with disposable income to spend on CAM, low-income or ethnic minority groups have probably always integrated traditional healing or healers. The paper by Wootton and Sparber begins to elaborate the diversity of CAM use in the United States and suggests that there are "several anomalies and areas of ignorance [that] remain and further high quality research is needed." The finding that women tend to use CAM more than men, the possible bimodal distribution between "new" high-income users and ethnic low-income users, as well as the age diversity of users and generational/cohort effects (Kessler et al., 2001), suggests there are important differences in utilization to be investigated. In addition, motivations for use must be linked to sociodemographic patterns as well as with the type of CAM practice utilized. The trends toward increased use of CAM, especially among the highly educated middle classes, may be understood in relationship to the emphasis on wellness and health lifestyles, and therefore must be investigated in a broader framework. While conventional medical care is a recognized aspect of health lifestyles (especially preventive medical care), CAM use has not yet been linked in the literature with health lifestyles.

While individuals may use certain healing modalities as an alternative or complement to conventional medical practices and for medical complaints, it may be that for some use of CAM is also part of a health lifestyle that emphasizes preventive health care. Individuals may also use CAM as part of a health lifestyle that promotes wellness. This is an important distinction both for understanding the objectives of health lifestyles in different populations as well as understanding the different potential benefits of CAM use. We introduce the idea of CAM use as an aspect of a wellness lifestyle, a lifestyle in pursuit of wellness, which also subsumes typical elements of a health lifestyle (e.g., disease prevention practices such as a healthy diet, stress reduction, regular exercise). People who already have a tendency to practice positive health behaviors as part of a health lifestyle might be attracted to the holistic self-care orientation of many CAM practices, or, CAM practitioners may implicitly or explicitly promote self-care and self-monitoring, which promotes modifications in wellness-related values, beliefs, or behaviors. Evidencing the effectiveness of CAM within this framework will require broader research methodologies than those within conventional biomedical and public health frameworks (Mason et al., 2002).

Recent literature hints at a relationship between CAM practices and aspects of health and wellness lifestyles. Goldstein (2000b) examines the relationship between the fitness culture and the growth of CAM. He argues there are six basic assumptions about health and healing that are shared by the fitness movement and by CAM. These include: (1) health as wellness, (2) personal responsibility for health, (3) the interpenetration of mind, body and spirit, (4) health as harmony with nature, (5) ambivalence toward science and technology, and (6) transcendence, restraint, and vigilance. Goldstein's analysis hypothesizes that participation in CAM is associated with health promotion and, unfortunately, the commodification of health.

A recent study by Schneirov and Geczik (1996) shows that CAM is associated at least in one geographic region with the practice of health lifestyles, including use of natural/health foods and self-help. They suggest this may be because of structural aspects of access to this growing industry rather than an association with health beliefs. However, Schneirov and Geczik also argue that participants in the networks of alternative health studied do display a "collective identity" that challenges deficiencies in modern institutions through the lifestyle choices they make and the redefinition of experiences with health and illness. This study does not distinguish between different forms of CAM, nor does it relate use with perceived benefits experienced by users. A recent study that does focus on patient perspectives on outcomes after treatment with acupuncture (Gould and MacPherson, 2001) found not only that 61% of patients had made some lifestyle changes, but also that 42% had con-

sciously changed their reasons for continuing with treatment, primarily as a shift away from physical problems toward mental emotional issues and concerns about general health and well-being. Cassidy's study of users of Traditional Chinese Medicine (TCM) also shows that while individuals sought care for musculoskeletal dysfunction, they simultaneously pursued TCM for mood care, and wellness care (Cassidy 1998a, 1998b). Further empirical study on the effectiveness of CAM in respective patient populations needs to take into account the relationship of CAM to the practice of health and wellness lifestyles and perceived wellness benefits.

## CONCLUSION: A BLUEPRINT STRATEGY FOR CAM RESEARCH

The purpose of this review is to propose a new theoretical framework from the sociology of health and illness as a contribution to the broader research methodology for the study of CAM. Previously, most research has been largely descriptive of CAM populations or centered on specific modalities in terms of their effectiveness for the treatment of particular biomedical disease entities (e.g., HIV/AIDS, low-back pain, cancer, etc.). Scholars have described the larger CAM phenomenon in terms of overarching philosophical commonalties or cultural values that are often in opposition to those of biomedicine. However, while these scholars proposed broader research agendas that might take this developing theoretical perspective into account, little empirical research has followed. This may be because of a lack of operationalized theory on broader measurements of health, as well as the complexity of developing research agendas that aim to explain the dynamic nature of the use and benefits of CAM, and take into account subgroup variability in CAM populations.

Our theoretical framework is on the level of auxilliary or middle-range theory (Merton, 1949), which specifies the linking of concepts and propositions without making claims of abstract universality. We developed this theoretical framework to link a broad definition of health and wellness, health and wellness lifestyles, and the dynamics underlying the use and potential benefits of CAM. Drawing on diverse literatures, we establish the significance of the connections among these three mutually influential elements, and have suggested more abstract theoretical linkages, for example, issues of modernity and lifestyles (Cockerham, et al., 1997) and even postmodern critiques of science and medicine (Gursoy, 1996) that may offer deeper explanations for the pursuit of wellness among CAM users. The specific causal connections among these elements are likely quite complex and can be inductively explored through empirical investigation.

Wellness has been largely a popular concept with little theoretical elaboration; however, as this review shows, its dimensions can and have been defined and operationalized in sociological and psychological research, even though it has not yet been presented as a construct that could be tapped into and utilized to assess the broader benefits associated with many CAM modalities. Social scientists studying health have long pointed out that perceptions of health and illness are key factors in the experience of individual health and well-being, and that individuals may be considered "sick" by their society's biomedical standards but still perceive themselves as "well." Wellness is more than not having or preventing illness, it is integrated fitness in the internal and external environment, ranging from physical functioning (ability to deal with disease) to psychological (emotional, cognitive) and spiritual well-being, to social adjustment in roles and relationships, to safety, wealth, freedom, opportunity, and happiness. That is, health is a bio-psychosocial phenomenon and a social construction that varies across populations and between individuals. Such a wellness conceptualization has been operationalized using psychological and social well-being items as well as physical functioning and perceived stress scales in a self-rated health and wellness survey (Blanks et al., 1997). This survey was developed to assess the broader health and wellness "benefits" of a form of CAM known as Network Spinal Analysis™ (NSA; previously Network Chiropractic) that embodies many of the principles common to CAM practices and systems highlighted by scholars previously mentioned (Micozzi, 1996).

Another key aspect of our theoretical framework that could inform a comprehensive research agenda on CAM are the relationships among health and wellness promotion, health lifestyles, and self-perceived health and wellness. Empirical evidence suggests health promotion may be a factor in individuals' use of many forms of CAM. The users of CAM practices who consider health promotion may represent a distinct subpopulation who could be better understood through research and theory on health lifestyles. Likewise the study of CAM users may contribute to research and theory on health lifestyles. It is possible that certain CAM users may practice health lifestyles not just because of disease prevention but because of improved wellness as an "end in itself." Thus, we have introduced the concept of wellness lifestyles, which, in linking the practice of health lifestyles and the pursuit of CAM for wellness, provides a powerful explanatory construct for framing utilization and effectiveness research.

We offer this theoretical framework as a blueprint for future research into CAM modalities, especially those that do not easily fit into a biomedical research paradigm. We believe it is essential to fit the research strategy to the particularities of the form of CAM being studied, but that broad measures of health, wellness, and wellness lifestyles will be necessary to fully explore effectiveness and patterns of utilization. Any analysis of wellness lifestyle and wellness benefits experienced by CAM users must also control for, and incorporate into empirical models, the sociodemographic characteristics that describe the life choices and life

chances of varying CAM populations. Other factors known to be associated with wellness, lifestyles, and CAM use (e.g., stressors, traumas, chronic ailments, gender, age, ethnicity, income) must be included in future research to investigate the broader psychosocial context of wellness lifestyles.

Social science and multivariate statistical modeling methods are available and necessary to capture the complex dynamics of these interlocking elements. In the accompanying paper (Schuster et al., pp. 357–367), we apply this strategy to data on a wellness oriented form of CAM as a preliminary case study to explore our theoretical framework of wellness lifestyles, testing the links among wellness, health lifestyles, and CAM use.

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TECHNIQUE

# The Transition of Network Spinal Analysis™ Care: Hallmarks of a Client-Centered Wellness Education Multi-Component System of Health Care Delivery

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**ABSTRACT**

**Network Spinal Analysis ™** (NSA) care has been transitioned from a health care system with the objective of correction of two types of vertebral subluxation, to a multi-component system of health care delivery with emphasis on wellness education for participating clients. NSA care is now delivered and communicated in discrete Levels of Care with emphasis on client participation through self-evaluation. Emphasis on wellness education will be introduced into NSA practice through training via a Certificate Program currently under development. This paper considers some hallmarks that delineate a wellness education, patient (client)-centered practice. The concepts presented relative to this wellness model of health care delivery are believed to be applicable to any approach with similar practice objectives. The perspective presented considers that the major aspects of a patient-centered, wellness education health care delivery system is multi-dimensional. Hallmarks include differentiating terms, and establishing a wellness mentality. Substantiation of the discipline must be established through credible published research regarding its efficacy and safety as well as a consistent and valid means of measuring progressive outcomes derived from the care received. The relationship of NSA to other disciplines is discussed.

**Key words:** *Wellness, wellness education, client-centered health care, health, health care, health care delivery, chiropractic, vertebral subluxation, subluxation.*

## Introduction

This paper has two primary intentions. The first describes the transition of **Network Spinal Analysis ™** [1] practice from its prior objectives to its current state of presentation within the health and wellness arenas. In describing this transition process, the second intent is to provide hallmarks of a practice that is centered on the participation of the client while emphasizing wellness education during care. Although, in this presentation, these links are described through the specific model of Network Spinal Analysis (NSA), the concepts and ideas reported are applicable and readily portable to a wide variety of health, wellness and educational approaches.

## The Transition of NSA Care

NSA care, as presented in this paper, represents an evolution from its earlier description in 1996.[1] At that time; NSA care was practiced solely as a system of health care delivery within the subluxation-based chiropractic model. Practitioners sought to reduce two types of vertebral subluxation with specific objectives underlying NSA application.

Over the past seven years, accumulating evidence and clinical observations have led to a transition of NSA's clinical philosophy and technical delivery. The clinical transition was first influenced by linking self-reported improved health and quality of life outcomes to aspects of NSA care.[2] For example, a substantial number of patients reported an increased awareness of deeper respiration approximately two months into care, whereas the **Somatopsychic Wave ™** phenomenon was reported approximately four months into care. Those experiencing an increased awareness of deeper respiration and/or the **Somatopsychic Wave** event also reported the greatest wellness and overall quality of life compared to those also under NSA care but not aware of these phenomena.[2]

The philosophy of the clinical application of care has evolved to include client participation through self-reports of health and wellness. For the client, this approach is believed to foster a greater sense of personal responsibility for their health, and a greater sense of participation in evaluating the benefits of NSA care. Moreover, these outcomes also assist the practitioner to complement clinical observations with client observations in the overall plan of care. Thus, greater patient involvement in their care and utilization of information derived from this approach designate NSA care as "client-centered."

Therefore, the presentation of NSA practice is now delivered and communicated in discrete Levels of Care. These Levels of Care are believed to represent progressive states of neu-

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rophysiological organization. This belief is substantiated in a recent report (Lohsoonthom and Jonckheere, 2003).[3] These researchers have reported that analysis of the sEMG signal reflect mathematical models that are distinctly more organized from Level One through Level Three of NSA care. As well, clinical evaluation of the active and passive neural control subsystems (Panjabi, 1992),[4] have suggested that the Levels of Care are reflecting sensory motor strategies underpinning the progressive states of neurophysiological organization.

Each Level of Care also has specific philosophical objectives designed as holarchial rather than hierarchical. This approach is intended to avoid "competition" among patients or a sense of lack of success in regard to progressing through the Levels of Care for both patients and practitioners. Also, as a holarchy, each level includes rather than transcends elements of the previous level. To provide such care, NSA practitioners are expected to meet competency in the areas of patient care, clinical knowledge, interpersonal and communication skills, practice-based learning and improvement, and professionalism. These skills, relative to NSA practice, will be taught through the NSA Certificate Program. This Program will be offered at the university level and is expected to be operational in 2004. Information may be obtained through the official website associatiofornetworkcare.com.

The technical evolution of NSA was initiated through clinical observations revealing that the character of the wave changed visually over time (duration of care). This consistent clinical observation suggested the need to continue enhancing care in a manner that would allow for greater differentiation of the body's changing responses to the NSA application. This led to further investigation of the **Somatopsychic Wave** event to characterize this phenomenon and to gain understanding as to how it might be linked to positive health and overall quality of life benefits. The first empirical evidence of the unique character of the wave was provided by Bohacek and Jonckheere (1998)[5] evaluating unfiltered surface electromyography signals (sEMG). These authors reported that the wave exhibited a dynamical nonlinear character distinct from voluntary muscle contraction. This finding complements the observation that the wave cannot be consciously generated by the client, but can be consciously halted. Although continued research will be necessary to elucidate the link between those experiencing the **Somatopsychic Wave** event and self-reports of improved health and quality of life, it is clear that the wave has unique properties. It may be that these properties are linked to neurophysiological processes not currently identified in the scientific literature.

The findings described above regarding client outcomes coupled with the information regarding the distinctiveness of the **Somatopsychic Wave** phenomenon, in relationship to the Levels of Care, suggested that NSA care should be transitioned to a *client-centered multicomponent system of health care delivery.*

**First Component**

The first component of NSA care is practical. This involves the application of specific low force spinal contacts made by precise touch through three well-defined levels of care (a forth is currently being developed). Through these contacts, practitioners initiate the Respiratory and **Somatopsychic Wave** phenomena believed to lead to a higher brain awareness of the body (somatic awareness) and its external and internal environment, particularly the spine.

**Second Component**

The second component of NSA care involves the belief that both of these wave phenomena assist the body in developing processes that enhance internal physiological and behavioral adaptive strategies. In support of this component, a relationship can be drawn between the physical application of care and subsequent changes in the recipient's health and wellness status. This second component of NSA care has been substantiated through study revealing statistically significant differences between health benefits reported by those under NSA care experiencing the wave phenomena as opposed to those under care who were not.[2] That is, a relationship exists between the practical application of care (first component) and positive changes in health and wellness status in conjunction with the development of the two waves (second component).

**Third Component**

A third component is psychosocial in nature. Findings from a recent study[6] indicated that "Network Care has a direct effect on client self-reported wellness, which is twice that expected from healthy lifestyle practices (i.e., exercise, risk avoidance, optimal food choices). Network Care also has a major indirect effect on wellness by promoting health lifestyle choices" (Schuster et al., 2003).[6] This suggests that NSA care, in and of itself, may have the potential to affect a person's perception of their state of wellness, additionally influencing the adoption of a lifestyle considered to be health promoting. Further research will be necessary, but it may be that NSA care represents a new approach to facilitate positive self-modification of behavior.

These three components appear linked together whereby the physical low force contacts elicit waves that create a strategy for dissipating and/or redistributing tension patterns. Ultimately, this significantly ameliorates health, life enjoyment, and the perception of wellness.

**Fourth Component**

Intrinsic to NSA practice is underpinning in the form of "wellness education." In the context of this paper, the fourth component encompasses the concept of a wellness education paradigm. This is viewed, minimally, as creating in the client an awareness and identification of (1) the differences between goals and objectives of allopathic practices (illness model) and non-allopathic practices, (2) strengths and weaknesses of both approaches (3) the body's inherent integrative (body-mind) abilities, (4) differences between illness behavior or actions and wellness actions, (5) physiological ramifications of healthy life style choices, and (6) the importance of participating through self-reports of health and quality of life in regard to their respective wellness care.

Practitioners will receive qualified instruction regarding these fundamental concepts of education via the Certificate Program previously described. Current observations indicate that changes in clients' perceived wellness occurs principally as a consequence of experiencing the Respiratory and **Somatopsychic**

**Wave** phenomena through application of the Levels of Care. Thus, wellness education is provided as a source of information possibly enhancing the outcome of perceived changes in wellness already apparent in NSA care.

### Current Objectives of NSA

Consequent to the transition of NSA care, the objectives have been reassessed and are presented below. There are terms within the objectives that are not germane to this paper, but will be presented in subsequent articles. The current objectives of NSA Care are to:

A. Promote practice member self-awareness of the spinal structures, including gross and subtle movement of spinal structures, spinal and somatic tension patterns, associated participation with the respiratory system, and responses to stress;
B. Initiate the production of spontaneous, self-generated somatopsychic responses that are postulated to dissipate tension or stored energy from the active, passive, and neural control subsystems described by Panjabi.
C. Promote or maintain through the active, passive, and neural control sub-systems, and the meningeal and emotional subsystems as described by Epstein those elements of spinal integrity that increase neural effectiveness, enhancing the body's ability to self-organize;
D. Detect and enhance the availability of the **Spinal Gateway ™** contacts for self assessment and self organization;
E. Detect the presence of indications of adverse mechanical spinal cord tension, and associated altered states of spinal and neural integrity;
F. Administer safe and effective applications of low force to affect the nervous system's capacity to enhance precognitive and cognitive self-awareness.
G. Promote self-regulation of adverse mechanical spinal cord tension through the natural oscillatory patterns of associated tissues via administrations of specific low force touch made by hand.
H. Evaluate the efficacy of the above by relating NSA application to practice member (recipients of NSA care) self-ratings regarding their wellness and quality of life.
I. Conduct research to investigate hypotheses linked to the objectives of NSA care.

### The Position of NSA relative to Chiropractic, the Biomedical Approach and Complementary/Alternative Medicine

Empirical research findings and clinical observations have influenced the transition of NSA care, as herein described. Further, NSA is expected to initiate neurophysiological strategies that elevate clients to a state of health and wellness beyond any previous state prior to commencing care. This expectation denotes a specific niche for NSA in the health care arena. This niche will ultimately allow for NSA to be practiced exclusively as "wellness care"[‡] adhering to the objectives outlined in this paper.

However, since many clients who first appear for NSA care are concomitantly receiving chiropractic, complementary or alternative medicine and/or medical care, it is important to position NSA relative to those disciplines in light of its unique objectives.

### Subluxation-Based Chiropractic

The subluxation-based chiropractor often considers him/herself to be a non-medical practitioner who does not treat conditions other than the vertebral subluxation (VS). [7] Research has provided evidence that recipients of NSA care experience benefits that transcend the single objective of correction of VS**.** However, since it has been clinically observed that correction of VS occurs in recipients of NSA care, NSA methodology remains of benefit to chiropractors practicing with the objective of correcting that condition.

### The Biomedical Approach

The biomedical approach is traditionally based on the patient's presenting complaint(s) and accompanying symptoms. It is presumed that any medical condition is related to a specific cause (biochemical or physical insult), resulting in symptoms that are unique to the presenting condition.[8, 9] That is, in the strictest sense, the biomedical model assumes a direct cause and effect between a disease or pathophysiology and its symptoms, with care consisting of administering counteractive pharmaceuticals and behavioral instructions, both of which, supposedly, the average patient will understand and follow. [10]

Critics have complained that this traditional approach underplayes the psychosocial aspects of the illness process as well as providing a poor fit to many health problems.[10-12] There are some areas, however, where the medical and psychosocial models do blend (chronic pain management for example),[10] and more attention is now oriented towards a person's "perceptions of somatic change" [10,12] being relevant to patient regulation of medications (i.e., blood pressure drugs). However, the traditional model is still prevalent and concerned with eradicating symptoms and disease.

This prevalence is evident in considering that over the last decade there have been reports of a noticeable trend of use of non-medical services and emphasis on wellness practices. [13, 14-16] However, Schuster et al report that those who are in wellness promotion also assess wellness as disease prevention. [16] Thus, while terminology regarding wellness is emerging in biomedicine, the concept of wellness as described in the current practice of NSA practice shares no resemblance to this terminology.

When NSA is practiced exclusively as wellness care, it does not provide for the correction of any specific disease or other affliction. Rather, the care is provided to enhance the interrelationship of body and mind. Thus, its objectives are distinct from biomedicine. In this regard, enhancement or re-establishment of the body-mind has been recognized for some time. Bakal[17] states that a loss or reduction of the integrity of body-mind communication (somatic awareness), brought about by any of a variety of reasons, can lead to a general or specific collapse of the immune system, or other system failure. Consequently, it is

[‡]Those wishing to practice NSA solely as wellness care must be duly certified personally by Dr. Epstein, and meet all requirements for practice as established by the Association for Network Care (ANC). For further information please contact the ANC at: www.associationfornetworkcare.com.

noteworthy that while NSA care does not seek to bring about a cure for any medical condition, any given recipient could possibly fit the profile of one hoping for a non-medicinal or non-surgical approach to correct or resolve a specific medical condition.

Clinical observations and published case reports [18] do attest to improvement in certain medical conditions in some recipients while receiving NSA care. Nevertheless, although amelioration of certain medical conditions may occur concomitant with NSA care, NSA practice as described in this paper is an application that extends beyond where the biomedical and therapeutic approaches end.

**Complementary/AlternativeMedicine (CAM)**

A distinction between various CAM approaches has been described by Schuster et al. [16] They point out that CAM modalities vary widely in scope of practice, healing objectives, and individual motivations for use. Although NSA may not share allopathic objectives as many CAM approaches do, certain values common to CAM practices including "high level wellness," "the interpretation of mind, body and spirit," and "holism/individual," "self-healing," and principles of vitalism are shared.

There are several CAM approaches that fall under the larger category of "somatic education." [19] Each of these approaches has some relationship between consciously learned movements of the body and enhanced state of mind, and for some, enhanced physical performance. A major distinction between these types of CAM and NSA, also a body-mind discipline, is reflected in the fact that the Respiratory and Somatopsychic Wave phenomena characteristic of NSA care are not consciously initiated, though they can be consciously ceased.

This distinction suggests that a mechanism, not apparent in other CAM approaches may be operable in regard to NSA care. Thus, NSA care as a unique non-allopathic approach to health and wellness will continue to evolve as the body of knowledge is broadened through research and clinical observations.

**Hallmarks: Overview of a Wellness Education Paradigm**

Since it is possible for clients to "transfer" the conditioning of illness thinking into their experience under "wellness" care it is important to consider wellness education as integral to eliminating pre-conditioned "well" versus "illness" thoughts and actions. That is, because health and illness for the most part remain embedded in traditional definitions, new perceptions and perspectives regarding these successful approaches and the concept of wellness, merit new models that are congruent with these ideas. Consistent with the development of new models, it is important to refine the practitioner's care as a form of education centered on wellness as distinct from illness care.

Some of the hallmarks involved in implementing a wellness education paradigm are presented. Several of the concepts discussed rely upon specific application of terms that are now appearing more frequently in the literature, often reflect different definitions or meanings. To maintain continuity, the ideas of health and wellness as presented in this treatise are differentiated.

**Differentiation of Terms**

**Health**

Health has been defined by the World Health Organization as "a state of complete physical, mental, and emotional well-being, not merely the absence of disease or infirmity."[20] Moreover, the current Physician's Desk Reference medical dictionary [21] defines health as "a state of characterized by anatomical, physiological, and psychological integrity, ability to perform personally valued family, work, and community roles; ability to deal with physical, biological, and psychological and social stress; a feeling of well-being and freedom from the risk of disease and untimely death." As Schuster et al[16] point out, "clearly the biomedical as well as the social science community now acknowledges, theoretically, if not empirically, the multifaceted and complex nature of health and well-being." Moreover, Schuster et al[16] note that a consensus is developing that health includes several domains including physical, psychological, mental, emotional, intellectual, social, and spiritual.

**Wellness**

Following an extensive review of the literature, Schuster et al,[16] define wellness relative to physical, psychological, mental, emotional, intellectual, social and spiritual health domains "as a higher order construct *integrating* these domains, and necessarily draws on the level of individual self-perception. Thus, we conceptualize wellness as the *generalized self-perception* of health. From this perspective, wellness is distinct from health-illness; an individual can deem themselves to be in an acceptable state of wellness whether they experience sub-optimal "health" in any given domain or area of functioning (see Greenberg, 1985.[22])" This concept of wellness, developed by Schuster et al, provides a novel description amply reflecting clinical observations by NSA practitioners and client self reported benefits of care.

They also point out "as wellness is a generalized self-perception, the relative importance of each domain is unique within each individual, while also incorporating the health values and beliefs of the surrounding social environment." (Greenberg,[22] as cited by Schuster et al.).[16] While the authors also clarify that "we are only beginning to address the dynamics of wellness," one important contribution to the concept of measuring wellness has been presented by Blanks et al.[2] In that study, wellness was assessed by summing scores for four health domains: Physical State, Mental/Emotional State, Stress Evaluation, and Life Enjoyment. This constituted a combined wellness scale. In their study a wellness coefficient was determined by comparing the scale "presently" and "before Network." The scale ranged from –1 to +1, with zero representing no change.

Another important contribution regarding the dynamics of wellness stem from the work of Schuster et al[6] linking exogenous variables to wellness through structural equation modeling (SEM). Analyzing data from the study of a population of over 2800 Network Chiropractic (now known as NSA) recipients, Schuster et al demonstrated that gender (females greater than males), and post-college education impact in a significant positive manner on perceived wellness.

Also, other authors have envisioned the idea of wellness from a position of developmental states of consciousness. While these ideas often lack empirical evidence they do provide concepts that can be tested for veracity. The collective writings of Pearce,[23] Epstein, [24] Pert, [25] Wilber, [26] and Wade [27] seem to provide a theme directed to the spiritual aspects of self-perception. This theme suggests that wellness is an integral state linking the personalized and undeniable experience of connection with a perceived transcendent source of strength and wisdom. One also experiences a sense of community, peace, wisdom and well-being. Wellness is manifested as movement towards deepening states of perception regarding one's total environment, refinement of adaptive responses, and an evolving pliable sense of self. Moreover, wellness is accompanied by a heightened sensitivity to emotions or actions involving gratitude, forgiveness, empathy, love and compassion in relation to the individual's life experiences. It is recognized that individuals will realize the experiences presented above in a progressive manner as the journey to wellness unfolds.

## Developing a Wellness Mentality

### Providing Information

An important step in a wellness education paradigm is to provide information that might not be obtained in allopathic approaches. In this context, wellness education cannot adhere to the concept of single causes for any particular condition or problem. This may be difficult, as heretofore many health care disciplines have promoted this viewpoint either by design or default. For example, the medical physician would see the tumor or the bacteria, virus or alteration of body chemistry to be the cause of a problem.[28]

The doctor of oriental medicine would see it to be an interruption to the flow of chi or life force.[29] The homeopathic physician seeks the remedy that in larger amounts would create the gestalt of the disease.[30] For the chiropractor, the problem is a vertebral subluxation altering communication between the brain and other tissues. [31] The nutritionist sees the cause as a lack of or excess of particular foods or other substances.[32]

Thus, recognition that illness is not simple cause and effect, but rather a complex phenomenon linked to and reflecting many aspects of the individual is essential to develop a wellness mentality.

### Awareness of Wellness Versus Illness Actions

Belief plays a significant role in healing and maintaining health. Belief can also guide our actions. For example, the causative pathophysiology and prognosis as reported to a patient, is often as much a product of the culture of belief of the practitioner as it is a product of clinical findings. However, research has also shown that personal belief can have healing or other positive restorative effects. [33] That is, just as nocebo, or negative belief can produce a negative outcome, placebo or positive personal belief can bring about healing or other positive restorative effects that may be classified as promoting a sense of wellness.

Thus, wellness and illness are viewed as a continuum, each representing an extreme. At any given time, one's position along the continuum represents the window through which the individual experiences their body, life circumstances, symptoms, sense of self, relationships and their world location in general.

A "wellness lifestyle," [6] whether considered as a reflection of empirical evidence or envisioned through subjective insight, is thought to manifest through human expression in a manner distinct from illness behavior. It is becoming increasingly evident that the actions taken by individuals that abide in the 'sickness" mode are quite different from those espousing the "wellness" mode. Macenbach et al.[34] compared determinants of excellent health with those of ill-health. The determinants were measured as absence of complaints of health and very good self-assessments of health. The authors concluded that education, employment status, age and gender accounted for two to three times the variance in ill-health compared to excellent health. Schuster et al.[16] suggest that the concept of positive health is empirically distinct from ill-health. Pizer [35] has pointed out that the sickness mode prompts action only when the sickness is apparent, whereas individuals enter the "wellness" mode voluntarily seeking ways to improve their overall state, thus avoiding the "sickness" mode. These concepts are important hallmarks for any practice that espouses a wellness model as the basis of care.

One could argue that the successful wellness outcome is linked to the specific intervention, but clearly the overall success of the health care system (or approach) is determined by many other factors. As pointed out by Benson,[36] and Barrett.[37] Patient care has become imbalanced by the heavy reliance on pharmaceuticals and surgery/procedures. Both authors contend that self-care must be reintroduced to balance the equation. Benson,[7,38], like authors of earlier chiropractic literature, points out that the individual must draw upon the body's restorative capabilities. Benson further points out that three components of his concept of "remembered wellness" are: (1) belief and expectancy on the part of the patient, (2) belief and expectancy on the part of the caregiver, and (3) belief and expectancies generated by a relationship between the patient and the caregiver. Thus, the modern wellness practice must carefully adjust belief and expectancy to maintain the balanced perspective that optimizes healing.

### Awareness of One's Body

It is well accepted that trauma can lead to alexithymia.[39] Alexithymia, is characterized by incapacity to recognize, name, or verbalize emotions,[40] and may be accompanied by alexisomia, or lack of body awareness.[17] This conditions inhibits an individual's ability to experience somatic awareness that "constitutes an innate wisdom that people have about their own psychobiological health." [17] When these conditions operate collectively or separately the person has lost the body-mind connection that is central to healing and health. This is borne out by studies showing that alexithymia is linked to subjective reports of poor health and physical symptoms.[41,42] One study ranked alexithymia as predictive of a greater risk of all cause death in a population of Finnish middle-aged men.[43]

Fortunately, positive changes in cognitive awareness of one's soma, including the spine, are observed in those receiving NSA care.[2] This essential component of healing and wellness, consistent with the concept of somatic awareness, may account for

self-reported improvement of clients of NSA. That is, as clients begin to experience improved perceptions of wellness, health, and overall quality of life, these perceptions are likely to be more pronounced compared with those who have been far distanced from "self."

**Summary and Conclusions**

1. The practice of NSA care has been transitioned from a health care system with the objective of correction of two types of vertebral subluxation, to a multi-component system of health care delivery with emphasis on wellness education for participating clients. While wellness education is not formally included as part of current NSA practice, this concept will be taught through a developing Certificate Program offered at the university level. Wellness education will be provided through a module and personalized lectures that involves the six components outlined in this paper. These components pertain to the concepts of illness and wellness that have evolved from academic literature and the popular press. This program is expected to be operational in 2004.
2. NSA is currently delivered and communicated in discrete Levels of Care with emphasis on client participation through self-reports. This transition was based on clinical observations and research findings that suggested the need for attention to the manner in which the unique somatopsychic and respiratory waves were initiated. This has been achieved through the development of three (a fourth is in development) Levels of Care, each with its own objectives and markers to designate progress.
3. The clinical philosophy has also evolved to include dialog between practitioner and client concerning survey self-reporting and wellness actions as opposed to illness behavior as part of the care regimen. This participation by the recipient of care creates a client-centered practice, focused on an awareness of outcomes by both client and practitioner.
4. New clients often visit NSA practitioners while receiving concomitant care either with a chiropractor, medical physician, or complementary/alternative practitioner. Consequently NSA care is positioned relative to these disciplines. NSA care is of benefit to chiropractors practicing with the professional objective of correction vertebral subluxation. While NSA care does not share objectives with biomedicine, clinical observations and published studies indicate that medical conditions may ameliorate or abate in recipients of NSA care. Although objectives may be different, NSA care shares some common values with other CAM approaches.
5. The current model of NSA is developing as a wellness education paradigm in addition to physical care. That is, among those receiving care adaptation of better health promoting life styles become apparent, as well as reports of overall quality of health and quality of life, increased perceived wellness, and enhanced somatic awareness. As these are all aspects of a developing wellness mentality, they are supportive of the success to date of the current method of providing NSA care.
6. It is clear that a wellness education paradigm must consider a number of variables. It is seemingly apparent that regardless of the system of care practiced, the outcomes related to a true wellness model are common to all. These variables will include establishing a mindset for both the practitioner and patient (client). That mindset will include cessation of seeking a singular cause for a given condition. This also includes the development of somatic awareness, experience of and trust in the body's innate restorative and healing ability, the clients' consideration of personal physical, mental, and emotional circumstances profiling their life, and ultimately a consistent and valid measurement of progressive outcomes derived from the care received. In order to integrate all of these variables, it may be necessary for practitioners in different disciplines to work in concert to share expertise regarding aspects of patient (client) care not regularly considered part of their training.
7. An active university based research program is maintained to provide evidence related to outcomes association with NSA care, as well as a means to measure those outcomes. In that regard, research conducted in regard to NSA care has produced a health and quality of life questionnaire that is applicable to any health care approach. The self-evaluation aspect of wellness care must have such an instrument to legitimately measure the subtle to profound changes that are being perceived by those under care. Additionally, NSA care is researched on a continuous basis to investigate its mechanism(s), contraindications (if any), global effectiveness, consistency of delivery, range of benefits, and patient (client satisfaction). This level of scrutiny enhances both public confidence and the practitioner's comfort in its delivery.
8. The need for continuing documentation that the wellness education approach is resulting in outcomes that justify its existence is imperative. Thus, continued research, publication of findings, and funding to carry out such costly research are agenda items that must next be considered in sustaining a client-centered wellness education system of health care delivery.
9. It is intended that the hallmarks presented in this paper will be of value to other practices with wellness objectives.

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CASE STUDY

# Successful In Vitro Fertilization in a Poor Responder While Under Network Spinal Analysis Care: A Case Report

*Simon A. Senzon, MA, DC*

**ABSTRACT**

**Objective:** This case report describes the successful in vitro fertilization (IVF) of a 34 year old female who had one previous aborted IVF attempt prior to Network Spinal Analysis (NSA) care. This case report is being presented to add to other case reports that show positive physiological changes in patients receiving NSA care.

**Clinical Features:** The IVF was attempted due to her partner's azoospermia. The first IVF attempt was on 3/26/02. The patient had a poor follicular growth after the standard hyper-stimulation process of the ovaries, including pre-treatment with Mircette (birth control pills) and 1mg/0.2ml of Lupron (a gonadotropin releasing hormone agonist), and 3-6 amps of Gonal-F (a recombinant fsh) starting on cycle day 3. Her baseline day 3 estradiol and LH levels were only 21.2pg/me and 5.0 I.U./L respectively. On cycle day 8, estradiol was only 56% and LH was 6.6 I.U./L. The Gonal-F was increased to 6amps. This first attempt was canceled due to the poor follicle growth. Only 3-4 follicles of insufficient size between 10-14mm each were found.

**Chiropractic Care and Outcomes:** On 4/11/02, the patient commenced regular NSA care. The second IVF attempt began on 6/6/02. The change in IVF protocol was the addition of Repronex (also a gonadotropin a combination of LH and fsh). The total increased dose of Gonal-F and Repronex was 6amps, compared to the first attempt of only 3amps which was then increased to 6amps of Gonal-F only.

**Conclusion:** On the second IVF attempt, estradiol was 1001pg/ml on day 8, and 2019pg/ml on day 11, with LH at 9.3. The Oocyte retrieval after the second attempt was 10 eggs, each approximately 18mm. A successful aspiration of eggs was completed on 6/17/02, and a successful pregnancy followed. The patient is still under NSA care, and is now in her second trimester with normal fetal heart sounds. The possible role of NSA care in the vigorous follicular growth and other health benefits is discussed.

**Key words:** *Network Spinal Analysis, NSA, In Vitro Fertilization, IVF, poor responder, hypothalamic-pituitary-ovarian axis, GnRH pulse generator, vertebral subluxation, chiropractic, infertility*

## Introduction

This case is reported as a contribution among other reports of physiological changes occurring in patients while under NSA care.[5-7] The present report describes a 34-year-old female Caucasian undergoing in-vitro fertilization (IVF). Prior to Network Spinal Analysis care (NSA), the patient underwent an aborted attempt at ovarian hyperstimulation at a private fertility clinic. Her follicle growth was only 4 four small follicles, which classified her as a poor responder. After commencing NSA care, which is a non-allopathic, non-therapeutic, form of health care,[1] the patient underwent a second successful attempt at IVF. Her follicle growth increased to 10 preovulatory sized follicles. This success was more than expected. The only change in the IVF protocol was a standard increase in gonadotropins, which is not a predictor of increased oocyte growth,[2] and may not improve the chances of a successful pregnancy in poor responders.[3] In one study, poor responders to 3amps of gonadotropin per day have a low pregnancy and birth rate even if the hMG is increased to 6amps and a high number of follicles and oocytes grow (as in this case). This may be due to poor quality of follicles and oocytes.[4]

Poor responders have a low chance of success. In fact, poor responders show characteristics of ovarian aging[8] and ovarian failure.[9] Protocol seems to make no difference in improving the chances of poor responders,[10] including an increase in gonadotropin. Although a minidose of GnRH is the first line of therapy,[11] one study showed 39.6% of poor responders out of 111 subjects did not respond at all to increased GnRH protocol.[12] The use of birth control pills as a preliminary approach to the GnRH flare-up protocol (as in this case), does not always

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make a difference with poor responders.[13] One study showed that lower doses of gonadotropins may be more predictive of a successful pregnancy than higher doses, and that higher doses may affect oocyte quality or endometrial receptivity.[14] In light of these facts, this patient had a successful ovarian stimulation which led to pregnancy. The possible correlation of NSA to the success of her pregnancy is explored.

## Case Report

### *Patient Presentation and Relevant History*

The patient presented for NSA care on 4/11/02. She complained of a "sore throat," and a "stiff and painful neck", she stated a desire to gain "overall balance and a release of neck pain" as an outcome of her care. She also stated that, "We'll be doing in vitro fertilization in the near future and I want to be receptive, balanced, and prepared." Thus one of her reasons for seeking NSA care was help with the IVF process. She stated a hope that NSA care would help her to be relaxed through the stressful IVF protocol, enhancing her ability to conceive.

The patient initially sought help for fertilization in June of 2001. Her laboratory findings from 6/19/01 showed a normal progesterone count of 14.50ng/mL. Her laboratory report from 7/23/01 showed a normal Prolactin count of 10.6ng/mL as well as normal FSH at 5.0mIU/L and TSH at 1.87mcIU/mL. She started regular visits at the reproduction clinic on 10/5/2001 with her partner. Her partner was diagnosed with azoospermia with a lack of vas deferens bilaterally. On 1/21/02 they were referred for genetic counseling due to their history of infertility. Viable sperm were available, due to percutaneous sperm aspiration, and so they were good candidates for IVF.

On 3/26/02, the patient underwent an IVF cycle, which began with 1mg/0.2ml of Lupron (a gonadotropin releasing hormone agonist), combined with Mircette (birth control pills). Her baseline estradiol was 21.1pg/ml and LH 5.0 IU/L. She was then given 3 ampules of Gonal-F (a gonadotropin) for five days, and on the eighth day of her contraceptive cycle, she had a low development of follicles: only 2 or 3 exceeded 10mm. Her estradiol was 56pg/ml, and LH 6.6 IU/L. Gonal-F was increased to 6amps for two more days. On the tenth day, there were only three follicles on the left ovary between 10- 12mm, and one on the right measuring 14mm. Due to the possible difficulty of conception with the azoospermia which otherwise relies on epididymal or testicular sperm for insemination, and such a low follicle count, the procedure was canceled. She was instructed to discontinue the medications and await a normal menstrual cycle before the procedure was attempted again. Her doctor explained to her the "poor prognosis" that is normal for "poor responders" and hence the decision to cancel the IVF attempt.

On 5/10/02, the patient presented on day three of her cycle with a 24mm cystic structure on the right ovary. This was diagnosed as a possible functional cyst from the previous cycle. Another scan was scheduled for the next menses.

### Clinical Findings and Impression

Evaluation of the patient on 4/11/02, following presentation for NSA care, reflected a standing postural evaluation of a left head tilt, an elevated right shoulder, and an elevated left hip. There was some cervical pain with flexion and extension, a restriction to left and right lateral bending, with pain and restriction on both left and right rotation. Anterior head carriage was approximately one inch. Prone spinal analysis revealed bilateral heel tension, bilateral inversion stress, bilateral leg adduction resistance, as well as bilateral leg abduction resistance.[1] On a scale of 1-5, 5 being the highest level of tension, all of the prone analyses were between 3-5. Seated muscle palpation[15] revealed moderate active muscle tension over the entire cervical spine, with mild muscle tension in the upper thoracic region. Mid and lower thoracic active muscle tension was moderate, while the lumbar spine held a high level of muscle tension. Passive vertebral (bony) palpation revealed mild tension in the upper cervical region, high tension in the mid-cervical region, and moderate tension in the lower cervical region. A high level of passive subsystem tension was found in the thoracic and lumbar spine. Sacral passive tension was moderate.

Paraspinal surface electromyography (semg) using the Insight Millenium Second Generation Subluxation Station, showed readings of normal muscle activity at T2(L), T8(L), T12(R), L1(L), L3(R), L5(L), and S1(L). Readings indicating mild elevation of muscle activity were recorded at T4(R), T6(L),

**Table 1a**
**April**

| %DF | NSD | Norm | UV | Site | UV | Norm | NSD | %DF |
|---|---|---|---|---|---|---|---|---|
| >>> | 1.6 | 3.8 | 21.4 | C1 | 24.4 | 3.9 | 1.8 | 14 |
| 17 | 1.8 | 4.4 | 33.3 | C3 | 28.5 | 4.3 | 1.7 | <<< |
| 30 | 1.8 | 4.2 | 12.5 | C5 | 9.6 | 4.1 | 1.8 | <<< |
| 140 | 1.9 | 4.8 | 52.0 | C7 | 21.6 | 4.6 | 2.0 | <<< |
| >>> | 2.7 | 4.9 | 14.2 | T1 | 50.9 | 4.9 | 2.6 | 257 |
| >>> | 2.8 | 5.0 | 6.3 | T2 | 34.6 | 5.0 | 2.9 | 451 |
| 118 | 3.0 | 6.5 | 24.8 | T4 | 11.4 | 6.4 | 3.2 | <<< |
| >>> | 3.5 | 8.4 | 13.4 | T6 | 22.8 | 8.2 | 3.5 | 71 |
| >>> | 4.1 | 9.6 | 9.9 | T8 | 22.6 | 9.5 | 4.5 | 129 |
| 39 | 4.2 | 10.0 | 26.0 | T10 | 18.7 | 10.0 | 4.3 | <<< |
| >>> | 4.5 | 9.8 | 7.4 | T12 | 12.6 | 9.8 | 4.4 | 72 |
| >>> | 4.1 | 8.7 | 8.5 | L1 | 16.5 | 8.7 | 4.0 | 94 |
| >>> | 3.1 | 6.1 | 5.5 | L3 | 6.7 | 6.2 | 3.4 | 22 |
| >>> | 3.2 | 5.2 | 7.4 | L5 | 9.6 | 5.3 | 3.5 | 31 |
| >>> | 2.7 | 4.4 | 4.6 | S1 | 7.4 | 4.4 | 2.8 | 62 |

**Table 1b**
**August**

| %DF | NSD | Norm | UV | Site | UV | Norm | NSD | %DF |
|---|---|---|---|---|---|---|---|---|
| >>> | 1.6 | 3.8 | 2.6 | C1 | 5.4 | 3.9 | 1.8 | 110 |
| >>> | 1.8 | 4.4 | 4.1 | C3 | 4.6 | 4.3 | 1.7 | 13 |
| >>> | 1.8 | 4.2 | 4.6 | C5 | 5.4 | 4.1 | 1.8 | 16 |
| >>> | 1.9 | 4.8 | 5.3 | C7 | 7.3 | 4.6 | 2.0 | 38 |
| >>> | 2.7 | 4.9 | 5.2 | T1 | 7.5 | 4.9 | 2.6 | 45 |
| >>> | 2.8 | 5.0 | 4.8 | T2 | 7.3 | 5.0 | 2.9 | 53 |
| >>> | 3.0 | 6.5 | 7.7 | T4 | 10.7 | 6.4 | 3.2 | 39 |
| 1 | 3.5 | 8.4 | 12.1 | T6 | 12.0 | 8.2 | 3.5 | <<< |
| >>> | 4.1 | 9.6 | 12.3 | T8 | 12.9 | 9.5 | 4.5 | 5 |
| >>> | 4.2 | 10.0 | 9.2 | T10 | 11.3 | 10.0 | 4.3 | 22 |
| >>> | 4.5 | 9.8 | 7.3 | T12 | 10.2 | 9.8 | 4.4 | 40 |
| >>> | 4.1 | 8.7 | 4.6 | L1 | 6.9 | 8.7 | 4.0 | 52 |
| >>> | 3.1 | 6.1 | 2.7 | L3 | 3.6 | 6.2 | 3.4 | 31 |
| 32 | 3.2 | 5.2 | 2.5 | L5 | 1.9 | 5.3 | 3.5 | <<< |
| >>> | 2.7 | 4.4 | 1.8 | S1 | 2.0 | 4.4 | 2.8 | 9 |

Table 2

| Postural Analysis | April | August |
|---|---|---|
| Anterior Head Carriage | 2 inches | 1 inch |
| Head Tilt | Right | None |
| Right Shoulder-Elevated | Yes | Yes |
| Left Pelvis-Elevated | Yes | Yes |
| Cervical Rotation (R) | Restricted | None |
| Cervical Rotation (L) | Restricted | None |
| Cervical Flexion | Pain | None |
| Cervical Extension | Pain | None |
| Lateral Bending (R) | Pain and Restriction | None |
| Lateral Bending (L) | Pain and Restriction | None |

L1(R), L5(R), and S1(R). Indications of moderate elevation of muscle activity were found at T8(R) and T10(R). High levels of muscle activity were noted by three standard deviations above normal means found at C1(L), C1(R), C3(L), C3(R), C5(R), C5(L), C7(L), C7(R), T1(L), T1(R), T2(R), T4(L), T6(R) and T10(L). Areas of significant asymmetry between the left and right side were noted at C7(L), T1(R), T2(R), T4(L), T6(R), T8(R), T10(L), T12(R), L1(R), and S1(R). The clinical impression for this patient was multiple facilitated subluxations at C5, C2, C1, as well as the sacrum. Light contacts were made at C5/6 on the right, C1/2 on the left as well as C2/3 on the right, and at S2 on the left to correct for an anterior and inferior sacrum on the left.[16] The initial plan of care involved 3 visits per week for 12 weeks, followed by 2 visits per week for the next 4 weeks. Thus, the patient was seen 2 or 3 times per week for 16 weeks, at which time a re- evaluation was conducted. At each visit, she was administered the appropriate NSA care based on clinical findings revealed through the analyses described above. [1]

**Results**

On 6/6/02 the second IVF procedure was initiated on the second day of her menstrual cycle. The patient was placed on 1mg/0.2ml Lupron on cycle day 21, in a pretreatment cycle. On day 3 of the next cycle, she was reduced to 0.05ml . On the third day of her menstrual cycle, she was placed on 3 amps of Gonal-F (which is recombinant fsh) and 3 amps of Repronex (which is human menopausal gonadotropin). On day eight of her menstrual cycle, her estradiol was 1001pg/ml, and five follicles were developing on each ovary. The patient's medical report stated a surprise on the part of the attending physician that such a vigorous response was observed in consideration of the previous poor response. On day ten of her menstrual cycle, the Gonal-F and Repronex were decreased to 2amps twice daily. At this time, the estradiol was 1617 pg/ml, and LH was 93%. On day 11 of her menstrual cycle, the estradiol was 2019pg/ml, with nine follicles approximately 18mm each (with two that were greater than 18mm). A human chorionic gonadotropin (HCG) injection was given, and the aspiration was completed 36 hours later. On day 13, nine eggs were found. Pregnancy was successfully established. From 4/11/02 through 6/13/02, the patient completed 21 NSA visits. A re-examination was completed on 8/1/02 after a total of 34 visits. Improvement was noted in all elements of the spinal evaluation including range of motion, prone spinal examination, seated palpation, and semg (tables 1a & b). There was no pain or restriction in any range of motion (table 2). Posture remained with a slight elevation of the right shoulder and left hip. Prone indicators of heel tension, inversion stress, abduction stress, and adduction stress were all below 3 on a scale of 1-5, 5 being the greatest tension[1] (table 3). Seated muscle and segmental palpation rated all areas from moderate to mild (table 4 & 5).

Table 3

| Exam Findings | April | August |
|---|---|---|
| Abduction Restriction (L) | 4 | 3 |
| Abduction Restriction (R) | 4 | 3 |
| Adduction Restriction (L) | 5 | 2 |
| Adduction Restriction (R) | 5 | 2 |
| Heel Tension (R) | 5 | 2 |
| Heel Tension (L) | 4 | 2 |
| Inversion Stress (R) | 3 | 1 |
| Inversion Stress (L) | 4 | 2 |

Paraspinal surface electromyography (semg) found decreased muscle activity at L1(L), and L3(L). Normal muscle activity was found at C1(L,R), C3(L,R), C5 (L,R), C7(L), T1(L), T2(L,R), T4(R), T8(L,R), T10(L,R), T12(L,R), L1(R), L3(R), L5(L,R), and S1(L,R). Indications of mild elevation of muscle activity were found at C7(R), T1(R), T4(R) and T6(L,R). There were no areas of high muscle activity. Areas of significant right versus left muscle activity asymmetry were noted at, C1(R), C7(R), T1(R), T2(R), T4(R) and L1(R). It should be noted that asymmetry from the first scan showed 9 areas that were greater than 60%, while asymmetry from the re-scan showed only one area greater than 60% (Table 1a &1b).

Table 4

| Muscle Palpation | April | August |
|---|---|---|
| Upper Cervical | 2 | 1 |
| Middle Cervical | 2 | 1 |
| Lower Cervical | 2 | 2 |
| Upper Thoracic | 1 | 1 |
| Middle Thoracic | 2 | 1 |
| Lower Thoracic | 2 | 1 |
| Lumbars | 3 | 2 |
| Upper Sacrum | 1 | 1 |

Table 5

| Bony Palpation | April | August |
|---|---|---|
| Upper Cervical | 1 | 1 |
| Middle Cervical | 3 | 2 |
| Lower Cervical | 2 | 1 |
| Upper Thoracic | 3 | 2 |
| Middle Thoracic | 3 | 2 |
| Lower Thoracic | 3 | 2 |
| Lumbars | 3 | 1 |
| Upper Sacrum | 2 | 2 |

An NSA intermediate care self-reported assessment was administered on 8/12/02. Instructions were, "Please answer the following questions with regard to the time since beginning care in this office." The patient's self-reported assessments are presented in table 6.

**Discussion**

The IVF process is based on the neuroendocrine regulation of the female reproductive system.[17] Normal follicle stimulation is dependent on a number of factors such as the release of

| Table 6 | |
|---|---|
| **Self Reported Assessment** | **Rating** |
| Musclar Comfort | 3 |
| Ease of mm Recovery from injury | 3 |
| Feelings of ease, peace | 3 |
| Ease of Breathing | 2 |
| Areas where I experience Breath | 2 |
| Experience of gratitude/joy | 2 |
| Ease of mm Movement | 1 |
| Depth/Vol of respiration | 1 |
| Ease of breath during exercise | 1 |
| Experience of release of spinal tension | 1 |
| Experience of body's rhythms | 1 |
| Muscular Strength | 0 |
| Nervousness | -1 |
| Depression or lack of interest | -1 |
| Difficulty concentrating | -1 |
| Difficulty falling asleep | -2 |
| Moodiness or temper | -2 |
| Fidgety or restlessness | -2 |
| Over reach to life stresses | -2 |

GnRH (gonadotropin releasing hormone) from the pulse generator in the hypothalamus, the response to this from the pituitary gland, and its release of gonadotropins (lutienizing hormone (LH) and follicle stimulating hormone (fsh)).[18] If GnRH is released at a frequency of 1 pulse per hour, then normal follicular growth ensues.[19] The first 14 days of the 28 day menstrual cycle is associated with an increase of frequency and amplitude of the GnRH pulse as well as folliculogenesis. The second fourteen days is associated with a decrease of amplitude and frequency of the pulse.[20] The frequency change and amplitude are related to plasma levels of estradiol and progesterone. Progesterone is thought to be a regulator of the pulse generator. [21,22] In order for IVF to occur, the ovaries are stimulated by exogenously increasing the FSH and LH. One study found normal follicle growth for Caucasian women between the ages of 28-37 undergoing standard IVF protocol and ovarian stimulation to be 8.7 +/- 4.4 oocytes, while appropriate estradiol levels were approximately 1006pg/ml.[23] In another study, women between 30-34 years of age, also undergoing ovarian stimulation, had an average oocyte retrieval of 10.2 +/ - 7.1, with estradiol levels at 871pg/ml.[24] Another investigation has shown that poor responders had 4.5 follicles, versus 7.5 in successful responders, with peak estradiol at 752pg/ml versus 1346pg/ml.[25] Based on these findings, the NSA patient discussed in this report was justifiably classed medically as a poor responder.

Due to the low success rate of overall pregnancy in poor responders, the positive response of this patient is significant. Especially since the known methods of follicle stimulation in poor responders does not show a significant increase in successful pregnancy. Poor responders may even represent early ovarian aging or failure.[8,9] Many factors can contribute to poor follicular growth and the disruption of the hypothalamic pulse generator, including stress, environment, exercise, sleep, and drugs.[20,26] The most primary disruption of the cycle is to the frequency and amplitude release of GnRH from the hypothalamus.[20] The pulse generator in the medial basal hypothalamus is due to oscillations of electrical activity. Any deviation of normal pulse frequency will disrupt the menstrual cycle.[19] Other factors that could disrupt this cycle are a breakdown in the hormonal feedback mechanisms. Both progesterone and estradiol are crucial to the success of the cycle. A decrease in estradiol will diminish progesterone production, and progesterone is essential to signal the amplitude and frequency of the pulse generator.[17, 27, 28] This may not directly affect the pulse generator in this patient's case, since progesterone is not released until after ovulation in a normal cycle. It may be possible that the normalization of stress levels prior to this cycle had an effect. There is no way of definitively knowing this in this case. IVF procedure does not rely on the pulse generator to boost gonadotropin, since Lupron effectively shuts down the pulse generator. So, while a normalization of the pulse generator in normal cycles would have a great effect on the follicular cycle, it may not be effected during an IVF cycle.

It is not possible in this case report to distinguish the possible effects of NSA and the increase in Repronex, both of which occurred prior to the successful IVF. That is, the increased vigorous response of the patient's oocyte growth could be related to the addition of Repronex, which was consistently at 3amps for the entire six days on the successful IVF (in addition to the 3amps of Gonal-F), as opposed to 3amps of only Gonal-F, which was then increased to 6amps on the first attempt. However, the possible role of NSA care is also of interest as reports suggest that such care may influence physiological processes.

There is some evidence that NSA care may elicit a neurological response that has been referred to as a "sympathetic quieting affect,"[6] the possible restoration of normal immune function,[5] and other neurophysiological changes over time.[7] As well, other factors relating to an increased state of wellness have been self-reported.[29] The positive outcomes associated with NSA care[5-7, 29] may be mediated through the spinal stabilizing subsystems which have been termed: active subsystem (muscles and tendons of the spinal column), passive subsystem (vertebra, discs, articulations, ligaments of the spine, as well as joint capsules and passive mechanical aspects of muscles), neural control subsystem (force and motion transducers of the ligaments, tendons and muscles, as well as the neural control centers),[15] and emotional subsystem ("informational substances" such as neuropeptides, which occupy the same anatomical and physiological locations as the other subsystems)[16] or emotional motor system (proposed to dissipate tension from the limbic system through large muscle movements).[30] The dissipation of spinal tension, as observed with this patient, may be mediated through the subsystems described above, most notably through the active muscle system, and the emotional motor system which has branches from the limbic system through every segmental level.[30]

The effect of stress on the menstrual cycle is well documented. In one study, endotoxin was injected into ovary-intact ewes to simulate the stress inflammatory response. [31] The endotoxin disrupted the frequency pulses of LH (which is a good indicator of the pulse generator frequency). [27] Follow-up studies on overiectomized ewes demonstrated that endotoxin inhibited pulsatile LH secretion at both hypothalamic and pitu-

itary levels.[31] Many factors can affect the activity of the pulse generator, including stress, drug intake, exercise, and sleep.[26] The release of corticotropin releasing hormone and vasopressin during the stress response mediated two actions on the menstrual cycle, the first is the inhibition of the gonadotropin-releasing hormone pulse generator, and the other stimulates gonadotropin secretion.[32] Impaired follicular development may be the most common reproductive dysfunction attributable to stress.[33]

NSA care may influence the neurophysiology of the stress response. The patient showed indications of this effect, including: a decrease of neurological findings in the spinal analysis at reassessment periods, a decrease of muscle activity as indicated by the semg readings, and post self-reported questionnaire responses. This suggests an improvement in health and quality of life while under NSA care. Since a qualitative change in the frequency or amplitude of the pulsatile gonadotropin signal is known to disrupt follicular development,[19,20] the proposed "sympathetic quieting effect"[6] associated with NSA care may have allowed for a normalization of frequency from the pulse generator in this patient. Data derived from unpublished semg studies have provided preliminary evidence that the somatopsychic wave[16] has dynamical properties, which become more predictable as the level of NSA care increases.[16,7] It is possible that the dynamics of such care are linked to the menstrual cycle as it is also proposed to be a dynamic and robust system.[34] Examining the evidence from Knobil,[19] and Filicori,[20] among others, while examining what they call, "physiology on the edge of chaos," Solé and Goodwin write, "The follicle, tuned to a narrow frequency range of pulsatile gonadotropin signal, fails to grow and mature if this range is violated."[31] Frequency control is one way for the dynamic regulation of the cycle. Solé and Goodwin continue, "A great many different processes, operating on different time scales, are all interacting. An extraordinary range of frequencies are integrated into a single coherent cycle: hypothalamic firing patterns of 3,000 cycles per minute (50Hz) alternating with 17 Hz firing frequency of 1 cycle per 28 days (4.14 x 10- 7 Hz). This is eight orders of magnitude in the frequency range!" Other influences they note are signals associated with emotional and nutritional states that can disrupt the menstrual cycle.[34] With so many interacting variables, the disruption of one aspect of the system can have many health consequences.

## Conclusion

In conclusion this report contributes to the literature supporting the positive physiological changes associated with NSA care. A postulated "sympathetic quieting affect" may have been a contributing factor in this patient's successful IVF and pregnancy. Further research is necessary to examine the role of NSA care in relation to sympathetic tone, the menstrual cycle, and the hypothalamus. It may be of interest to investigate the influence of NSA care in normally menstruating women who have had plasma levels of Lutienizing Hormone (LH) assessed regularly. Frequency pulsation of LH is a good indicator of the pulse generator's frequency and amplitude.[27] Optimally, this testing would be done every ten minutes for thirty days. Such findings could be compared to other such studies.[15] Or, the LH plasma could be monitored at less frequent intervals, this would give a useful though incomplete picture of LH frequency.[17,31] As well, a more general study would be useful to compare the success rates of a group of poor responders who are receiving NSA care, to a similar control group not receiving NSA care.

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REVIEW

# Insult, Interference and Infertility: An Overview of Chiropractic Research

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**ABSTRACT**

**Objective:** Infertility is distinct from sterility, implying potential, and therefore raises questions as to what insult or interference influences this sluggish outcome. Interference in physiological function, as viewed by the application of chiropractic principles, suggests a neurological etiology and is approached through the mechanism of detection of vertebral subluxation and subsequent appropriate and specific adjustments to promote potential and function.Parental health and wellness prior to conception influences reproductive success and sustainability, begging efficient, effective consideration and interpretation of overall state and any distortion. A discussion of diverse articles is presented, describing the response to chiropractic care among subluxated infertile women.

**Clinical Features:** Fourteen retrospective articles are referenced, their diversity includes: all 15 subjects are female, ages 22-65; prior pregnancy history revealed 11 none, 2 successful unassisted, 1 assisted, 1 history of miscarriage. 9 had previous treatment for infertility, 4 were undergoing infertility treatment when starting chiropractic care. Presenting concerns included: severe low back pain, neck pain, colitis, diabetes, and female dysfunction such as absent or irregular menstrual cycle, blocked fallopian tubes, endometriosis, infertility, perimenopause and the fertility window within a religious-based lifestyle, and a poor responder undergoing multiple cycles of IVF.

**Chiropractic Care and Outcome:** Outcomes of chiropractic care include but are not limited to benefits regarding neuromuscular concerns, as both historical and modern research describe associations with possible increased physiological functions, in this instance reproductive function. Chiropractic care and outcome are discussed, based on protocols of a variety of arts, including Applied Kinesiology (A.K.), Diversified, Directional Non-Force Technique (D.N.F.T.), Gonstead, Network Spinal Analysis (N.S.A.), Torque Release Technique (T.R.T.), Sacro Occipital Technique (S.O.T.) and Stucky-Thompson Terminal Point Technique. Care is described over a time frame of 1 to 20 months.

**Conclusion:** The application of chiropractic care and subsequent successful outcomes on reproductive integrity, regardless of factors including age, history and medical intervention, are described through a diversity of chiropractic arts. Future studies that may evaluate more formally and on a larger scale, the effectiveness, safety and cost benefits of chiropractic care on both well-being and physiological function are suggested, as well as pursuit of appropriate funding.

**Key Words:** *chiropractic, vertebral subluxation, pregnancy, infertility, research funding,Applied Kinesiology, Diversified, Directional Non-Force Technique, Gonstead, Network Spinal Analysis, Torque Release Technique, Sacro-occipital Technique, Stucky-Thompson Terminal Point Technique*

## The Potential

Inherent in both the history and promise of being born female, is the potential of motherhood. As a growing girl acquires the appropriate amount of body fat to sustain the energy demands of pregnancy, the innate wisdom of the body alerts the pulse generator in the hypothalamus and coordinates hormones to stimulate the shift from childhood to puberty[1]. And so it goes, the potential for reproduction continues through life's decades until naturally evolving to transform the potential, rewiring the female system for the shift into menopause.

The fulfillment of potential relies on function. The women described in this issue[2-15] entered chiropractic care for a variety of reasons, but aware of the gap between how her body was designed to function and the reality of how her body was functioning, and aware of the tension between potential and reality. Along the process of evaluating presenting complaints, and health histories that included chronic low back pain, neck pain,

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colitis, diabetes and female problems such as absent or irregular menstrual cycles, blocked fallopian tubes, endometriosis, infertility, perimenopause and the fertility window within a religious-based lifestyle, and a poor responder undergoing multiple cycles of IVF, among a wide variety of ages, circumstances and interventions, the authors applied chiropractic principles to identify interference. Their findings revealed the presence of vertebral subluxations in all participants, which this issue offers to describe and document, utilizing a variety of the chiropractic arts. How does the pureness of potential change to the dreams and despair associated with infertility? We start by exploring…

**The Culture and Insult**

Current statistics reflect an expanding infertility culture comprised of those struggling to become pregnant and an industry offering intervention. Infertility is described as the failure to achieve conception by couples who have not used contraception for at least one year,[16] although recent suggestions revise this description to a more compact time guideline for those over 35, that of 6 months.[17] Statistics from the CDC report in the U.S. there are about 6 million women and their partners affected by infertility.[18] Medical research suggests contributing factors are 55% female and 35% male,[19] while for almost 500,000 couples this research is unable to identify any causative factor.[20] The industry supplying infertility intervention, about 40 clinics in 1986, numbered approximately 360 in 2001[21].

For the women referenced in this issue, infertility presented as either a silent surprise, was proceeded by previous warnings of problems in the menstrual cycle or with previous pregnancies, or coexisted with seemingly non-related trauma. The changes in the fertility window during perimenopause are also discussed, from the perspective of attempting pregnancy while adhering to a religious-based lifestyle. Of the 14 articles discussed, eleven concurrent with this issue, 3 previously published, 8 of the women had received previous unsuccessful medical infertility treatments (for this pregnancy), and 4 were undergoing treatment at the time they entered chiropractic care, either clomid therapy or a multiple cycle of IVF.

Factors reported to contribute to this expanding infertility culture are the insults and irritations associated with modern work and lifestyle habits. The hypothalamus gland is pivotal to reproduction in both men and women, and stress, nutrition and physical activity can influence this gland.[22] It is worth considering all factors, as not only can fertility be altered, but once achieved the fetus is sensitive to drugs, x-ray and environmental chemicals which can cause birth defects, and chronic stress experienced while pregnant can alter the development of physiologic systems that provide for growth and protection of the child.[23] As a woman reflects upon choices from the perspective of potential motherhood, her relationship to her environment and lifestyle are to be reconsidered, and while pregnancy is commonly viewed as a 9-month process, it's suggested that a 12 month time frame is appropriate, incorporating a minimum 3 month preparation period.[24] If not explored previously, this is the time to identify and address what insults or irritations from trauma or daily living, left unchecked, can contribute to the process of infertility or an unsuccessful pregnancy.

As the story of a woman's life unfolds, lifestyle irritants she may have been exposed to can include alcohol, smoking (which can damage eggs), and caffeine (inhibits egg production and can be found in commonly available medications, NoDoz, Excedrin, Anacin).[22] Prescription medications of concern include long term use of either thyroid replacement medication which can affect ovulation or birth control pills that can decrease pituitary function. Nutritional insults include food hypersensitivity and insulin resistance as concerns. Excess weight can be an irritant, as women who are overweight by 40% are less likely to conceive.[25] Environmental toxicity, which can include pesticides (i.e. lawn chemicals), chemical solvents in household products and dusts. Recreational habits, if they include athletic training or racing that alters or stops the menstrual cycle, can be a concern. Emotional lifestyle is also important, as reportedly women who are depressed are less likely to become pregnant. The chemical changes involved in depression may decrease the production of luteinizing hormone (LH), making it less likely to release an egg.[22] Attempted pregnancy outside a suggested "age window" has been suggested to be a factor, we will explore in detail later.[26]

Women's work habits and their impact cannot be ignored. The creative class, which is 38 million strong, is likely to have long work weeks of 49 hours or more, nearly half of all managers and nearly 40% of all professional people did so.[27] Insults on metabolism can occur from excessive work hours, frequent travel (especially across time zones), developing a sedentary lifestyle or developing stress response habits which irritate, such as caffeine (coffee, OTC drugs, energy bars), soda pop, smoking, or a depleting the adrenal system. Biomechanical irritations can result from work stations that are not ergonomic, or excessive computer or phone use.

The history of insults and irritations documented in this issue include physical (car accidents, childhood falls, athletic demands on child or adult, scoliosis, chronic low back or neck pain), chemical (diabetes, colitis, long term use of birth control pills, poor diet, headache and migraines, hormonal changes including perimenopause, amenorrhea, irregular cycles, blocked fallopian tubes, endometriosis, poor IVF responder), and mental/emotional (work stress, miscarriages, infertility). The true value of describing these insults and irritations, is in what this really tells us, as surely not everyone who is exposed to these common factors is infertile. What is the reason some people are able to adapt to these insults and daily irritations with ease, while others flounder and present with dis-ease, with in-fertility? D.D. Palmer, the founder of chiropractic, asked, "I desired to know why one person was ailing and his associate, eating at the same table, working in the same shop…was not. Why?"[28]

**The Interference**

The mysteries of the human system, in all their complexity and brilliance, can only be packaged awkwardly when attempting to reduce altered function to defense of a single villain, rather spectators are implored to explore the processes of life and their attendant relationships and stress.

A lone factor, be it insult, irritant, hormone, gene, etc., with whatever the potential it may possess for altering the body, must still rely on the response of that body to determine it's impact.

Essential to all processes of life is the nervous system, which perceives the environment and coordinates the cellular community's biological response to the impinging environmental stimuli.[23] It is reasonable to consider that a system that is properly functioning to it's potential, may resist destructive forces more successfully and with less damage. What happens when that association is compromised through interference in the nervous system? What behaviors change, as the ability to successfully respond to presenting stress or coordinate the necessary relationships is inhibited and an appropriate adaptive response may be compromised. An increased possibility for resulting distortion in function and well-being is to be considered. Chiropractic's understanding of the processes of life, including relationships and stress is found in the descriptions of interference and subluxation. Chiropractic principle 31 explores the topic of interference as follows: "Interference with transmission in the body is always directly or indirectly due to subluxations in the spinal column".[29] Subluxation, as defined by the Association of Chiropractic Colleges, is a "complex of functional and/or structural and/or pathological articular changes that compromise neural integrity and may influence organ system function and general health".[30] 100% of the women referenced in this issue, who were struggling with infertility, had evidence of interference, as detected by the presence of subluxations.

Essential when considering the topic of interference, is the importance of timing, as subluxations can occur during childhood, even birth, and if unchecked and unresolved, can alter the course of a life, or a family. Articles by Rosen and Ressel document a history of childhood trauma, in one instance associated with gymnastic injuries, and another at 13, when a chair was pulled out from under and caused a forced pelvic landing. Both experienced infertility, in fact, one woman's menstrual cycle stopped completely at 18, only to resume at 65 after receiving chiropractic care.

The Chiropractic Textbook[29] by Stephenson describes the power of reproduction as the ability of the unit to reproduce something of like kind, the power to perpetuate it's own kind, and with assimilation, excretion, adaptability and growth, is one of the five chiropractic principle signs of life. We proceed to explore how these principle signs of life are promoted through…

**The Mechanism and Art**

A variety of the chiropractic arts are referenced, 8 total. Their commonality includes the initial protocol of evaluating for the vertebral subluxation complex, and once identified, proceeding to apply chiropractic care to promote integrity, function and well-being. Their disinctions and relevance to this issue follow:

Torque Release Technique (T.R.T.),[31] utilized by Anderson-Peacock, Bedell, Kaminski and Nadar, is tonal, non-mechanistic and non-linear, and employees a neurologically-based analysis that incorporates non-linear time sequence adjusting priorities, and the Integrator™, a torque and recoil release adjusting instrument. Attention is given to the subulxation as a separation from wholeness, an imbalance between incoming forces and internal resistive forces, often an exaggerated perception of stress causing inappropriately excessive internal resistive response. Categories of stress include: Physical (trauma, thermal, electro-magnetic, gravity), chemical (nutritional, toxic, mood altering), and mental (perceived threats of stress, emotional and genetic). TRT research cites work by Burstein and Potrebic (1993) of Harvard Medical School, which provides evidence for the direct projection of the spinal cord neurons to the amygdala and orbital cortex, and suggest these pathways play a role in neuronal circuits that enable somatosensory information, including pain, to effect function, including behavior, autonomic and endocrine. The stress histories presented by authors utilizing TRT include, physical (trauma from motor vehicle accident, a fall resulting in a fractured sacrum), chemical (nutritional distortion associated with colitis, blocked fallopian tubes), and mental/emotional (negative emotions resulting from 2 miscarriages, and emotional stress from decreased perimenopausal fertility window within a religious-based lifestyle).

In Sacro-Occipital Technique (S.O.T.),[32] utilized by Blum and Rosen, specific categories define parameters of clinical findings to evaluate neruophysiological changes affecting the autonomic system, that can result in aberrant parasympathetic-sympathetic balance and viscero-somatic reflex dysfunction. The trademark is its use of wedge shaped blocks to normalize the attitude of the pelvis in a gentle, specific way, including stabilizing the SI joint, reducing meningeal tension, or relieving pressure from the intervertebral discs safely and without force. Attention directed at pelvic integrity is essential, as pelvic imbalances and subluxations can play a pivotal role in pelvic organ malpositions. Pelvic distortions are associated with both cases, including a history of childhood gymnastic injuries and car accidents, and a chronic colitis case(12 years).

In a case study by Adams, Applied Kinesiology (A.K.)[33] is described as "a functional neurologic assessment process that extends the neurological examination, utilizing manual muscle testing to identify subtle shifts away from optimal neurologic status". Attention was given to the 3 diaphrams, cranial, thoracic and in particular the pelvic, which forms the floor of the abdominal cavity and is associated with sacral motion. Adjustments of the sacrum and uterus allowed a (neurological) reorganization process that involved all three diaphrams, addressing nerve interference and allowing the body's innate intelligence to promote restoration and healing. The woman in this study was diabetic and amenorrheal, and never had unassisted menstrual cycles (on birth control pill therapy), 4 months after starting care, unassisted cycles started and within another 16 months she became pregnant through natural means.

Shelley contributes a case study applying Directional Non-Force Technique (D.N.F.T.),[34] a high speed, low force impulse approach, utilizing "leg reflex" in locating subluxations and a light thumb thrust in delivering adjustments, addressing both bony and soft tissue. The goal is to only adjust a primary subluxation, allowing compensatory misalignments to resolve spontaneously once the primary nerve disturbance is eliminated, promoting proper alignment to the vertebrae and increasing the potential for health regardless of the presenting complaint. In this instance, infertility may be associated with restrictions of sacral movement, which alter the flow of cerebrospinal fluid and may impact the hypothalamus and/or the pituitary gland,

affecting production of hormones vital to reproductive function. Medical tests documented functional changes in estrogen levels, endometrial thickness and cervical mucus prior to and after the application of chiropractic care, all were at more favorable levels after care and the subsequent IVF cycle was successful.

Network Spinal Analysis (N.S.A.)[35] care utilizes low force touch, applied at spinal gateways to assist the brain to connect more effectively with the spine and body, and as a consequence, the individual develops new strategies for living and healing. Care is advanced though a series of levels. Senzon describes the possible role of N.S.A. care in relation to sympathetic tone, the menstrual cycle and the hypothalamus, with specific attention on the pulse generator. The author documents detailed physiological changes in a poor responder undergoing multiple cycles of IVF, pre and post the application of N.S.A. care.

The application of Gonstead Technique[36] is described by Lyons in a case study regarding a 27 year old athletic woman with a 5 year history of infertility. The Gonstead approach benefits from the mechanical engineering background of it's founder, who developed the "foundation principle" to explain how a fixation in one area of the spine created compensatory bio-mechanical changes and symptoms in another. Based on tonal, postural and segmental models, and attention is directed to the integrity of the disc. Initial evaluation and one month of care are described, after which the patient became pregnant. Diversified Technique[37] was used for a portion of the case contributed by Kaminski. It is a segmental model, the subluxation is described in terms as alterations in specific intervertebral motion segments. Parameters can include, but not be limited to, motion and static palpation, visual observation, Deerfield leg check and cervical syndrome test.

In a commentary by Ressel,[9] utilizing Stucky-Thompson Terminal Point Technique, we are offered a description of the process of response to a trauma, specifically a fall triggering a vertebral subluxation complex, associated with severe disc and osseous remodeling and affecting reproductive function, including proper function of the fallopian tube transportation system and ovulation mechanics. Essential for fertilization is the proper function of the fallopian tubes, who's muscles carry the egg to meet sperm, muscles which rely on the nervous system to control their actions. If function is suboptimal, Ressel's experience suggests a misaligned vertebra present in the lower spine, affecting this transport system and when corrected promotes proper function. In this article, a traumatic fall occurred at the beginning of this woman's reproductive years, however the response by the body was never effectively interpreted, her menstrual cycles subsequently halted and she spent her life infertile.

Previously published chiropractic research discussing infertility includes cases by McNabb (1994)[13] and Webster (1995).[14,15] McNabb describes a 36 year old infertile female with scolosis and a history of deep pelvic pain and progressive dysmenorrhea, who became pregnant after receiving chiropractic care. He suggests her symptoms were "indicative of some physiological dysfunction" and the fact that the patient was unable to conceive while experiencing these pelvic symptoms further indicates some abnormal physiology" (no anatomical pathology present). "It is also my impression, that the timing in the cessation of the pelvic symptoms and the ability to conceive was not coincidental".

Webster offers two cases:

1) A 32 year old infertile woman, no menses for 12 years, multiple medical infertility treatments were unsuccessful. After two months of chiropractic care, with attention on adjustments in the lumbar region, menses started and after regular cycles for four months, unassisted pregnancy occurred.
2) A 26 year old woman, infertile for several years, multiple medical infertility treatments were unsuccessful. Patient had a severe scoliosis with a Cobb's angle of 58 degrees. After 6 months of chiropractic care, with adjustments applied to sacrum, lumbar and cervical regions, the Cobb's angle decreased to 47 degrees, and one month later, unassisted pregnancy occurred.

**The Outcome**

A variety of outcome measures were described by the authors in this issue, they include:

Health Status Questionnaire, computerized thermography and surface electromyography, protocols of each individual chiropractic art, documenting physiological changes in concurrent medical evaluations, and last but not least in this issue regarding fertility - babies.

Health Status Questionnaire (self rated) outcomes were documented in articles by Bedell and Senzon.

- Applicability - tracking QOL changes during the course of chiropractic care is relevant as an indicator of progress in well-being, also both stress and depression are reported irritants to fertility.
- Validity - this offered a tool where the subjects were allowed an active forum to note the results of care, and in effect, validate their experience
- Reliability - This reflects the consistency with which improvements are made, in subluxation-based approaches, care is consistent and progressive, not symptom-centric, and therefore offers the potential of true improvements, rather than irregularities of crisis care.
- Sensitivity - The assessments were designed for a lay person to successfully evaluate their experiences within a range of choices that is not stressful for them. It is not overly sensitive in that professional training is required to complete.
- Practical - Very, they are portable, and easy to incorporate within a care plan.
- Safety - Physically safe, and not intended to cause emotional and mental harm.

Computerized thermography and surface electromyography outcomes were documented by Anderson-Peacock, Bedell, Kaminski, Lyons, Ressel, Senzon and Shelley.

- Applicability -These are objective, instrument testing which detect and record increased aberrant autonomic and motor nervous system function. They are a tool to track progress while under chiropractic care.

- Validity - This tool documents and measures changes in patterns of subluxation.
- Reliability - These instruments are calibrated to provide consistency in application and results
- Sensitivity - these instruments are able to track patterns over time, and are designed to provide useful readings that are sensitive
- Practicality - Needing only a computer, they are portable and very practical for screenings. Utilized by many chiropractors, as reflected by the numbers of authors who used this to measure outcome.
- Safe - very safe, not an invasive test. Protocols of each individual chiropractic art are described in detail within their articles, we will not address here.

Outcomes in physiological changes documented in medical evaluations were reported by Senzon, Shelley and Ressel.

- Senzon
  - 3/26/02 - 1st IVF attempt, on cycle day, estradiol only 56%, LH was 6.6 I.U./L., attempt canceled due to poor follicle growth (poor responder to exogenous ovarian stimulation)
  - 4/11/02 - commenced regular NSA care
  - 6/06/02 - 2nd IVF attempt, increased estradiol, and LH, 10 eggs retrieved
  - 6/17/02 - successful aspiration of eggs completed and pregnancy followed
- Shelley
  - 10/17/2001 1st IVF attempt (unsuccessful)
  - 11/03/01 enter chiropractic care early Feb'02 - endometrial thickness greatly improved, estrogen and cervical mucus at more favorable levels
  - 02/17/02 - 2nd IVF attempt
  - 03/02/02 - positive pregnancy test
- Ressel
  - at 18 years old, menstrual cycle ceased (cycle was altered and then ceased after a traumatic fall)
  - at 65 years old, enter chiropractic care
  - in approximately 4 weeks, spotting start and was referred for endocrinology work-up
  - work-up confirm no pathology, cycles resumed, advise to use birth control

And last, but not least, we document the pregnancy time frame for infertile women in this issue, after receiving chiropractic care and possible associated improvement in physiological function. See Table 1.

Several of the authors note the inclusion of additional health care models to assist the transition initiated by chiropractic care to restoring health and function with ease, they include: Adams - nutritional evaluation and support, Bedell - assessment and monitoring of nutritional and emotional needs (i.e. stress reduction techniques), and Shelley - patient visited Acupuncturist for 4 visits.

Dr. David Simon of The Chopra Center writes "Infertility may result from altered regulation of pituitary hormones, or from abnormal nervous-system influences on the ovaries and fallopian tubes".[20] What these outcomes suggest is, regardless of age, history or previous intervention, after the normalization of neurologic activity from the application of chiropractic care, proper nervous system influence was allowed to occur with a possible associated impact on fertility. Controversial? There are numerous researched articles which document this mechanism in the relationship between normal neurological activity and improved female function regarding the menstrual cycle.[38-42] For controversy we shall proceed to…

**The Controversies**

What are the great debates taking place, some stirred, some stirring, what topics here provoke thought and discussion? When considering parenthood or struggling with unsuccessful attempts at pregnancy, several public health issues emerge from this most personal topic - age, safety and money.

Age, a perennially socially charged issue, has been elevated to a dilemma when viewed in context of fertility. In FY'00, a massive ad campaign by the American Society of Reproductive Medicine (ASRM),[26] was launched, including an age-centric message that indicated infertility is a disease and those primarily affected are women in their mid-thirties and up.The ads provoked outrage and criticism from experts in many fields,

**Table 1**

| Author | Age | How Long Infertile | Time between start of chiropractic and Pregnancy |
|---|---|---|---|
| Adams | 22 | Primary Amenorrhea | w/in 4 months start unassisted cycles, 20 months pregnant |
| Anderson- | 36 | 9 yrs | within 3 months |
| Peacock | 35 | 2 yrs | within 2 months |
| Bedell | 27 | 2 miscarriages in 6 mo. | App. 3 months (and carried to term) |
| Blum | 32 | 7 yrs | After body recover from 12 yrs of unresolved colitis (take 1yr., pregnant 1 month after) |
| Kaminski | 31 | >1yr | diagnosed with "lazy" reproductive system 3 months start regular cycles, app. 6 mo. pregnant |
| Lyons | 27 | 5 yrs. | App. 1 month |
| Nadler | 42 | perimenopause | In 5 weeks, cycle shift from 24-26 days with 8-10 Days flow to 29-30 days, w/in months - pregnant |
| Ressel | 65 | amenorrhea since 18 | cycles restart in app. 4 weeks |
| Rosen | 34 | always | app. 4-5 weeks |
| Senzon | 34 | IVF | see above |
| Shelley | 32 | 2 yrs - IVF | see above |

including a government demographer specializing in reproductive health, as reports indicate their statistical overview was shaped for advertising copy, not shaped from independent research.[43] The ASRM defended its actions by suggesting their campaign was preventative, and likened it to dentists encouraging people to use fluoride. The former president also revealed the tone was strategic, to satisfy a goal of putting pressure on insurance companies to cover more infertility treatment.

The rates for first births for women in their thirties and forties have quadrupled since the 70's, instigated by changes in culture, both lifestyle and work What would happen to the American economy and creativity if women felt more pressure to produce a family first rather than produce a career and left the work force in significant numbers to have babies in their 20's and 30's? Or if they all expected to bring their babies to work, could corporate America support their workers and create an environment that is family friendly?

Social and economic issues notwithstanding, what really drives these issues is health. The Mind/Body Medical Institute, which is under the direction of Harvard Medical School, in their Infertility Program brochure offers "Our typical patient is married, in her mid-to late-thirties, has been trying to conceive for three years, and has finished the infertility work-up and basic treatment. Many patients are either contemplating high-tech treatment or have had failed cycles. The average patient reports two-three physical symptoms, which have become worse since the infertility,…"[44] This information is very telling, these women have physiological changes including symptoms and infertility, which are chronic and progressive, that medical infertility intervention has not succeeded, and they are in their 30's. Dr. Andrew Weil addresses the issue of fertility and age with this comment, "Chances are a healthy couple will be able to conceive even after fertility begins to wane. It may just take a little longer".[45] Perhaps the real controversy is not age at all, but the basic health of these women, how and why has it deteriorated over time, and what type of care could offer them benefits?

**Safety.**

Recent reports indicate that there is currently "no central registry to track birth defects among babies conceived through so-called assisted reproductive technologies, even though about 40,000 babies in the United States were conceived with IVF".[46] While all drugs and invasive procedures have potential side effects, this confirms there is no documentation on the effect that these interventions have, and how many generations they impact, an issue of some concern as common does not equal safe.

A study published in November 2002 in the online version of the *American Journal of Human Genetics*[47]reported that "babies conceived by in vitro fertilization may be at increased risk for a rare genetic disorder that predisposes them to cancer". The study, conducted by scientists from the Johns Hopkins School of Medicine and Washington University in St. Louis tracked children born with Beckwith-Wiedemann syndrome and discovered a statistically significant association with conception by IVF. Beckwith-Wiedman syndrome children are at a high risk for developing cancers of the kidney, liver and other tissues prior to puberty, as well as being born abnormally large with large tongues and poor closures of the abdominal wall, associated with hernias and necessitating surgical repair. The authors indicate these findings are compelling and should lead to further study.

In addition to considering the safety of any chemical or invasive intervention, there is also the issue of the safety of health procedures that are symptom-centric, rather than addressing the cause of physiological dysfunction, allowing the public to walk around in a symptom reduced state of dysfunction. As noted by the preceding quote from the Mind/Body Medical Institute's profile and by the described health histories of the 12 women involved in these new retrospective studies, women suffering from infertility also suffer from other symptoms, exogenous hormonal stimulation doesn't address this. A case study by Rosen demonstrated that a woman had previous IVF treatment for her first child, but there was no improvement in her other distortions or her ability to become pregnant between that intervention and her second child until she received chiropractic care. 100% of the women in this issue had a reduction of physiological dysfunction, evident by both subjective and objective findings after chiropractic care. This is not to be dismissed.

**Money**

In addition to any possible emotional expense, Infertility treatments can incur significant financial hardship. Articles in the popular press report on women spending $3,300 in one month on injections,[21] Egg donation procedures can run about $25,000,[48] Mind/body infertility two-day retreats (400 individual, 750 couple + hotel),[44] etc. For many couples this is not realistic, and again, there are the additional symptoms of physiological dysfunction that need evaluation and care, and all of this needs time. The public deserves to know about natural, cost effective, safe approaches that can help promote and restore health.

A contributing factor as to why many women experiencing infertility are not aware of the benefits of chiropractic care is the paucity of research funding allocated towards chiropractic, which is completely out of sync with the utilization and value of chiropractic within the healthcare system, it is the largest and fastest growing form of non-medical healthcare. Some controversial statistics:[48]

| **Category** | **Chiropractic** | **Medicine** |
|---|---|---|
| Funding by | In 107 years, total 10 million | in 2000 alone, just the top 25 medical schools |
| U.S.Gov. | | received 6 Billion |
| Medicare | 0 dollars to train residents | Beth Israel alone receives $57,010 per resident per year |
| F/T researchers | <100 total (app. 70) | Pfizer alone has app. 12,000 |

While of special value to those couples suffering with infertility, these controversies are worthy of engagement by a broader audience, and leads us to consider…

## The Future

Biology is our biography, our body tells the story of our life, our heritage and where we've been, it reflects our present experiences and offers a window into our potential for the future. Research is a formalized accounting of the relationship between biology and biography.

This issue offers an account of women who's biology expressed infertility, the diversity of their biographies, i.e. ages, circumstances and external interventions, and an exploration of what chiropractic offers to these women. In essence, what chiropractic offers is not an intervention, what chiropractic offers is a culture.

Chiropractic offers a culture where the innate wisdom of the body is recognized, and determines principles and practice. A culture that is a distinct science, art and philosophy, that promotes natural function and potential. The Chiropractic culture offers an approach that is drug free. A culture free from the burdens of drug side effects and financial challenges. Chiropractic offers a culture that works, the new moms described in this issue joins millions of others that benefit from chiropractic care.

In attempts to understand and categorize chiropractic, those outside this culture often relate it to what's familiar to them - the world of management of pain/disease/symptoms, when in essence chiropractic is a distinct model and not able to be fully grasped from such a perspective. And hence, the public is offered back pain guidelines by medical reviewers[49] or insurers, and part of the value of this study is to interrupt that misperception.

The tracks for understanding health have been defined by the well worn tracks of disease-centric care, and in efforts to move forward, many use this track for speed to attract attention to their cause. Even the advent of "Alternative Medicine" is generally a track to address symptoms and disease, rather than to promote potential, generating a form of health illiteracy. The tracks for well-being and potential, for recognizing, quantifying, promoting and protecting this approach are not yet built on a broad level, but they have been alive in chiropractic for 107 years.

While many members of the public, press and health care providers are raising their voices and concerns about the tremendous funding and consideration funneled with priority to a prescription-based approach to health care, the results of this attention have yet to be fully actualized. In a fuller discussion of defining health or separation from health, and how complex and elegant the being part of human is, why is understanding limited to disease - consider interference, why is understanding limited to symptoms - consider insult, why is understanding limited to diagnosis - consider process, and finally why is understanding health limited to how much time and money is spent on being sick, consider spending energy and time to promote natural adaptation and function.

Chiropractic's natural approach to promoting health and well-being, is not solely a romantic or intellectual venture, far from it, this viewpoint has an impact on the economy, both national and personal, and on lives, family's lives. One factor that increases health care expenses is the amount of time involved in finding a provider or approach that can truly interpret what care is needed, there are many who spend years with physiological dysfunction, searching for an answer. The women described in these articles spent years, even decades, living with dysfunction, how much money, time, performance and well-being was lost along that path, and by how many millions is that multiplied by each day?

In closing, my recommendations are:

1) Advocate more research on wellbeing and function, and the development of associated assessments and outcomes
2) Encourage greater health literacy in the public as well as with those involved in healthcare, which includes approaches that promote well-being and potential, distinct from disease-centric models
3) Develop well-designed studies on the number of women/men in chiropractic care with physiological changes including but not limited to changes in reproductive function
4) Encourage those considering parenthood to have a chiropractic evaluation during the preparation phase of pregnancy, as parental health and wellness influences reproductive success and sustainability
5) A call for deliberate and speedy action to address the extreme inequity in research funding for chiropractic.

And finally, for those within the culture of infertility, this body of work offers for your consideration, documentation of a variety of articles describing the improvement in reproductive function after the application of chiropractic care. We welcome any comments, feedback or discussion on this work.

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ORIGINAL RESEARCH

# Chaotic Modeling in Network Spinal Analysis: Nonlinear Canonical Correlation with Alternating Conditional Expectation (ACE): A Preliminary Report.[1]

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**Abstract** — This paper presents a preliminary non-linear mathematical analysis of surface electromyographic (sEMG) signals from a subject receiving Network Spinal Analysis (NSA). The unfiltered sEMG data was collected over a bandwidth of 10-500 Hz and stored on a PC compatible computer. Electrodes were placed at the level of C1/C2, T6, L5, and S2 and voltage signals were recorded during the periods in which the patient was experiencing the "somatopsychic" wave, characteristic of NSA care. The intent of the preliminary study was to initiate mathematical characterization of the wave phenomenon relative to its "chaotic,"and/or nonlinear nature. In the present study the linear and nonlinear Canonical Correlation Analyses (CCA) have been used. The latter, nonlinear CCA, is coupled to specific implementation referred to as Alternating Conditional Expectation (ACE). Preliminary findings obtained by comparing canonical correlation coefficients (CCC's) indicate that the ACE nonlinear functions of the sEMG waveform data lead to a smaller expected prediction error than if linear functions are used. In particular, the preliminary observations of larger nonlinear CCC's compared to linear CCC's indicate that there is some nonlinearity in the data representing the "somatopsychic"waveform. Further analysis of linear and nonlinear predictors indicates that 4th order nonlinear predictors perform 20 % better than linear predictors, and 10th order nonlinear predictors perform 30% better than linear predictors. This suggests that the waveform possesses a nonlinear "attractor"with a dimension between 4 and 10. Continued refinement of the ACE algorithm to allow for detection of more nonlinear distortions is expected to further clarify the extent to which the sEMG signal associated with the "somatopsychic"waveform of NSA is differentiated as nonlinear as opposed to random.

## Introduction

Over the past ten years there has been growing interest in modeling experimentally observed time series as nonlinear deterministic or possibly chaotic dynamical processes.[1] For example, the analysis of economic time series[2] (prediction of the stock market), the analysis of geophysical seismographic time series (prediction of earthquakes), and most recently, the virtual explosion of applications related to the analysis of physiological time series[3] (dynamical analysis of heartbeats to predict fibrillation, dynamical analysis of brain waves to predict epileptic seizure, etc.) reflect the wide variety of interests in this area.

The present research fits within this last trend, with the exception that, while many physiological time series have been deemed chaotic by some intuitive criteria, it is the intent here to apply a more rigorous mathematical evaluation of the presence of chaos in the very specific sEMG signal recorded during the "somatopsychic" waveform, characteristic of Network Spinal Analysis (NSA).[4] The "somatopsychic" waveform being studied is observed to undulate primarily between the sacrum and cervical areas of the spine, over a range of amplitudes and frequencies. Whereas these parameters do not appear sequentially predictive in any one subject, there does appear to be a commonality of the distribution of amplitudes and frequencies among the larger population of subjects expressing the "somatopsychic" wave. The present preliminary study presents information acquired to evaluate the nature of this specific waveform as to its linear versus nonlinear character. Since the waveform associated with NSA care has a neuromuscular component, it lends well to measurement by sEMG. Subsequently, the sEMG signals lend well to mathematical analysis.

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In the present study, caution is being exercised to avoid incorrectly classifying the sEMG signal as nonlinear. This has been reported as a potential problem with the false near neighbor (FNN) approach, as purely random signal has been incorrectly classified as deterministic by this approach.[5] More generally, while the FNN test works well for low order systems, it is not clear whether it works well for systems of higher order.[5] This cautious approach is a reflection of concerns regarding the analysis of chaos in biomedical data, in general. This recent attitude has been triggered by some doubts that have arisen relative to the benchmark study allegedly indicating that the timing between heartbeats is chaotic.[6,7] A point of consideration is that there are many factors that affect heart beats; i.e., psychological factors, breathing, stress associated with being hooked up to an apparatus, etc. There is also some concern that these extraneous factors might have influenced the signal leading to misinterpretation as chaos in the data analysis.

This is not to say that there is no chaos associated with the heart rhythm, but there is some doubt as to whether the data has been correctly collected or analyzed. Moreover, adding to the complexity of evaluating the chaotic nature of heart rhythm, it can also be argued that the heart is naturally subject to psychological and other physiological factors, and that it is hard to conceive heartbeats outside the human body.

While the heart is subject to some voluntary control via breathing, the NSA wave, on the other hand, does not appear to be under any known voluntary control. In fact, if the recipient were to try to interfere with the wave, it would simply cease rather than being modified by voluntary control. Thus, the absence of voluntary control over the NSA sEMG wave signal compared to the considerable voluntary control of factors affecting the electrocardiogram (EKG) signal, renders the former less susceptible to extraneous factors contributing to its incorrect classification.

There has been some dynamical analysis of EEG and EMG signals.[8,9] However, the novelty in the present study is the specificity of the sEMG data, being collected during the administration of NSA care at times when the subject was experiencing the "somatopsychic" wave. Since no previous analysis of this data has been performed, it is of interest to compare these findings with those pertaining to EMG data collected during other physiological events, some of which have been classified as chaotic in nature. Thus, information gained from this on-going study of the "somatopsychic" waveform associated with NSA care is anticipated to be of value to the larger scientific community engaged in the investigation of the chaotic nature of other less repeatable physiological systems. Data derived from this study will also be used to profile any changes which might occur in the sEMG signal patterns relative to different Levels of Care described in the clinical application of NSA.[4] This growing body of information is expected to enhance the clinical application of NSA, as well as serving to further elucidate its underlying mechanisms of action.

## Methods

### *Data Acquisition*

The analyses presented in this preliminary study are based on sEMG data collected during a series of sessions in which a subject, who granted consent to participate in the study, was administered NSA care. The study was conducted in the private office setting with NSA care provided by a certified NSA practitioner.[4]

The data obtained was in the form of raw (unfiltered) sEMG signals in micro-volts. The EMG apparatus, an Insight 7000 (EMG Consultants, 255 W Spring Valley Ave., Maywood, NJ 07607) was modified to research standards by accepting data over a bandwidth of 25 to 500 HZ. Electrodes were applied at the levels of C1/C2, T6, L5 and S2, following the application protocol recommended by EMG Consultants.

The sEMG signal was transported directly to disc and retrieved for analysis on a 330MHz PC compatible computer and HP workstation.

The application of the nonlinear Canonical Correlation Analysis (CCA) was applied through the implementation of a specific algorithm referred to as Alternating Conditional Expectation (ACE).[10]

## Analyses

Two approaches have been utilized in the initial analysis to ascertain if any deterministic nonlinear processes are involved in the sEMG signal. These include the False Near Neighbor approach (FNN),[1] and the linear and nonlinear Canonical Correlation Analyses (CCA), with accompanying implementation of the Alternating Conditional Expectation (ACE) algorithm.[11]

The FNN was utilized initially due to its popularity, although its relevance has been brought into question especially as applied to EMG signals. The CCA, alternatively, is a fundamental tool used by statisticians which has appeared reliable on EMG data.[12] To date, in the present study, this approach has been applied qualitatively. The analysis has centered on the question of whether or not there is some nonlinear dynamical processes in the sEMG signal under study.

The nonlinear CCA has been implemented using two approaches. The first used low order polynomials as simplified models of the nonlinear distortion whereas the second approach used the well-known Alternating Conditional Expectation (ACE). The ACE method provides very explicitly the nonlinear functions that are generating the data. With the ACE method, it is possible to establish the shape of the attractor as well as its topology, etc.

### Canonical Variate Analysis

The canonical correlation analysis of an experimentally observed signal

$$\{X(k): k = 1, 2, \ldots, K\}$$

is a technique to detect the dynamics involved in the signal and to answer such questions as: "Is this signal random?" "Is it correlated to other factors?" "Are there some deterministic features despite its noisy manifestation?" Hotelling first introduced the linear canonical correlation analysis in biomedical data processing context in 1936.[12]

The canonical correlation analysis has both linear and non-

linear applications. The linear application answers the question, "Can $\{X(k)\}$ be modeled by a linear dynamical process driven by some noise?" In particular, what are the deterministic matrices *F, G, H* and *E* such that

$$\xi(k+1) = F\xi(k) + Gw(k)$$
$$X(k) = H\xi(k) + Ew(k) \qquad (1)$$

where $w(k)$ is considered a "white noise" process, that is, the $w(k)$'s are statistically independent. Here, *E,F, G* and *H* represent the linear and deterministic part of the sequence, while the nonlinear and random parts are combined into *w*. Clearly, the smaller $Gw(k)$ and $Ew(k)$ are, the easier it is to predict $\xi(k)$ and, therefore, X $(k)$. The variable $\xi(k)$ is called the *state;* it is that part of the past $\{\ldots, X(k-2), X(k-1)\}$ necessary to predict the future $\{X(k), X(k+1), \ldots\}$. The dimension of the *state* is known as the *order* of the system. Before any analysis is performed the *order* of the system must be found or estimated. Furthermore, any finite sequence can be approximated by a system of the form (1) with arbitrarily small *w*. However, to produce such an approximation, the *order* of the system may need to be very large. Hence, the goal is to produce a low order model for which $Gw(k)$ and $Ew(k)$ are small.

Alternatively, the nonlinear canonical correlation analysis answers such questions as, "Can $\{X(k)\}$ be modeled as a nonlinear system driven by white noise?" To be specific, what are the deterministic functions *f, g, h* and *e* such that

$$\xi(k+1) = f(\xi(k)) + g(w(k))$$
$$X(k) = h(\xi(k)) + e(w(k)) \qquad (2)$$

where $w(k)$ is a white noise process? If the underlying system that produced the observed sequence { X $(k)$ } is nonlinear, then models of the form (2) will have smaller noise terms $g(w(k))$ and $e(w(k))$ than the corresponding linear model (1). The difficulty with nonlinear analysis is that it is much more involved than the linear one, and to date only simplified versions of the nonlinear canonical correlation analysis are used.

Linear Canonical Correlation Analysis

The linear analysis proceeds as follows: At times, *k* defines the *L* (where *L* stands for "lag") past observations

$$X_-(k) = (X(k), \ldots, X(k-L+1))$$

and the L future observations

$$X_+(k) = (X(k+1), \ldots, X(k+L)).$$

Define the correlation between the past and the future to be the *L x L* matrix

$$C_{-+} = \frac{1}{K-2L+1} \sum_{k=L}^{k-L} X_-(k)^T X_+(k)$$

Define the autocorrelation of the past as

$$C_{--} = \frac{1}{K-L+1} \sum_{k=L}^{K} X_-(k)^T X_-(k)$$

and that of the future

$$C_{++} = \frac{1}{K-L+1} \sum_{k=0}^{K-L} X_+(k)^T X_+(k).$$

Define the Cholesky decomposition of $C_{--}$ and $C_{++}$,

$$C_{--} = T_-^T T_-$$
$$C_{++} = T_+^T T_+$$

where the T's are lower triangular matrices.

The canonical correlation matrix C is defined as

$$C := T_-^{-T} C_{-+} T_+^{-1}.$$

This matrix can be decomposed as

$$C = U\Sigma V$$

where U and V are orthogonal matrices and

$$\Sigma = \begin{bmatrix} \sigma_1 & 0 & \ldots & 0 \\ 0 & \sigma_2 & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \ldots & \sigma_L \end{bmatrix}$$

where the $\sigma_i$'s are called canonical correlation coefficients and are ordered so that

$$1 \geq \sigma_1 \geq \sigma_2 \geq \cdots \geq \sigma_L \geq 0$$

These coefficients are the crucial numerical values in the canonical correlation analysis and are providing much information about the sequence { $X(k)$ }.

A first interpretation is that the predictability of the future of a sequence given its past (hence a measure of its deterministic as opposed to random aspect) is the past/future mutual information

$$-\frac{1}{2} \log \det (I - \Sigma^2).$$

In practice, no matter how large *L* is, the canonical correlation coefficients have a break point,

$$\sigma_1 \geq \ldots \geq \sigma_D >> \sigma_{D+1} \geq \ldots \geq \sigma_L.$$

Hence, it can be concluded that only the first D coefficients are important. The rationale for ignoring the tail coefficients $0.1 \approx \sigma_{D+1} \geq \ldots \geq \sigma_L \geq 0$ is that they represent instrumentation and other noises and numerical rounding errors and are too unreliable to take into consideration. Therefore, a $D^{th}$ order model of the form (1) would perform nearly as well as a $L^{th}$ order model.

If the canonical coefficients $\sigma_1 \geq \ldots \geq \sigma_D$ are "large" i.e., close to 1, then the sequence $\{ X(k)\}$ is nearly linear and deterministic; that is, it can be accurately modeled with a system of the form (1) with $w(k) = 0$. On the other hand, if the coefficients are small, but not too close to zero, then the sequence is either random or nonlinear; that is, the linear model of the form (1) would have large $Gw(k)$ and $Ew(k)$ terms.

Nonlinear Canonical Variate Analysis

The nonlinear canonical variate analysis[13] is an extension of the linear canonical correlation analysis. If a system is nonlinear, then the canonical correlation coefficients (CCC's) are larger for the nonlinear analysis compared to the linear analysis. Indeed, an increase in the nonlinear CCC's as compared to the linear CCC's is an indicator of nonlinearity. Such an increase is apparent for the sEMG signal of the "somatopsychic" waveform characteristic of NSA care. It can, therefore, be concluded from the present preliminary information, that some type of nonlinearity is present in the sEMG signal.

To perform a complete nonlinear canonical variate analysis (CVA) is rather complex. Instead, the correlation is found only for simple "nonlinearities." In particular, the nonlinear CVA requires the discovery of vector valued functions $\Phi$ and $\Theta$ such that

$$-\frac{1}{2}\, log\ det\ (I-\Sigma_{\Phi(X_-),\Theta(X_+)})$$

is maximized, where $\Sigma_{\Phi(X_-),\Theta(X_+)}$ denotes the canonical correlation matrix of the signals $\Phi(X_-^+)$ and $\Theta(X_+)$. This is equivalent to choosing $\Phi$ and $\Theta$ such that the mean square prediction error

$$E\|\Phi([X(k),\ldots,X(k-L+1)]) - \Theta([X(k+1),\ldots,X(k+L)])\|^2) \qquad (3)$$

is minimized where L is the number of "lags" of the system. As a simplification, the functions $\Phi$ are restricted to be simple polynomials of the form

$$\Phi([X(k),\ldots,X(k-L+1)]) = \sum_{i=0}^{L} \alpha_i X(k-i) + \beta_i X(k-i)X(k-i) + \gamma_i X(k-i)X(k-i-1). \qquad (4)$$

Furthermore, $\Theta$ is restricted to be linear, i.e.,

$$\Theta([X(k+1),\ldots,X(k+L)]) = \Sigma\alpha^+{}_i X(k+i).$$

Since not all possible functions are allowed, the minimum of (3) might not be achieved. However, (3) might be smaller than in the case where only linear functions are used. Note that if $\beta=\wp=0$ then $\Phi$ is linear, hence the nonlinear CVA encompasses the linear CVA. If the $\Phi$ that minimizes (3) is such that $\beta$ and $\wp$ are non-zero, then it can be concluded that the future $\{X(k+1),\ldots,X(k+L)\}$ is related to some nonlinear function of the past $\{X(k),\ldots,X(k-L+1)\}$.

Ace Method

In the continued investigation regarding whether the sEMG signal is due to a nonlinear system as opposed to a random system, it has been found prudent to search for the system generating the data and to evaluate the extent to which it is nonlinear. One reason for not applying tests for nonlinearity (e.g. FNN) is that it is very hard to determine if the results are an artifact of the test or a real product of the data. Furthermore, such difficulties seem to occur with most, if not all, tests for nonlinearity. Alternatively, estimating the nonlinear system has clear results. If one can construct a low order nonlinear system such that its output is the same as the sEMG signal, then clearly the sEMG signal is generated by a low order nonlinear system. If the output of the constructed nonlinear system is the same as the sEMG signal, allowing for some small noise, then the sEMG is mostly nonlinear. In this way, one can precisely gage to what extent the sEMG signal is nonlinear.

Another advantage of directly identifying the system generating the sEMG signal is that a linear system can easily be determined which reflects the best linear system generating the sEMG signal. This linear system then provides a benchmark to be compared with nonlinear systems. However, the disadvantage of identifying the system directly, and the reason why so many tests for nonlinearity have been developed, is that it is computationally difficult to construct these nonlinear systems.

The objective of ACE is to search for a possibly nonlinear system, likely driven by small residual "white noises," that is generating the sEMG signal. In particular, the objective is to find *state* variables $\xi_i, i \leq N$, and possibly nonlinear functions $f, g, h$ and $e$ such that

$$\begin{bmatrix} \xi_1(k+1) \\ \xi_2(k+1) \\ \xi_3(k+1) \\ \vdots \\ \xi_N(k+1) \end{bmatrix} = \begin{bmatrix} f(\xi_1(k),\xi_2(k),\ldots,\xi_N(k)) \\ \xi_1(k) \\ \xi_2(k) \\ \vdots \\ \xi_{N-1}(k) \end{bmatrix} + \begin{bmatrix} g(w(k)) \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

$$X(k) = h(\xi(k)) + e(w(k))$$

where w is a "white noise", $X$ is the sEMG signal and N is typically the order D where the sequence of nonlinear CCC's shows a break.

A particular approach is to assume that f is linear and h is the projection of the first factor. That is,

$$f(\xi_1(k),\xi_2(k),\ldots,\xi_N(k)) = \sum_{i=1}^{N} \alpha_{i-1}\xi_i(k)$$

and $h(\xi)=\xi_1$. Hence, $\xi_i(k)=X(k-i+1)$. In this case, the sEMG signal is modeled by the Auto Regressive (AR) model

$$X(k+1) = \sum_{i=0}^{N-1} \alpha_i X(k-i). \qquad (5)$$

Such linear predictors are rather simple to determine and provide comparison benchmarks for all other predictors.

Nonlinear predictors are very hard to construct. A well-established approach is the Alternating Conditional Expectation (ACE) algorithm.[11] Although this algorithm does not construct the most general type of nonlinear predictor, it does generate a large class of predictors.

It is assumed that mean $(X) = 0$. The objective of the $N^{th}$ order best linear predictor is to find coefficients $\alpha_i$ that minimize

$$E(\alpha_0 X(k)+\alpha_1 X(k-1)+\alpha_2 X(k-2)+\ldots+\alpha_{N-1}X(k-N+1)-Y(k+1))^2$$

where $Y(k+1)=X(k+1)/\text{var}(X)$ and var($X$) is the variance of $X$. The ACE algorithm generalizes this by, instead of searching for coefficients $\alpha_1$, searching for functions $\phi_i$ and $\theta$ (see Figures 2-4) with $\|\theta\|_{L2} = 1$ so as to minimize

$$E(\phi_0(X(k))+\phi_1(X(k-1))+\phi_2(X(k-2))+\ldots +\phi_{N-1}(X(k-N+1))-\Theta(Y(k+1)))^2. \quad (6)$$

To link this to the previous nonlinear CCA, the above prediction error is "small" if the nonlinear canonical correlation coefficients between the sets of variables

$$\{X(k),X(k-1),\ldots X(k-N+1)\},\{Y(k+1),Y(k+2),\ldots,Y(k+N)\}$$

are "large," i.e., close to 1.

Instead of searching over all nonlinear distortions of the above two sets of variables, a search is done over a certain class of smooth functions. This class includes linear functions; thus, the ACE algorithm is more general than the best linear predictor and will have a prediction error no greater than that of the best linear predictor. Furthermore, if the ACE algorithm results in a prediction error that is smaller than the prediction error due to the best linear prediction error, it can be assumed that the process generating X is nonlinear.

However, if the ACE algorithm fails to do better than the best linear predictor, it cannot be assumed that the process is linear. Indeed, there are many nonlinear functions that may be generating X and that are not incorporated in the ACE algorithm. For example, functions of the general form

$$f(X(k),X(k-1),\ldots)=\sum_{i,j}\gamma_{i,j}X(k-i)\ln(X(k-j))$$

are not necessarily considered by the ACE algorithm. In particular, only functions of the form

$$\theta^{-1}(\phi_0(X(k))+\phi_1(X(k-1))+\ldots+\phi_{N-1}(X(k-N+1))) \quad (7)$$

are considered. While this is a large class of functions, it does not generate all possible functions. Furthermore, generating these nonlinear functions $\phi_1$ and $\theta$ takes considerable computational effort. Thus, it is difficult to check high order functions.

Since the ACE algorithm generates functions of a single variable, these functions can easily be plotted. The best linear predictor can be viewed as also generating functions $\phi_i$, but the $\phi_i$'s are restricted to be linear. Thus, not only the prediction errors can be compared, but also the shape of the linear functions generated by the best linear predictor and the possibly nonlinear functions generated by the ACE algorithm can be compared.

## Preliminary Results

### *Canonical Correlation Analysis*

By observing the variation in the linear CCC's compared to the nonlinear CCC's it can be determined whether the nonlinear functions of the form (4) lead to a smaller expected prediction error (3) than if linear functions are used. In particular, if the nonlinear CCC's are larger than the linear CCC's it can be concluded that there is some nonlinearity present in the system. Figure 1 shows the linear and nonlinear CCC's of burst of sEMG activity labeled as Burst C, a particular burst of sEMG activity. The information presented in this figure indicates the presence of some nonlinearity in the sEMG data collected during the NSA "somatopsychic" wave.

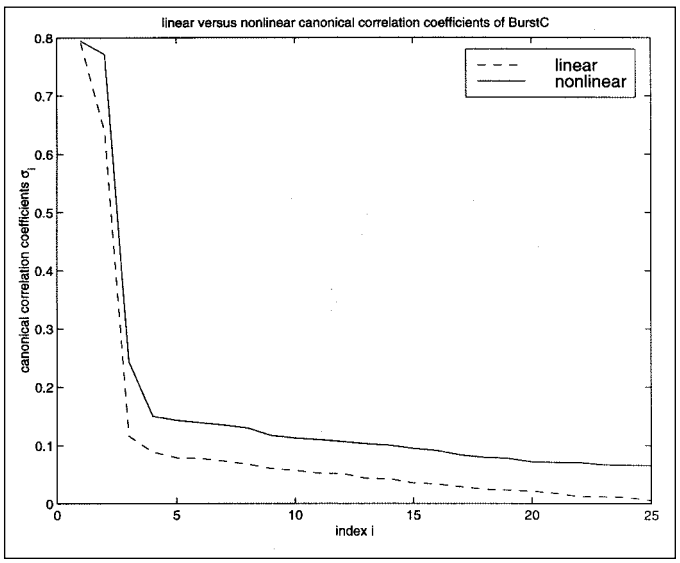


**Figure 1. The linear and nonlinear CCC's for the sEMG of the waveform associated with NSA are shown. The key difference between the plots is that the second coefficient is much larger in the case of the nonlinear canonical correlation. This is an indicator that some nonlinearity is present.**

### *The ACE Method*

The first tests were on a particular burst of sEMG activity labeled as "Burst C." Fourth order predictors (N=4) were computed. The mean square prediction error for the best linear predictor was 0.42, whereas the prediction error for the ACE method was 0.33. This implies that the ACE method predicts about 20% better than linear prediction.

Tenth order predictors (N=10) were also found. The results were similar to the fourth order predictors. The linear prediction error was 0.41 and the ACE prediction error was 0.29 - a 30% improvement. Furthermore, linear prediction did not improve as the order increased, whereas the ACE method appeared to be improving. However, the improvement was slow. These findings corroborate the assumptions of the simplified nonlinear CCA. Specifically, both approaches indicate that the dimension of the attractor is somewhere between 4 and 10.

There is no direct relationship between high order systems and complexity. For example, the chaotic Lorenz map, which is related to the weather, is only of order 3, and is highly complicated. However, systems of high order (e.g. the stock market) also tend to have complicated dynamics. Modeling high order systems is very difficult. Clearly, the waveforms of the NSA sEMG data are complicated. It is hoped that the order of the system that describes the waveforms will be relatively low order. Since the order 10 predictor performs well, it appears that a sig-

nificant part of the waveform is generated by a low order nonlinear dynamical system.

Figures 2-4 depict the nonlinear functions $\phi_i$ with $i$=1,…,10 and $\theta$ generated by a tenth order ACE algorithm and the linear functions generated by the best linear predictor. The figures reveal that some of the functions, $\phi_1$, $\phi_2$ and $\theta$ are nearly linear with some saturation. Additionally, functions $\phi_1$ and $\phi_2$ appear to be the most significant since they range from -2 to 2 and -5 to 5, respectively. The other functions $\phi_1$ with $i$=2,…,10 appear very nonlinear. These plots also include the linear functions generated by the best linear predictor. Note that the linear trend of the nonlinear functions roughly coincides with these linear functions. This similarity is strong for the most significant functions $\phi_9$ and $\phi_{10}$.

## Discussion and Tentative Conclusions

Further study will be necessary to clarify the extent to which the sEMG signal associated with the waveforms of NSA is due to a nonlinear versus random source. The findings that the fourth order ACE predictor performs 20% better than the fourth order linear predictor and the tenth order ACE predictor performs 30% better than the tenth order linear predictor are encouraging. Moreover, the structure of the prediction error will require further investigation. The histograms of the linear and nonlinear prediction errors look very similar (Figure 5). It is known that the maximum of the canonical correlation between two sets of variables is achieved when the nonlinearly distorted variables are jointly Gaussian.[14] Hence, it appears that to insure that the best possible nonlinear predictor has been developed, the histogram of the prediction error should be Gaussian. However, it is not clear at this point in the study whether a good, but not quite optimal, predictor would yield a nearly Gaussian error.

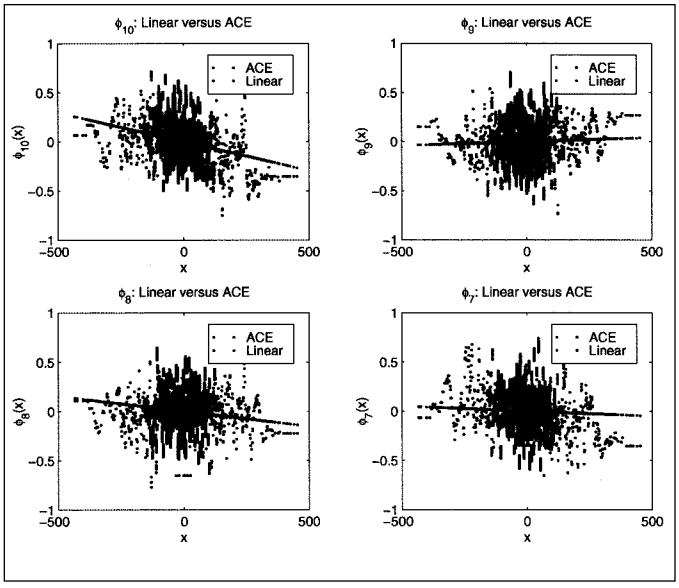


**Figure 2. The nonlinear functions $\phi_i$ for $7 \le i \le 10$, generated by the ACE algorithm as defined by equation (6) are shown. For comparison, the linear functions used in the least mean square linear predictor (5) are shown. Note that the functions generated from the sEMG data by the ACE algorithm are nonlinear.**

It is suspected that the following features of the ACE procedure may have to be refined to provide the clearest analysis:

1. The function $\theta$ has been introduced by statisticians to allow for more freedom in the modeling and to link the ACE algorithm to the nonlinear canonical correlation analysis. It is customary to invert the function $\theta$ to obtain $Y(k+1)$ as a nonlinear function of the past as in equation (7). However, applied to the present sEMG signal, $\theta$ appears to saturate and

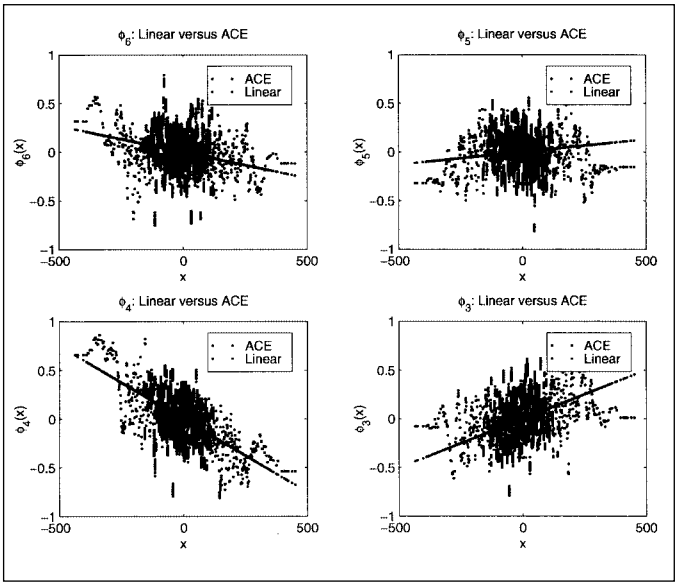


**Figure 3. More nonlinear functions, $\phi_i$ for $3 \le i \le 7$, are shown along with their linear counterparts. As in Figure 2, the functions generated from the sEMG data by the ACE algorithm are nonlinear.**

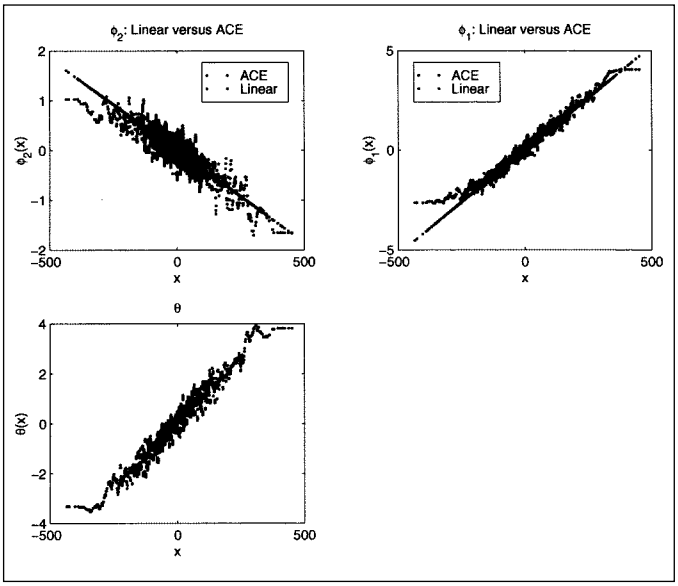


**Figure 4. The nonlinear functions $\phi_1$, $\phi_2$ and $\theta$ are shown. These functions are used for nonlinear prediction so as to minimize (6). The linear functions used in the best linear predictor (5) are also shown. Note that these functions follow the strong linear trend. However, there is sufficient deviation from the linear trend to lower the prediction error from the linear case of 0.41 to the nonlinear case of 0.29.**

is, hence, not an invertible function. The particular way the function is presented in this sEMG analysis requires re-interpretation of its lack of invertibility relative to the degree of singularity of the nonlinear system. A singular nonlinear system is a system of the form

$$F(\xi(k+1),\xi(k))=0$$

whereas a regular system is of the form

$$\xi(k+1)=f(\xi(k))$$

In this sEMG case, the function $F$ appears to be

$$F(\xi(k+1),\xi(k)) \equiv \theta\left(\frac{\xi_1(k+1)}{\mathrm{var}\xi}\right) - \sum_{i=0}^{N-1}\phi_i(\xi_{i+1}(k))$$

If $\theta$ is a pure limiter that saturates between the values $\theta_\star < \theta^*$, then it would be a case similar to the Lorenz attractor, where the dynamical system flips back and forth between two components of the attractor, which in this case would be the hypersurfaces $\sum_{i=0}^{N-1}\phi_i(X(k-i))=\theta_\star$ and $\sum_{i=0}^{N-1}\phi_i(X(k-i))=\theta^*$. However, it appears that most of the motion is concentrated not on the saturating part of $\theta$ but rather in between. It appears, therefore, that the motion is concentrated on that part of the *state* space $\Re^N$ bounded by the two hypersurfaces; that is, the space defined by $\theta_\star \le \sum_{i=0}^{N-1}\phi_i(X(k-i)) \le \theta^*$

2. If $\theta$ is interpreted as the degree of singularity of the system, it turns out that the ACE algorithm bears significant limitation as to the range of allowable nonlinearities in the sense that it does not allow cross coupling of the form $X(k-i)X(k-j)$.

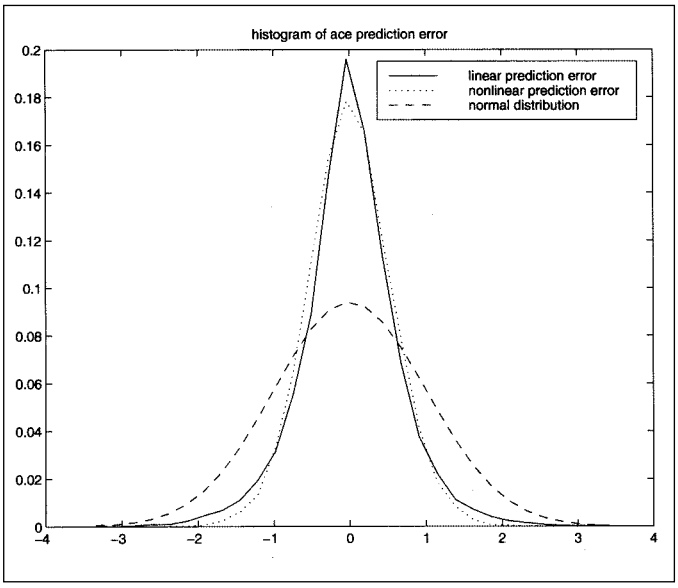


**Figure 5. The error histograms of both the ACE and best linear methods are shown along with a histogram of a normally distributed error. Ideally, the histogram of the prediction error should be normally distributed. It is shown that the ACE prediction error is minimally more normally distributed than the best linear method.**

Therefore, there is a need to adapt the ACE algorithm to the sEMG analysis. In particular, given the interpretation of the lack of invertibility of $\theta$ to be a measure of the degree of singularity, it appears to be important to extend the ACE procedure to allow for more nonlinear distortions. Hence, it may be necessary to develop the following extrapolation of ACE:

a. An $N^{th}$ order ACE prediction error $E_0$ is found.

b. The ACE algorithm is used to predict $E_0$ with the cross term $X(k)X(k-1)$. Thus a new prediction error $E_1$ is found.

c. In the same manner, the cross terms $X(k)X(k-i)$ are used to predict $E_{i-1}$ for $i \le N$

d. The same procedure is repeated for $X(k)X(k-i)X(k-j)$.

Before deciding whether chaos is present in an experimentally observed time series, the preliminary consideration should be whether the sequence is, for the most part, a manifestation of random or nonlinear phenomena. As far as the sEMG signal in the present study is concerned, it is apparent that most of the sequence can be justified by nonlinear rather than linear or stochastic phenomena. To conclude that the sEMG signal is chaotic will require a definition of chaos. In so far as it has been argued that a time series is chaotic whenever it can be explained by nonlinearities despite its external random appearance, the sEMG signal herein studied fits the definition of chaos. However, the most recent trend is that the concept of chaos is relevant to the theory of dynamical systems and as such requires more than just nonlinearity. In particular, the definition would require such dynamical concepts as existence of non-periodic recurrent points, transitivity, etc. From this point of view, further study will be required to demonstrate that the sEMG data is predominantly chaotic in nature.

However, the most important achievement is that the nonlinear phenomena, chaotic or not, underlying the sEMG have at this juncture of study been identified and an "attactor" has been found. Perhaps the most important issues will be whether there is some difference among the attractors of all three levels of NSA care, and to what extent the attactor(s) bear similarities with those of other physiological events, including classical and other forms of muscular activity. Moreover, it will be important to further investigate the uniformity of these findings among a spectrum of individuals undergoing NSA care, as well as evaluating data derived from sEMG electrodes being placed at different anatomical locations relative to the spine.

## Acknowledgments

The authors would like to acknowledge EMG Consultants, Inc., 255 W. Spring Valley Ave., Maywood, NJ

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CASE REPORT

# Reduction of Psoriasis in a Patient under Network Spinal Analysis Care: A Case Report

*Madeline Behrendt, D.C.*

**Abstract** — This case report describes the progress of a 52 year old male with chronic psoriasis, first diagnosed in April of 1992. After the condition exacerbated over a five year period, he was placed on 12.5 mg/week methotrexate, and oral immunosuppressant medication in October of 1997. After commencing the medication, the condition reduced from 6% body coverage, with flares of 15-20%, to a body coverage of 5%. Following a cessation of the oral medication in February, 1998, the condition recurred at the previous uncontrolled level within one month. The patient was again placed on 12.5 mg/week methotrexate, and subsequently the condition reduced to 5% body coverage. The patient's dose was reduced to 10 mg/week, and later to 7.5 mg/week, with the psoriasis remaining at 5% coverage. On 5/18/98, the patient commenced regular NSA care. He reported a reduction in the psoriasis condition on 6/3/98, and was taken off the oral medication on 6/25/98. The reduction continued, and the patient was advised by his medical physician on 7/01/98 to continue the cessation of oral medication. As of 9/30/98 the psoriasis had decreased to 0.5% to 1.0 % of coverage, and prior plans to initiate ultraviolet-A therapy were canceled. As of 11/98, a five month period since cessation of methotrexate, the patient has remained under regular NSA care, with no recurrence of psoriasis body coverage greater than 1%, the only medication being a topical ointment. This is contrasted to the recurrence after one month, following the patient's first cessation of methotrexate, and prior to NSA care. The possible role of NSA care in the reduction of the patient's psoriasis, and other health benefits is discussed.

*Key words: Network spinal analysis, NSA, psoriasis, methotrexate, plaques, vertebral subluxation, chiropractic.*

## Introduction

The present report describes a 52 year old male Caucasian diagnosed with psoriasis. Prior to Network Spinal Analysis care, the patient experienced a reduction of psoriasis under medical care, with a subsequent exacerbation one month after he ceased taking medication. After commencing NSA care, which is a system of spinal health care delivery within the subluxation based chiropractic model, subsequent reduction of the condition occurred concomitant with the patient's second cessation of medication.

NSA, which is currently estimated to have over 12,000 recipients of care worldwide, is not purported to be palliative or a cure for medical conditions. However, the purpose of this case report is to contribute to other reports which link NSA care to discernible physiological changes associated with the care received.[1,2] Relative to this perspective, psoriasis is thought to be an auto-immune disease, linked to multiple genes, effecting men and women with equal frequency.[3,4] While research has not revealed the etiology of this condition, it is believed to be provoked by local trauma, overexposure to the sun, infection, stress and physical illness.[3-5] Psoriasis is characterized as a disorder of the keratinocytes, which are formed in the lower epidermis of the skin. As these psoriasis cells rise to the skin's surface, their normal healthy life span is reduced from 26 days to 3-4 days. This rapid proliferation of keratinocytes is coupled to an aggregation of T lymphocytes, as might occur in an infection, and numerous blood vessels. The highly vascularized accumulation of skin cells, and T lymphocytes results in the physical appearance of scaly, red elevated lesions.[3-5]

Since the condition is often cleared under the influence of immunosuppressant drugs, such as methotrexate,[3,4,6] there is support for the theory that psoriasis is an immune-related disorder. While any area of the body can be effected, psoriasis is frequently found on the scalp, lower back, elbows, knees, groin, genitals, and skin folds. The disease is also characterized by its chronic nature which may go in and out of remission.[3-5]

## Patient Presentation, Relevant History, and NSA Care

The patient who was first introduced to Network Spinal

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Analysis on 5/12/98, presented for Network Spinal Analysis (NSA) care on 5/15/98. The subject complained of general muscle soreness and stiffness, and pain in his neck and mid-back.

He had previously been diagnosed with psoriasis in April of 1992, one month after receiving a beta-blocker for elevated blood pressure. The condition gradually increased in severity from 1% body coverage to 6%, with "flare ups" ranging from 15-20% body coverage, by August 1997. Lesions were predominantly on the legs (shins) and feet.

The patient began methotrexate therapy (12.5 mg/week) in October of 1997, followed by a reduced body coverage to 5%. On 3/3/98, medical evaluation revealed a recurrence ("flare-up") of lower extremity plaques after the patient had mistakenly abstained from taking methotrexate one month prior. Even though the condition was reduced under oral medication, both physician and patient were concerned since methotrexate therapy was reported to cause liver damage, immunosuppression, and a plethora of other potential side effects.[6] However, following recurrence of psoriatic plaques, the patient once again elected to undergo methotrexate therapy (12.5 mg/week).

Medical evaluations on 3/31/98, and 5/5/98, with patient receiving methotrexate (10 mg/week) reported continued resolution of plaques, and clinical laboratory findings accompanying these medical visits indicated the patient was tolerating the medication well. On 6/2/98 dosage of methotrexate was reduced to 7.5 mg/week, as the condition appeared to be controlled at 5% coverage. However, at this time the patient was advised that during the coming winter months, he should expect to undergo ultraviolet-A-therapy along with oral medication. After undergoing a methotrexate taper from October of 1997 through 6/25/98, receiving a total dosage of 414.5 mg, the patient was advised on 6/25/98 by his physician to cease oral medication as the psoriasis had remained at a controlled level since 3/14/98.

## NSA Care

The methods and protocols regarding NSA which were followed with regard to this patient, as well as the objective of NSA in regard to correction of vertebral subluxation, have been described previously, including the indicators of subluxation.[7] Preliminary chiropractic evaluation of the patient on 5/15/98 revealed head in flexion and rotated to the right, elevated left shoulder, with right "foot flare." Prone spinal analysis revealed presence of left short leg, left ankle inversion, left heel tension, bilateral leg adduction resistance, and bilateral leg abduction resistance, and a left cervical syndrome. Prone examination demonstrated the presence of right hip elevation, left shoulder elevation, and visual "tensing" of the upper thoracic area.

Sitting and prone muscle palpation revealed "marked, ropey" bilateral vertical bands in the upper cervical, lower cervical, and upper thoracic regions of the spine. Less "ropey" character of spinal musculature was detected between T4 and L5.

The patient was seen three times per week and re-evaluated at 8 weeks. The patient was seen regularly on Monday, Wednesday, and Thursday mornings at 9:30 a.m. during which time he was administered the appropriate NSA care based on the findings relative to the indicators of subluxation described above.[7]

Based on the initial findings of 5/15/98, in accordance with NSA protocol,[7] care was initially applied on 5/18/98 by using Level One spinal contacts in a sequence which included: Phase 2 through Phase 1 on the left of the second sacral segment, C2 contact in an inferior to superior direction, followed by Phase 5 through Phase 1 contacts administered bilaterally at the level of the second sacral segment. C5 and coccyx were also contacted to address tension in the upper thoracic area. This pattern of adjustment was modified somewhat from visit to visit depending on the presentation of the patient with regard to indicators of subluxation, as described above, and areas of spinal tension. Overall, the segments which were contacted for adjustment, in a sequence consistent with NSA protocol,[7] were: S2, S3, C2(left), C2 (inferior to superior), C2/coccyx, C3(left), C5/coccyx, C5(left), C5(inferior to superior), and the left occiput.

## Results

*Level One Care*

The patient completed 23 visits between 5/18/98 and 7/20/98 (Table 1), during which time he was in Level One of care. Based on the patient's presenting chiropractic examination profile, coupled to his six year history of chronic psoriasis gradually increasing in severity, with no history of non-medicated remissions, informed consent was obtained to report the patient's progress while under NSA care.

*Patient Commentary:*

During the time period between 5/18/98 and 7/20/98, under Level One Care,[7] the patient reported the following:

5/18/98 - Mowed lawn over weekend felt great for the first time.

5/20/98 - Patient noted easier to get in an out of his vehicle. Positive changes in spinal musculature tension, and other regions of discomfort.

5/27/98 - Sleeping better than ever. Mowed lawn again with continued ease. Continuation of other changes noted on 5/20/98.

5/29/98 - Same as 5/20/98 and 5/27 with regard to spinal musculature.

6/01/98 - Same as above with regard to spinal musculature.

6/03/98 - Reported notice of reduction of psoriasis. "stiff left side."

6/05/98 - "okay."

6/08/98 - Reported less tension in spinal musculature, more aware of areas of comfort and ease.

6/12/98 - Stiff left side.

6/15/98 - "Much better overall."

6/17/98 - Noted positive changes in spinal posture, tension in spinal musculature, more ease in regions of discomfort, improved respiration, overall increase in flexibility.

6/18/98 - "Doing well." Spouse noticed overall improvement, requested him to continue care.

6/24/98 - Continued improvement.

6/25/98 - Patient discussed health

6/29/98 - Patient reported a general overall flexibility.

7/01/98 - "Good."

7/02/98 - Patient stated Dermatologist took him off methotrexate therapy, with next medical visit scheduled in September, 1998, in the absence of a "flare up." Patient also recommended judicial natural sunlight, with further suggestion for ultraviolet-A therapy consideration in September, 1998. Continues with temovate, a topical ointment.

7/06/98 - "Good."

7/08/98 - "Just plain exhausted."

7/09/98 - "Better" but after driving, discomfort in the neck area.

7/13/98 - "Bad weekend."

7/16/98 - No comments

7/20/98 - Re-evaluation. Patient notes since the beginning of NSA care to date the following observations:

a. more aware of spine, but not discomfort, especially at work.
b. aware of spinal tension/restricted movement independent of pain
c. better posture, more upright and flexible.
d. movements in general are easier.
e. feels a sense of "ease" in various areas of his spine.
f. more aware of where he holds areas of tension in his spine
g. patient experienced spontaneous movements in remote regions of his spine to where the adjustment was administered.
h. has experienced a sense of "unwinding" of tension in his spine.
i. discontinued methotrexate, psoriasis greatly improved notably on his legs, with continued resolution on his feet, high blood pressure dropped. Generally feel much better. Colleagues inform the patient that he is more pleasant to be around.

**Level Two Care**

The patient continues care to date, November, 1998. Clinically, he demonstrates considerable reduction of indicators of vertebral subluxation, and exhibits a notable reduction in previous tension in the spinal musculature, and requires less frequent visits. As of 10/28/98 he was in his third month of Level Two Care (Table 1).[7] On 9/30/98, while under Level Two of Care, the patient reported that the psoriasis was resolved on his feet as well as legs (Figure 1). The only medication he has used since withdrawing from methotrexate on 6/25/98, has been temovate, a topical ointment. He was not recommended by his medical physician for ultraviolet-A phototherapy (PUVA) during his September medical visit, even though he had been exposed to very limited natural sunlight between his 6/01/98 visit and September, 1998. During this same period he reported periods of work stress. However, he continued to experience reduction of psoriasis, with only minimal, less than 1% coverage of early plaques which seem to resolve without further advancement (Figure 1).

**Discussion**

While NSA care does not claim to be palliative or a cure for any medical condition, the present study suggests that it may be a factor in the reduction of psoriasis in the care of this patient. It is notable that the patient, prior to NSA care, had an approximate six year history of psoriasis without any non-medicated reduction or remission. Moreover, when the patient, mistakenly ceased his dosage of 12.5 mg/week, within a month the condition was back to its uncontrolled level.

The patient's second cessation of the immunosuppressant medication (7.5 mg/week), following the advise of his physician, occurred at a time when he was stable at 5% coverage, and had also been regularly under Level One of NSA care for 5 weeks. One week later, the psoriasis had reduced to approximately 1% and his medical physician, based on the reduction of the condition advised continued cessation of oral medication. Rather than an expected return of the condition, as with the first cessation of oral medication, the patient as of November, 1998 is currently at 0.5 % to 1.0 % body coverage, with the only medication being applications of a topical ointment. The period since the second cessation of oral medication has been five months, during which time the psoriasis has not exceeded 1% body coverage. The patient has reported that it is a relief to have ceased the oral medication as it has the potential for a wide

**Figure 1. Photograph of Patient displaying the distribution of psoriasis plaques as of November 20th, 1998. Remaining plaques are isolated to the ankle foot areas, which represent approximately a 1% coverage.**

range of serious side effects. The patient also reported that it was surprising to his medical physician that the psoriasis had remitted to such a level in the absence of oral medication.

This author is unaware of any reports in the scientific literature regarding remissions of psoriasis in conjunction with chiropractic care. One study has characterized the incidence of psoriasis patients in a chiropractic clinic in Sweden.[8] The study found among 1500 patients, 98 (6.5%) had been diagnosed with psoriasis, as compared to an incidence in the general population of 2%. Gender distribution was nearly equal, and the average age was 50.7 years, about the same age as the patient reported in this study (52 years). The Swedish patients with psoriasis tended to receive chiropractic "treatments" more than twice as frequently as non-psoriasis patients. Another study correlated psoriatic arthritis with changes in the cervical spine.[9] Two patterns of cervical spine abnormalities were observed; erosive lesions and another similar to ankylosing spondylitis. Moreover, it has been reported that a patient diagnosed with psoriatic arthritis, with extensive ankylosis, responded with increased cervical range of motion after toggle/recoil adjustments to C1, with decreases in clinical symptoms paralleling increased range of motion.[10]

Although the last two studies mentioned above dealt with arthritis conditions likely associated with psoriasis, they provide evidence that the cervical spine and other spinal abnormalities can be associated with psoriasis, and that chiropractic care, notably the adjustment, can be of value.

The present report suggests that in addition to chiropractic benefits which improve range of motion and perhaps pain, other symptomatic features of psoriasis may abate under the influence of NSA care. Other factors, as well, which affect the patient's quality of life, such as "feeling better," "sleeping better," and being more pleasant to be around, may also reflect NSA care, as it is a model of chiropractic care which is postulated to specifically promote improvement in neurological integrity through relieving adverse mechanical cord tension.[7] Moreover, based on evidence that psoriasis is an auto-immune disease,[4] it may be hypothesized that restoration of the integrity to the nervous system would also enhance normal immune function. This is a plausible concept as the field of psychoneuroimmunology has demonstrated the close link between the nervous system and the immune system. [11-13]

## Conclusion

In conclusion, it appears that some benefit in the reduction of psoriasis, as well as the patient's perception of health improvement, may be associated with regular NSA care. However, since psoriasis is known to exhibit episodes of remission, it cannot be overlooked that NSA care may have been coincidental to the remission. In order to be properly evaluated, this possibility will require more thorough investigation. Moreover, in consideration of the potential dangers of the standard drug therapy available to patients with this condition, it is suggested that a clinical trial in a population of psoriatic patients would be appropriate to evaluate the possible benefits of NSA care separate from other forms of care, or administered concurrently.

**Table 1.** Relationship Between Medication Tapering, NSA Care, and Status of Psoriasis in the Patient. *

| Date(s) | Medication (mg/wk) | Dose | Level of NSA Care | Psoriasis Status |
|---|---|---|---|---|
| 4/92 -8/97 | Tazorac | ointment | - | 1% -6% body coverage |
| | | as needed | - | (Flares = 15 - 20%) |
| 10/97 | Methotrexate | 12.5 | - | Reduced to 5% |
| 2/98-3/3/98 | | Mistaken cessation | - | Flares = 5%-20% |
| 3/4/98 | Methotrexate | 12.5 | - | Reduced to 5% |
| 3/31/98 | Methotrexate | 10.0 | - | Reduced to 5% |
| 5/5/98 | Methotrexate | 10.0 | - | Quo |
| 5/18/98 | Methotrexate | 10.0 | Level One | Quo |
| 6/01/98 | Methotrexate | 10.0 | Level One | Quo |
| 6/02/98 | Methotrexate | 7.5 | Level One | Quo |
| 6/25/98 | Medically advised cessation | - | Level One | Reduced to 1.0% |
| 7/01/98 | - | - | Level One | Reduced to 1.0% |
| 7/02/98 7/20/98 | - | - | Level One | Reduced to 0.5 - 1.0% |
| 7/28/98 | - | - | Level Two | Quo |
| 9/30/98 | - | - | Level Two | Quo |
| 9/30/98 | No further medical therapy, only topical ointment Temovate | - | Level Two | Quo |
| 10/28/92 | - | - | Level Two | Quo |

* See Patient Presentation, Relevant History, and NSA Care

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ORIGINAL RESEARCH

# Changes in Digital Skin Temperature, Surface Electromyography, and Electrodermal Activity in Subjects Receiving Network Spinal Analysis Care

*Eric B. Miller, Ph.D., Peter D. Redmond, D.C.*

**Abstract** — A preliminary study was conducted to evaluate changes in digital skin temperature (DST), surface electromyography (sEMG), and electrodermal activity (EDA) in a group of twenty subjects receiving Network Spinal Analysis (NSA) care. Data, simultaneously derived from all three parameters, were considered to be indirect correlates of sympathetic nervous system activity. Subjects, including a group of five controls, were assessed for a period of 17 minutes. The continuous assessment period included a baseline interval of 4.5 minutes, followed by a 12.5 minute period which was divided into five 2.5 minute intervals. Care was administered to the NSA recipient group immediately after the baseline period, whereas controls received no intervention following baseline. Results revealed no significant differences in DST either within or between the two groups. Surface EMG readings were relatively constant over the five intervals following baseline in the NSA group, while controls showed significant ($p < 0.05$) increases in sEMG at the second through fifth intervals relative to the first interval following baseline activity. Electrodermal activity was significantly decreased ($p < 0.01$) in the NSA group in the second through fifth intervals compared to baseline. Moreover, decreases varied between intervals, but exhibited a leveling from the third through fifth interval. Control subjects, alternatively, exhibited an increase in EDA in all intervals following baseline. The extent of increase resulted in EDA activity significantly greater than the NSA group at the third through fifth intervals. It was concluded that the increase in EMG activity in the control groups may have reflected an increasing level of anxiety due to the duration of the recording period. Since the NSA group expressed constancy in sEMG activity during the same period, coupled to significant decreases in EDA, a "sympathetic quieting effect" was postulated to occur in subjects receiving NSA care. This conclusion is consistent with hypothesized neurological pathways linked to responses observed during NSA care, as well as other reports of self-reported improvements in mental/emotional state and stress reduction in patients receiving Network Chiropractic Care.

*Key words: Network Spinal Analysis, vertebral subluxation, sympathetic nervous system digital skin temperature, surface electromyography, electrodermal activity.*

## Introduction

While one of the primary objectives of Network Spinal Analysis (NSA) is correction of vertebral subluxation,[1] recent study regarding Network Chiropractic, now practiced as Network Spinal Analysis (NSA), has provided evidence of enhanced self-reported "wellness" benefits.[2] Through retrospective recall, recipients assessed a spectrum of health related measures, including the ability to cope with stress, before as compared to their present experience under Network care. Although results from this provocative study of Network Care support anecdotal reports concerning its positive outcomes, it is important to demonstrate if such accounts are accompanied by physiological changes in NSA recipients.

While these survey results suggest that positive changes occur in association with this form of care, questions regarding the biological mechanisms promoting these changes are yet to be resolved. However, it stands to reason that generalized improvements in health which involve positive coping with stress could be a reflection of reduced sympathetic nervous system activity.[3-5] If, indeed this is the case, the research hypothesis is proposed that changes indicative of decreased sympathetic activity should be demonstrable concomitant with NSA care.

Measurements are available for such an assessment. Early observations of changes in electrical activity of the skin in

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response to various physical and emotional stimuli were made by the French Neurologist, Charles Fere[6] and the Russian physiologist, Tarchanoff.[7] Although both were measuring electrodermal activity (EDA), their approaches were different in that Fere measured the flow of an externally applied current between two skin electrodes, while Tarchanoff measured the difference in electrical potential between two skin areas. Both, however, recorded their findings as galvanometric deflections. Hence the measurement of EDA became known among early researchers as galvanic skin response (GSR).[7] Fere believed that the changes in EDA following sensory and emotional stimuli were indications of nervous system excitation, or "arousal."

Although its physiological basis has yet to be thoroughly resolved, investigation suggests that EDA is the product of changes in sweat gland activity.[8,9] Sweat glands, while widely distributed in the skin , appear to serve different functions based on their type and location. Apocrine sweat glands which are closely associated with hair follicles, are believed to principally serve in thermoregulation.[10] Eccrine glands, however, which are predominantly found in the palms and soles of the feet are believed to be associated with sympathetic activity due to their profuse sympathetic innervation. Study has shown an association between putative sympathetic outflow and eccrine activity, with increased activity noted particularly in the palms and fingers in situations that were emotionally arousing.[11]

Additionally, DST[20] and sEMG (through biofeedback)[12-17] have also been shown to be associated with changes in sympathetic output. Based on information which links EDA, DST, and sEMG to varying levels of sympathetic outflow, the present study focused on recording changes in these parameters before and during the clinical application of NSA. The information was collected with the intention of investigating the relationship between improved ability to cope with stress, reported in NSA recipients, and physiological changes evoked through the sympathetic nervous system.

## Methods

### *Subjects and Study Setting*

This initial study was designed as a preliminary investigation to compare patients' baseline DST, sEMG, and EDA to changes which might occur during the administration of NSA. Twenty subjects, all of whom were regular recipients of NSA for a minimum of 3 months, were selected for this study. The study population consisted of 16 females and 4 males, ranging in age from to 20 - 54 years of age (mean 40.0 ± 10.0, median, 43.0 years). Inclusion criteria were: (1) Patients 18 years or older, (2) Patients who had attained a level of response to NSA indicating the ability to engage both the respiratory and somatopsychic waves,[1,2] and (3) patients with no chronic pain syndromes or other conditions which would create a chronic state of anxiety or stress.[29] The significance of the somatopsychic and respiratory waves, as well as the methods and clinical objects of NSA care are described elsewhere.[1,12] The nature of the present study was explained to each individual, and written consent to participate was obtained. The investigation was conducted in the private office setting at the West Chester and Philadelphia locations of the South Street Healing Center, in Pennsylvania between the months of January and March, 1997.

### *Physiological Measurements*

Electrodermal activity, was determined in the form of digital skin conductance employing a J & J i330 physiological monitoring system, interface and modules (J&J Engineering, Inc., Poulsbo, WA). In order to record skin temperature and skin conductance simultaneously, two temperature/ electro- dermograph T-601 modules were used, one for measuring temperature, the other for conductance. One unit incorporated a thermistor probe (TS-600) capable of measuring changes as small as 0.006 degrees Fahrenheit, while the other utilized an EDG silver/silver chloride electrode cable harness (CH-600) capable of measuring changes as small as 0.01micromho.

The measurement of EDA was determined by application of two finger electrodes (SE-35). Prior to placement, a small amount of conductivity gel (Signa ECG electrolyte cream # 17-05) was placed on each circular electrode which was attached to a velcro strip with a snap fastener. The electrode assembly was then snapped securely to the first pad (most proximal) of the left index and ring fingers. The tip of the finger was avoided in order to reduce the probability of contact artifact. Prior to the study, the constant voltage (0.166 VDC, 0 to 50 micromhos) EDG was calibrated to 20.0 ± 0.3 micromhos, with a factory calibration board.

Digital skin temperature was determined by attaching the thermistor probe to the dorsal surface, just after the fingernail, of the left middle finger with dermacell-type (porous) paper tape. The thermistor was placed in the center (both length and width) of one piece of tape, and then placed on the finger so that the thermal cable ran downwards toward the wrist. The paper tape was used to secure the thermistor to the finger snugly, but so tight as to have the patient perceive their pulse-beat. Prior to the study, the T-601 module (range of detection between 60 - 100 degrees F) was calibrated with a standard thermometer with a 0.1 degree F resolution, or against the other T-601 module.

Surface electromyography was monitored with a EMG 501 module which employed two surface silver-silver chloride electrodes making contact with Signa electrolyte conductive cream (no. 17-05), and one ground (Thought Technology, Montreal, Quebec, no. miep 02-000). The two electrodes were placed on each side of the spine at the level of the sixth thoracic vertebra. This configuration generated microvolt data in the bandpass region of 100 - 200 Hz. The microvolt data, indicative of muscle activity in that region, was summed rather than being reported unilaterally. The cable from the electrodes was allowed some slack and then taped or clipped to the subject's clothing to avoid a "pull effect" on the sensors which could affect the readings.

### *Study Design*

An initial baseline measurement for EDR, DST, and sEMG was continuously recorded for each subject for a period of 4.5 minutes. Although subjects were in the room for approximately 10 minutes prior to the recording period, the baseline period further allowed subjects to equilibrate to the nearly constant

ambient room temperature (between 23 - 26 degrees C) and normal room sounds, including soft background music, inherent to the study environment.

Immediately following the 4.5 minute baseline measurement period, continuous readings of the same three parameters were recorded for an additional 12.5 minutes. Attention was given to maintaining a relatively constant room temperature (between 23-26 degrees C) to avoid a "sweat response" which would be expected to effect the parameters being studied. The total period was divided into five intervals of 2.5 minutes each for ease of analysis which also permitted comparison between the baseline period, during which subjects were seated, and subsequent intervals during when each subject was prone. This resulted in a cumulative recording period, including baseline, of 17.0 minutes. The administration of appropriate spinal contacts, as part of the NSA protocol, commenced immediately following the acquisition of baseline data. Baseline data was acquired with subjects in the seated position. Immediately following the baseline period, each subject was positioned in the prone position. The practitioner's table is designed with a longitudinal opening to allow the nose and mouth to receive air, while permitting the face to be flush to the table top. This prevents undue stress to the head and neck area while the subject is in the prone position.

In the absence of any intervention, values would be expected to change over the baseline period, and the subsequent five intervals. To assess the extent of change, five subjects, under NSA care, were selected from the first five interviewees meeting the selection criteria. These subjects served as controls receiving no NSA intervention during the measurement period. These subjects, four females and one male, ranging in age from 37 - 40 years (mean, 44.0 ± 8.0, median, 40 years) were monitored over the entire baseline period, plus five subsequent intervals. The

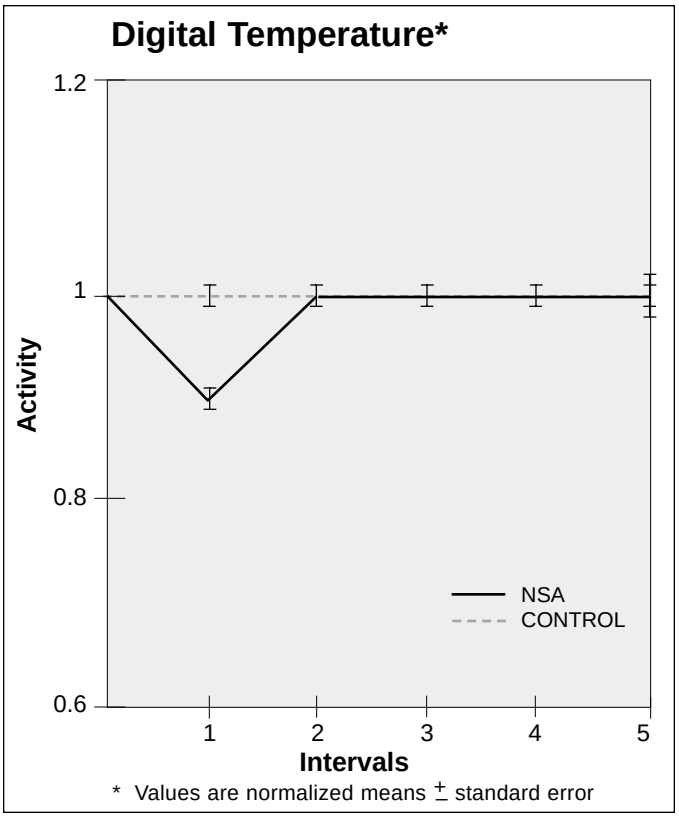
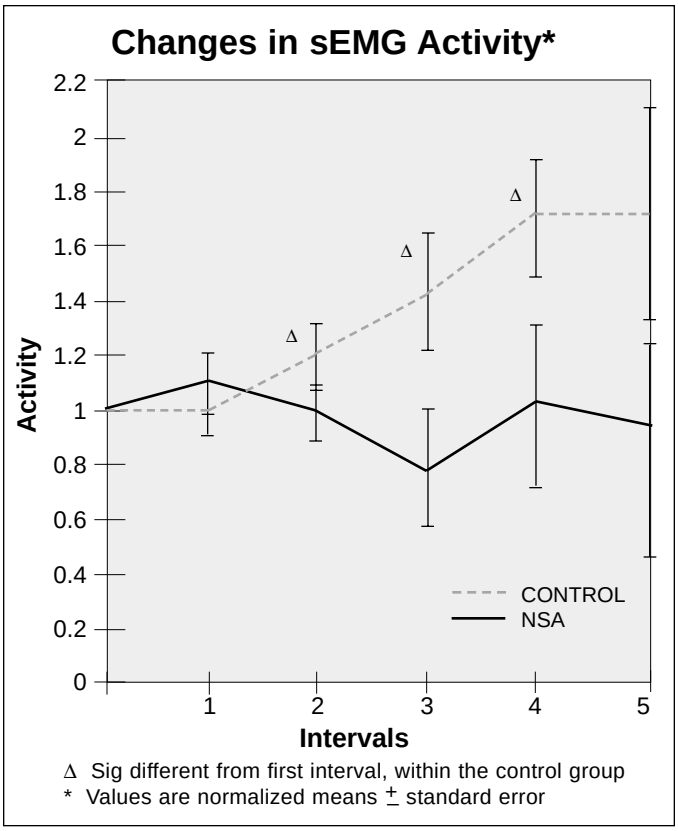



Table 1. Digital Temperature* in Controls and Subjects Receiving a Time Course of Network Spinal Analysis Care.

| | | Time Course of Care | | | | |
|---|---|---|---|---|---|---|
| Interval | Baseline | 1 | 2 | 3 | 4 | 5 |
| Elapsed Time (min) | (0-4.5) | (4.5-7.0) | (7.0-9.5) | (9.5-12.0) | (12.0-14.5) | (14.5-17.0) |
| *NSA* | | | | | | |
| TEMP (F ± s) | 83.8 ± 6.4 | 83.1 ± 7.9 | 83.4 ± 7.3 | 83.6 ± 7.6 | 84.0 ± 7.3 | 84.3 ± 7.4 |
| Std. Error | ± 1.43 | ± 1.77 | ± 1.13 | ± 1.70 | ± 1.63 | ± 1.66 |
| TEMP (F ± s) | 1.0 | 0.9 ± 0.04 | 1.0 ± 0.03 | 1.0 ± 0.04 | 1.0 ± 0.05 | 1.0 ± 0.06 |
| Std. Error | | ± 0.01 | ± 0.01 | ± 0.01 | ± 0.01 | ± 0.01 |
| *Controls* | | | | | | |
| TEMP (F ± s) | 85.8 ± 1.9 | 87.3 ± 2.5 | 87.9 ± 2.0 | 88.4 ± 1.8 | 88.0 ± 1.9 | 87.1 ± 1.9 |
| Std. Error | ± 0.84 | ± 1.12 | ± 0.89 | ± 0.80 | ± 0.85 | ± 0.85 |
| TEMP (F ± s) | 1.0 | 1.0 ± 0.02 | 1.0 ± 0.02 | 1.0 ± 0.03 | 1.0 ± 0.03 | 1.0 ± 0.04 |
| Std. Error | | ± 0.01 | ± 0.01 | ± 0.01 | ± 0.01 | ± 0.02 |

* Temperature is expressed in degrees Fahrenheit (F).




methods of patient placement and instrument recording were exactly as that administered to the group receiving NSA care.

*Light Touch Contact Points During NSA Care*

Throughout the course of the study, during which time NSA was administered to each subject, various light touch contacts were made to specific regions of the spine, based on the established protocol described elsewhere.[1,18] The anatomical landmarks contacted involved one or more of the following: the occiput (0X), atlas vertebra (C1), axis vertebra (C2), fifth cervical vertebra (C5), right post sacral iliac (PSIR), left post sacral iliac (LSIR), medial left sacral base left (MLSB), medial right sacral base (MRSB), bilateral sacral base (BSB), tip of coccyx (TC), right coccyx (RC), left coccyx (LC). Since the subluxation status of each patient was unique, the sequence and number of tissue contacts thus varied accordingly.

*Analysis of Data*

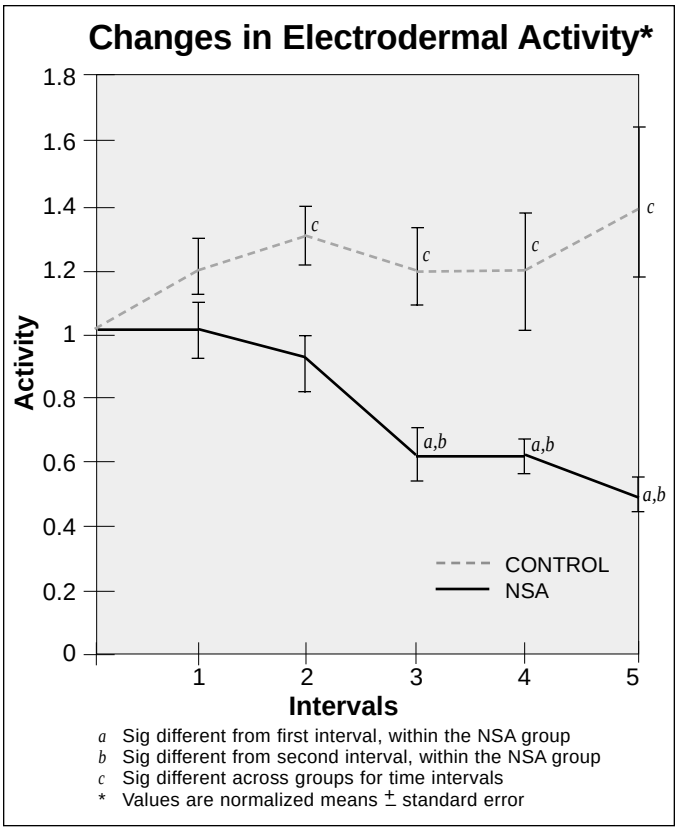
Data derived from the measurement of EDA, DST, and sEMG were evaluated for both the control group and NSA care recipients as a time series. Since absolute values varied between individuals, all values were also normalized by dividing by the baseline value, then averaged. Thus, for these three parameters (considering both absolute values and normalized values) each

Table 2. Changes in Surface Electromyography (sEMG) Activity in Controls and Subjects Receiving a Time Course of Network Spinal Analysis Care.

| | | Time Course of Care | | | | |
|---|---|---|---|---|---|---|
| Interval | Baseline | 1 | 2 | 3 | 4 | 5 |
| Elapsed Time (min) | (0-4.5) | (4.5-7.0) | (7.0-9.5) | (9.5-12.0) | (12.0-14.5) | (14.5-17.0) |
| *NSA* | | | | | | |
| sEMG Activity ± s (microvolts) | 3.5 ± 1.0 | 3.6 ± 2.2 | 3.1 ± 1.7 | 2.6 ± 3.5 | 3.1 ± 4.9 | 2.9 ± 5.5 |
| Std. Error | ± 0.22 | ± 0.49 | ± 0.38 | ± 0.78 | ± 0.10 | ± 1.23 |
| sEMG Activity ± s (normalized) | 1.0 | 1.1 ± 0.6 | 1.0 ± 0.4 | 0.8 ± 1.1 | 1.0 ± 1.5 | 0.9 ± 1.7 |
| Std. Error | | ± 0.11 | ± 0.09 | ± 0.25 | ± 0.34 | ± 0.38 |
| *Controls* | | | | | | |
| sEMG Activity ± s (microvolts) | 8.5 ± 5.4 | 5.4 ± 6.9 | 11.7 ± 9.8 | 15.3 ± 12.8 | 14.7 ± 12.1 | 16.4 ± 16.4 |
| Std. Error | ± 2.41 | ± 3.10 | ± 4.38 | ± 5.71 | ± 5.40 | ± 7.32 |
| sEMG Activity ± s (normalized) | 1.0 | 1.0 ± 0.2 | 1.2 ± 0.3† | 1.5 ± 0.5† | 1.7 ± 0.5† | 1.7 ± 0.8 |
| Std. Error | | ± 0.09 | ± 0.13 | ± 0.22 | ± 0.22 | ± 0.36 |

† Significant difference from the first time interval, within the control group (Results for p values).

of the five post baseline intervals were compared to their respective baseline, and subsequently to each prior interval, by a paired two-tailed T-test, $p < 0.01$. Additionally, NSA care recipient data (absolute data as well as normalized values) were compared to control data, using the same approach as described above. In this instance, data was analyzed by an independent two-tailed T-test. A larger alpha of 0.05 was used when comparing sEMG normalized data since the large standard deviations observed were expected to preclude significant differences at an alpha of 0.01. The F test was employed to determine if the two samples reflected equal or unequal variances. For graphic comparisons normalized data were expressed as mean ± standard error to demonstrate the variance around the respective mean values.




**Results**

*Digital (Peripheral) Skin Temperature*

Digital skin temperature (Table 1, Figure 1), for NSA care recipients varied between 83.1 ± 7.9 to 84.3 ± 7.4 degrees Fahrenheit (28.4 to 29.1 degrees centigrade). Controls ranged from 85.8 ± 1.9 to 88.4 ± 1.8 degrees Fahrenheit (29.9 to 31.3 degrees centigrade). Comparison of absolute temperatures within the control group and the NSA recipient group revealed no significant differences between any of the time intervals, nor when the five intervals were compared to baseline. Moreover,

Table 3. Changes in Electrodermal Activity (EDA) in Controls and Subjects Receiving a Time Course of Network Spinal Analysis Care.

| | | Time Course of Care | | | | |
|---|---|---|---|---|---|---|
| Interval | Baseline | 1 | 2 | 3 | 4 | 5 |
| Elapsed Time (min) | (0-4.5) | (4.5-7.0) | (7.0-9.5) | (9.5-12.0) | (12.0-14.5) | (14.5-17.0) |
| *NSA* | | | | | | |
| EDA (umhos ± s) | 6.1 ± 4.4 | 6.3 ± 4.5 | 5.2 ± 4.0‡ | 3.8 ± 3.5†‡^ | 3.4 ± 3.1†‡^ | 3.1 ± 2.7†‡^ |
| Std. Error | ± 0.05 | ± 0.05 | ± 0.20 | ± 0.5) | ± 0.60 | ± 0.70 |
| EDA (normalized) | 1.0 | 1.0 ± 0.4 | 0.9 ± 0.4 | 0.6 ± 0.4‡^ | 0.6 ± 0.3‡^ | 0.5 ± 0.4‡^ |
| Std. Error | | ± 0.09 | ± 0.09 | ± 0.09 | ± 0.07 | ± 0.09 |
| *Controls* | | | | | | |
| EDA (umhos ± s) | 2.4 ± 1.9 | 2.7 ± 2.2 | 2.9 ± 2.4 | 2.9 ± 2.6 | 2.9 ± 2.7 | 3.2 ± 3.0 |
| Std. Error | ± 0.85 | ± 0.98 | ± 1.07 | ± 1.16 | ± 1.20 | ± 1.34 |
| EDA (normalized) | 1.0 | 1.2 ± 0.2 | 1.3 ± 0.2 | 1.2 ± 0.31[1] | 1.2 ± 0.41[1] | 1.4 ± 0.51[1] |
| Std. Error | | ± 0.09 | ± 0.09 | ± 0.13 | ± 0.18 | ± 0.22 |

† Significant difference from baseline, within the group (Results for p values).
‡ Significant difference from the first interval, within the group (Results for p values).
^ Significant difference from the second interval, within the group (Results for p values).
1 Significant difference across groups (controls - NSA recipient group, (Results for p values).

when the normalized values were compared, no significant differences were observed either within groups or between the groups. It appeared as though fluctuations recorded in both groups represented normal distribution. The values obtained were found to be within the range of normative skin values for the dorsum of the foot (29.7 - 35.4 degrees centigrade), reported by Uematsu et al (1988),[19] and the hand, as reported by Arena and Hobbs (1995). [20]

*Surface Electromyography*

In regard to surface EMG readings, expressed as microvolts, mean values varied more within the control group than the NSA recipient group (Table 2). There were no statistically significant differences within the NSA recipient group when data was compared against the baseline or between the five intervals following baseline. Moreover, when data for the NSA recipient group was normalized to the baseline value, the changes over time were small (Table 2, Figure 2).

Within the control group, mean values ± standard deviation, ranged from a baseline mean of 8.5 ± 5.4, to between 5.4 ± 6.9 and 16.4 ± 16.4 for intervals after baseline (Table 2, Figure 2). Comparative data for the NSA recipient group ranged from 3. 5 ± 1.0 (baseline) to between 2.6 ± 3.5 and 3.6 ± 2.2 for the remaining five intervals. Within the control group there were no statistical differences when microvolt data was compared relative to baseline and all subsequent intervals. Moreover, likely due to the large standard deviations, there were no statistical differences (for microvolts or normalized data) between controls and NSA recipients when baseline values and all subsequent intervals were compared, even though the mean microvolt magnitudes were considerable between the two groups (Table 2). Normalized values, evaluated within the control group, revealed significant increases occurring between time intervals two ( $p = 0.022$), three ( $p = 0.028$ ), and four ( $p = 0.049$) when compared to time interval one, following baseline (Table 2, Figure 2).

*Electrodermal Activity (EDA)*

Electrodermal activity, recorded in micromhos (umhos), decreased consistently within the NSA recipient group over the second through fifth intervals following baseline. Alternatively, the control group exhibited essentially a constant level of electrodermal activity over the entire time course (Table 3).

Within the group receiving NSA care, significant micromho decreases ( $p = 0.001$) were observed between baseline and the third, fourth, and fifth intervals of EDA measurement (Table 3, Figure 3). Moreover, differences also decreased significantly between the first and the second ($p = 0.009$) through the fifth intervals ($p = 0.000$). Additionally, significant decreases in EDA were also revealed between the second interval and the third through fifth intervals ($p = 0.000$). Although mean values expressed a decreasing trend from the third through fifth intervals, there were no significant differences between the remaining times, suggesting a leveling of EDA by the third interval.

Alternatively, within the control group, no significant differences were observed between baseline values and any of the five subsequent intervals, or between any of the five intervals following baseline.

When normalized data within the NSA recipient group was compared, significant decreases were observed between the first interval and the third through fifth intervals ($p = 0.000$). This same phenomenon was also observed between the second interval and the third though fifth intervals ($p = 0.000$), Table 3, Figure 3. Although EDA continued a trend of decreased activity, there were no significant differences between the third or fourth intervals and subsequent time periods. This also indicated a leveling in the decreasing pattern commencing by the third interval.

Within the control group, there were no statistically significant differences in normalized values. However, when normalized values were compared between the control group and the NSA recipient group significant differences were observed for the third ($p= 0.002$), fourth ($p = 0.001$), and fifth ($p = 0.000$) intervals. In each instance, control values represented an increase in EDA from baseline while the same intervals reflected decreases in EDA from baseline in the NSA recipient group (Table 3, Figure 3).

## Discussion

The methods used in this study were employed to indirectly evaluate changes in sympathetic nervous system activity in subjects undergoing Network Spinal Analysis (NSA) care. The recording of surface electromyography (sEMG),[13-17, 20-26,29] electrodermal activity (EDA),[8,20,21] and digital (peripheral) skin temp (DST)[8,19,20,29] are well established for such detection. For example, the association between "muscle tension," recorded as increased EMG activity, and sympathetic outflow, is well documented.[13-17]

As previously described, differences in peripheral skin temperature have been taken to be a correlate of changes in peripheral vasoconstriction associated with the sympathetic nervous system.[19,20,29] This relationship is based on the physiological ramifications of vasoconstriction on the temperature of surrounding tissues; that is, tissues surrounding a vascular bed will tend to cool since constricted vessels pass less warm blood than if they were dilated. Thus, tissues tend to warm and cool as the immediate vascular bed constricts and dilates. However, ipsilateral measurements of this parameter (expressed as absolute temperature) has proven difficult, since surface temperatures vary with time, different regions of the body, and between individuals.[19] Thus, the best index of change; contralateral changes in surface temperature, is best suited to detect anomalies in the otherwise symmetrical distribution of temperature. It is apparent from the present study, as well as the scarcity of data derived from other studies, that future measurement of changes in surface absolute temperature will likely require very sensitive instrumentation to detect the subtle changes which occur.

Electrodermal activity (EDA) is an index of choice within the behavioral sciences for indirectly measuring sympathetic activity.[8] This confidence is based on the anatomy of the skin which reveals that eccrine sweat glands abundantly supply the skin in all areas except the lips, concha (outer ear), and the gen-

ital areas. Additionally, the secretory portion of these glands is predominantly innervated by the sympathetic nervous system. Evidence suggests that "bursts" of sympathetic activity elicit electrodermal activity.[11] Study has shown that ventral root fibers innervate the secretory portion of the sweat gland and the muscles controlling piloerection.[8]

Investigators have suggested that EDA involves a number of cortical centers including the premotor cortex, sensorimotor cortex, limbic system, and hypothalamic areas, as well as the reticular formation, which are involved with motivational and emotional behavior.[9,27] These suggestions are of interest since a similar pathway may be involved in generating the respiratory and somatopsychic waves, which are a characteristic response to NSA care.[18]

While sweating serves to cool the body, as well as being a behavioral response, it is necessary to establish some rationale as to which response is most likely to represent an increase in EDA. In this regard, eccrine glands (notably in the fingers) respond only weakly at certain levels of heat, but strongly to psychological and sensory stimuli.[8] Thus, if subjects are studied in a setting with a constant typical room temperature, as in the present study, it is not likely that such an environment would necessitate a "cooling" effect initiated through the hypothalamus. Thus, measurement of the extent of "sweating," in such an environment would more likely be the result of sympathetic nervous system activity associated with some form of psychological and/or sensory stimulation.

Relative to information regarding DST, sEMG, and EDA, interesting findings were recorded in the present study. For example, the varying temperatures conformed to normative data reported elsewhere.[19,20,29] Moreover, there were no significant differences in peripheral temperature within the NSA or control groups, or between groups, over the course of the study. Because both controls and the NSA group exhibited only small changes in peripheral temperature from baseline, normalization of values reflected essentially no change over the five intervals in either of the two groups. Thus, in the absence of instrumentation extremely sensitive to small changes, the present observations suggest normal variation within and between groups rather than any differential in sympathetic activity.

As previously described, the sEMG data collected in the present study was for the purpose of characterizing any overall change in paraspinal muscle activity associated with NSA care, as opposed to a specific diagnostic application. That is, it would be important to record the activity of the paraspinal musculature, right versus left, if muscle activity was being contemplated as a component of the vertebral subluxation.[28] Nevertheless, in the present study, sEMG bilateral data at the level of the sixth thoracic paraspinal musculature is contrasted to that for the same spinal level reported by Gentempo et al.,[28] as well as values reported by Cram and Cahn[13]. The Gentempo study recorded muscle activity of 80 subjects in the seated position reporting values of 8.40 $\pm$ 3.50 microvolts for the left sixth thoracic paraspinal region, and 8.20 $\pm$ 3.50 for the contralateral level, while Cram and Cahn reported values at the sixth thoracic level as 2.5 $\pm$ 2.6 for 104 subjects in the seated position. In the present study, baseline data for the 20 subjects in the NSA group, and the 5 control subjects, conformed to the range reported by the study of Gentempo et al., as well as that of Cram and Cahn. However, neither of the these reports mentioned data collected in the prone position, nor was EMG data collected for a period as long as 17 minutes. Both of the variables may have contributed to the variation among subjects in the present study. In this study, however, it does not appear that altering the position of the patient from the seated to prone position resulted in a change in physiological response. Although physiology may change between the prone versus seated position, the constancy of the DST, the elevation of sEMG activity in controls but not NSA subjects, as well as the opposite changes in EDA in the present study, suggests that the change in position elicited no particular response. However, further study is merited to evaluate the seated and prone positions to ascertain more specifically if any effect can be attributed to one or the other.

The variation in sEMG activity reported in this study, both within and between the control and NSA groups, may also have been due to different states of subluxation within both populations, since muscle activity has been demonstrated to increase in response to stress.[29] Even though mean values varied considerably, between the control and NSA recipient groups, there were no statistical differences. This is consistent with similar findings reported for facial sEMG by Arena and Hobbs.[29] However, there was a significant increase in sEMG activity in the control group when data was normalized against the baseline values. By comparison, such a relative change was not observed in the NSA group, which expressed a slight decrease in mean values throughout the same time period. The continuous increase in paraspinal sEMG in the control group may have been due to the stress of remaining in the prone position for 12.5 minutes after baseline. Alternatively, no such phenomenon was observed in the NSA group, subjected to NSA care after the first 4.5 minutes of the recording procedure. It is, therefore, suggested that the administration of NSA contributed to a more "relaxed" state of those receiving care. While this putative state of relaxation may be speculated to have a conscious component, it is also probable that those under NSA care were experiencing a *"sympathetic quieting effect."*

Further support of a *"sympathetic quieting effect"* associated with NSA was supported by EDA. Electrodermal activity, as previously described, has been linked to sympathetic nervous system output. In the present study, this parameter provided a clear distinction between control subjects and those receiving NSA care. It was evident that the NSA group expressed a steady, significant decline in EDA for the second through fifth intervals following baseline. The control group not only showed no comparable change, but rather displayed a pattern of gradual increase in mean values following baseline.

Within the NSA group, all intervals other than the first were significantly decreased relative to baseline. A pattern was also evident in which each of the intervals was significantly decreased from the first and second intervals following baseline. Since the third through fifth intervals were not statistically different, it is presumed that a "leveling off" effect had occurred between 9.5 - 12.0 minutes under NSA care, which continued through the 17 minute recording period. Although no significant differences within the control group were observed, a different pattern was evident, in which the mean EDA was

observed to increase from baseline in all following intervals. Of interest, the magnitude of the change, relative to baseline, in the control group resulted in EDA activity significantly greater that the NSA group for intervals three through five, the same time periods when the "leveling off" effect was observed in that group. This pattern of increase in EDA in the control group was consistent with the group's increase in sEMG. These observations, taken together, further suggest a lower level of sympathetic activity, or *"sympathetic quieting effect"* in the NSA group, compared to controls.

Another interesting aspect of the current study revolved around the use of music during the 17 minute recording period, for both control and NSA subjects. This was done on the assumption that it created a "relaxing" atmosphere for the patients. However, since the control subjects expressed an increase in sEMG, and EDA following baseline, while the NSA group did not, it is difficult to speculate on the actual influence of the background music. It will, therefore, be important for future studies to evaluate these same physiological parameters in controls and those receiving NSA care in the absence and presence of different types of music.

## Conclusions

1. The 20 subjects receiving NSA care experienced a substantial decrease in EDA over the course of a 17 minute recording session. This was accompanied by a stable sEMG pattern and DST, considered peripheral temperature. By contrast, the 5 subjects receiving no intervention experienced a constant DST, but expressed substantial increases in sEMG activity when relative (normalized) to the baseline value. As well, the control group expressed a pattern of increased EDA activity relative (normalized) to baseline, which was also significantly higher than the NSA group for the same intervals. These findings suggest a higher level of sympathetic activity in the control group, perhaps associated with the 17 minute period required for the recording protocol. By contrast, the NSA group, subjected to the same protocol exhibited an apparent *"sympathetic quieting effect"* which, in this preliminary study, appears to be associated with the NSA care.

2. There is no ready explanation for the lack of digital temperature change in the two groups other than to speculate that the extent of sympathetic change was not great enough to elicit a change in skin temperature. It may also be that the instrumentation was not sensitive enough to detect small changes in temperature, thus resulting in fairly large standard deviations, which when applied to closely matched temperature values resulted in a statistical type II error. Further study with more sensitive instrumentation will be required to test this hypothesis.

3. Additional study will also be required to confirm the findings presented herein. The present study was limited by available subjects meeting the inclusion criteria. Thus, even though the present study was preliminary in nature, it is evident that a larger population of subjects, notably more controls, will have to be assessed under the same setting to gather more information on the measures studied as well as other parameters indirectly measuring sympathetic response. This will be necessary to enhance the statistical power of further evaluations, and also to provide a broader base of subjects upon which to more thoroughly assess gender and age effects. Another important element to be considered involves the application of NSA care. The protocol, while the same in concept, is administered differently as patients progress through the three levels of care.[1] It will, therefore, be important to assess subjects who are representative of each of these three levels. The present study did not clearly differentiate that aspect of care, and consequently, may have masked changes which otherwise would be more characteristic of Level One, Level Two, or Level Three.[1]

4. While the present data must be interpreted with caution for the reasons stated, it is apparent that a *"sympathetic quieting effect"* may be operable during NSA care. This is consistent with its hypothesized mode of action linking cortical centers, the limbic system, hypothalamic areas, and the reticular formation to the generation of the somatopsychic and respiratory waves, characteristic of NSA care. Moreover, it is also consistent with significant self reported improvements in wellness domains including mental/emotional state and stress evaluation.[2]

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# Journal of Vertebral Subluxation Research

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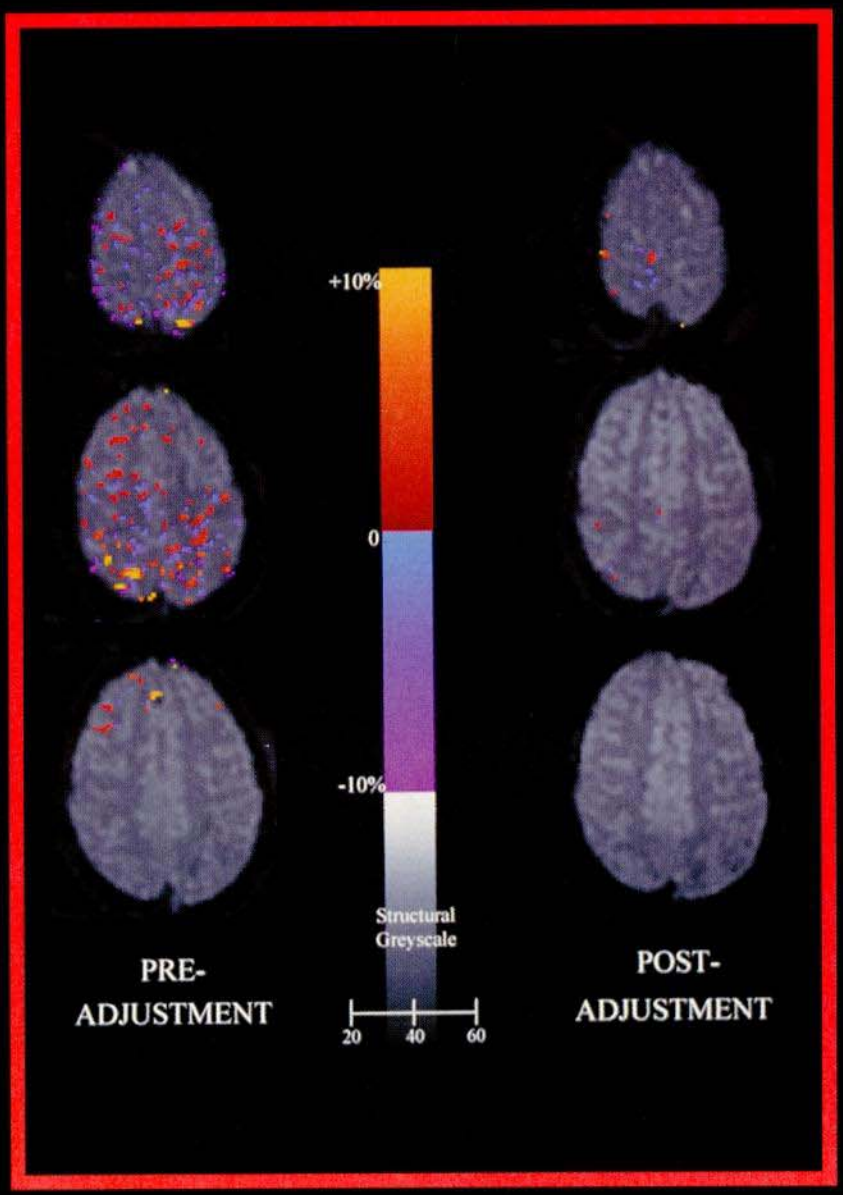


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*Functional Magnetic Resonance Imaging: About the Cover (cover picture). Journal of Vertebral Subluxation Research, 1998; 2(1): Cover*

**About the Cover:** Functional Magnetic resonance Imaging (fMRI), which measures the relative presence of oxy-hemoglobin, has gained attention as a non-invasive medium through which high resolution images of the brain and other tissue may be acquired. This technology may provide a useful assessment of cortical changes following chiropractic intervention. Images of the patient depicted on the cover, on the left, reflect cortical activity (lighted areas in the parietal cortex, frontal cortex areas 9, 10; visual association areas 19, 37, and 39) associated with the learning process of a "novel" muscular maneuver of the foot. Images on the right reflect cortical activity following a Network Spinal Analysis (form of chiropractic) adjustment session, taken approximately 20 minutes after the first set of images, involving the same activity. The decrease in "lighted" areas before and after the adjustment session suggests that less cortical "planning" or "activity" is associated with the "novel" foot maneuver. Thus, the ability of fMRI to visualize changes in cortical activity may play a significant role in elucidating the consequences of vertebral subluxation correction on neurological function.

ORIGINAL RESEARCH

# An Impairment Rating Analysis Of Asthmatic Children Under Chiropractic Care

*Robert L. Graham, D.C.; Richard A. Pistolese, B.S.**

**Abstract** — A self-reported asthma-related impairment study was conducted on 81 children under chiropractic care. The intent of this study was to quantify self-reported changes in impairment experienced by the pediatric asthmatic subjects, before and after a two month period under chiropractic care. Practitioners, representing a general range of six different approaches to vertebral subluxation correction, administered a specifically designed asthma impairment questionnaire at the appropriate intervals. Subjects were categorized into two groups; 1–10 years and 11–17 years. Parents/guardians completed questionnaires for the younger group, while the older subjects self-reported their perceptions of impairment. Significantly lower impairment rating scores (improvement) were reported for 90.1% of subjects 60 days after chiropractic care when compared to the pre-chiropractic scores ($p < 0.05$) with an effect size of 0.96. As well, there were no significant differences across the age groups based on parent/guardian versus self rated scores. Girls reported higher (less improvement) before and after care compared to boys, although significant decreases in impairment ratings were reported for each gender. This suggested a greater clinical effect for boys which was supported by effect sizes ranging from 1.2 for boys compared to 0.75 for girls. Additionally, 25 of 81 subjects (30.9%) chose to voluntarily decrease their dosage of medication by an average of 66.5% while under chiropractic care. Moreover, information collected from patients revealed that among 24 patients reporting asthma "attacks" in the 30 day period prior to the study, the number of "attacks" decreased significantly by an average of 44.9% ($p <.05$). Based on the data obtained in this study, it was concluded that chiropractic care, for correction of vertebral subluxation, is a safe nonpharmacologic health care approach which may also be associated with significant decreases in asthma related impairment as well as a decreased incidence of asthmatic "attacks." The findings suggest that chiropractic care should be further investigated relative to providing the most efficacious care management regimen for pediatric asthmatics.

*Key words: asthma, adjustment, children, chiropractic, impairment rating, pediatric, vertebral subluxation.*

## Introduction

Bronchial asthma is a disorder of increased tissue responsiveness of the tracheobronchial tree to various stimuli, resulting in paroxysmal contraction of bronchial airways.[1] The airway obstruction in asthma is due to a combination of factors that include spasm and edema of the smooth muscle of the airways, and increased mucus secretion.[2] With more severe asthma, the asthmatic is forced to compensate for bronchoconstriction in order to permit gas exchange to take place. This is done by breathing at high lung volumes, which enlarges the total lung capacity, resulting in a mechanical opening of the airways. Unfortunately, breathing in a hyperinflated state requires a marked increase in the inspiratory muscle forces and results in varying degrees of dyspnea and fatigue, likely due to the patient's use of accessory muscles of ventilation (platysma and S.C.M.[3]). Sternocleidomastoid muscle contractions have been shown positive correlation with the development of severe airflow obstruction, hyperinflation, and a marked reduction in gas exchange.[4]

A positive correlation between chiropractic care administered for the correction of vertebral subluxation and the patient's perception of decreased respiratory effort, and severity of symptomatology, has been noted in several studies of patients ranging from 2 to 63 years of age.[5,6,7,8,9,10] Chiropractic care has been proposed to significantly reduce non-specific bronchial hyperactivity (n-BR) as well as patient rated asthma severity.[7] Non-specific bronchial hyperactivity (n-BR) measures the resistance to breathing of the bronchial airways after histamine dihydrochloride challenge. Although objective evidence is slow emerging in regard to the effect of chiropractic care on respiratory function there have been some reports.[11,12] Of particular interest is a recent report showing improved forced expiratory volume in patients following adjustments for upper cervical subluxation.[13]

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Vertebral subluxation is characterized, in part, by vertebral misalignment (kinesiopathology), neuropathology and myopathology.[14 15 16 17] It has been demonstrated that pressures as little as 10mm Hg can cause significant neural dysfunction, decreasing the number and amplitude of action potentials by up to 60% of initial values.[18 19 20] This mechanical pressure on the nerve and surrounding tissues which may cause tissue ischemia is proposed to result in the release of chemical inflammatory agents such as substance P [21 22], bradykinin, and histamin [22] as a result of the osseous misalignment and subsequent neuromuscular pathophysiology. This neuromuscular pathophysiology can exist with or without associated pain.[23]

Recent study on the neurogenic mechanisms of asthma has focused on the release of neuropeptides by an axon reflex pathway. These peptides, which include substance P, calcitonin-related peptides, and neurokinin A (a bradykinin), have been shown respectively to have vascular permeability and mucus secretagogue activity, bronchial vascular dilation effect, and a bronchoconstrictor activity.[2] These are the same neurotransmitters postulated to be released from tissues in the presence of vertebral subluxation,[21] which may initiate and/or complicate the asthmatic condition.

As the vertebral subluxation is believed to negatively effect neurological function, [21] the neuroanatomy and physiology of structures associated with respiratory effort could be affected by this condition. In this regard, the neuroanatomy and physiology related to the cervical area reveals that the respiratory center consists of neurons located bilaterally and divided into three major collections. These are the dorsal respiratory group located in the dorsal portion of the medulla oblongata which mainly regulates inspiration, the ventral respiratory group which regulates both inspiration and expiration located in the medulla oblongata, and the pneumotaxic center located dorsally in the superior portion of the pons which helps to regulate rate and pattern of breathing.[24] The medulla oblongata passes inferiorly through the foramen magnum and the C1 spinal canal.[25] It has been theorized [26] that misalignment (a component of vertebral subluxation) of C1 can cause stress and subsequent neural dysfunction to the medulla oblongata and spinal cord. Additionally, the phrenic nerve from the cervical plexus, which innervates the diaphragm, receives fibers from the third, fourth and fifth cervical nerves.[27]

Accessory muscles of breathing such as the platysma and sternocleidomastiod muscles also receive innervation from nerves of cervical origin. The platysma muscles are innervated by the cervical branch of the facial nerve, and the sternocleidomastiod muscles are innervated by the spinal branch of the accessory nerve as well as branches from the anterior rami of the second and third cervical nerves. These nerves are intimately associated with the upper cervical area.[25 27]

Misalignment of thoracic vertebra may cause neural dysfunction to the nerves which innervate anterior serrati, scaleni, abdominal recti, and internal and external intercostal muscles which function to raise and lower the rib cage during respiration. Misalignment of thoracic vertebra may also cause costotransverse fixation, which can limit diaphragmatic excursion and increase respiratory effort. Additionally, the lower thoracic nerves also contribute to the innervation of the diaphragm.[27] Consequently, the presence of vertebral subluxation, i.e. kinesiopathology, neuropathology and myopathology, may increase the asthmatic patients perception of respiratory effort. The present study, therefore, was designed as a preliminary assessment of perceived change in the extent of impairment of pediatric asthmatic patient's while under chiropractic care for the correction of vertebral subluxation.

The importance of gathering data relative to the pediatric population is apparent considering current statistics. In the United States, asthma affects an estimated 14-15 million persons, including 4.8 million (6.9%) under 18 years.[28] In 1993, asthma accounted for an estimated 198,000 hospitalizations and 342 deaths among persons less than 25 years of age. Children were more likely than teens and adults to receive asthma care in the outpatient settings; adolescents and young adults were more likely than other age groups to receive emergency care.[28] Although the treatment of asthma by medication is prevalent, and for many life sustaining, the health complications associated with this approach are well known.[29 30 31 32] Since the correction of vertebral subluxation is non-invasive, the documentation of changes in asthma related impairment, which could reduce or eliminate the need for medication, is a necessary step in evolving the most efficacious care for the millions of children challenged by this condition.

## Methods

*Subjects*

Potential subjects for this study were sought through newspaper advertisement. All subjects between the ages of one to seventeen years of age with a previous medical diagnosis of asthma were considered. Informed consent was obtained from the parents, and/or legal guardian, consistent with the Human Subjects Committee protocol of the Michigan Chiropractic Council. Qualifying subjects were required to be studied for a period of 60 days. A total of 81 subjects participated, all of whom completed the study duration of 60 days. The subject population consisted of 37 females and 44 males ranging in age from one to 17, with a mean age of $10 \pm 4.13$ years.

*Practitioners*

A total of 33 chiropractors in various locales of the state of Michigan volunteered to participate in this study. All practitioners were members of the Michigan Chiropractic Council. Each practitioner followed the same procedures in obtaining data for the study. Subjects were evaluated over a period of 60 days during which time they were examined for the presence of vertebral subluxation in accordance with the protocols of the techniques employed by each participating chiropractor. These techniques included, Activator Methods, Diversified, Gonstead, Upper Cervical Technique-H.I.O, Network Spinal Analysis, and Thompson Terminal Point Technique, all of which have been described elsewhere.[33] When vertebral subluxation was indicated to be present, subjects were administered chiropractic adjustment(s) followed by an evaluation for the correction of vertebral subluxation according to the procedures of the methods practiced. No recommendations concerning the use of medication in the treatment of bronchial asthma were made to subjects by

any of the chiropractors participating in the study.

*Self-Reported outcomes of Asthmatic Impairment*

It was necessary to develop an instrument appropriate to survey the population of subjects in the present study. The most suitable format was found in the Oswestry Low Back Pain Disability Questionnaire.[34,35] This questionnaire was chosen because its disability orientation closely related to anecdotal reports from Michigan Chiropractic Council members regarding the level of impairment observed in patients who had been diagnosed with asthma. However, it was necessary to modify the instrument to reflect areas of impairment which would specifically relate to breathing difficulty instead of low back pain. This was accomplished by substituting the phrase "breathing problems" in the place of "low back pain," and changing the content of the ten broad areas (Appendix). In its final form, the instrument was composed of ten questions. For each of the ten questions, participants were asked to choose one of the six replies that best described their impairment. These answers were subsequently scored 0-5, with 5 being the highest level of impairment. As with the Oswestry Questionnaire, the final score was a percent of the highest score which could be reported (5 x 10 = 50). Since some of the questions were not relevant to the age level of participants (such as walking difficulties), these sections were not answered. Therefore, the highest score attainable was adjusted accordingly, with the percentage reflecting the change. This instrument, adapted from the Oswestry format is herein referred to as the Modified Oswestry Impairment Rating Scale (MOIRS).

In each practice, the questionnaires were completed prior to the commencement of care, and again 60 days following the initial visit. Subjects 11 years and older completed the questionnaires, while parents or legal guardians acted for younger patients. Additionally, subjects or parents/ guardians were asked to supply information regarding changes in number of asthma attacks, and medication usage via an informal questionnaire.

*Analysis of Data*

Pre and post care scores on the MOIRS were evaluated by a two tailed paired sample t-test assuming equal variances,[36,37] and a two tailed independent t-test assuming unequal variances[36,37] for (1) gender effects, (2) age effects, and (3) response scores based on completion by the subject versus parent or guardian. Significance was determined for all analyses at $p < 0.05$. Response scores were not evaluated as a function of the practice from which they were derived since the number of individual subjects per practice was too low to achieve statistical power.

Additionally, utilizing scores from the MOIRS as a measure of change in impairment, effect sizes[38] were determined to assess the clinical significance associated with chiropractic care. Effect size was determined by the following relationship [mean MOIRS pre care score — mean MOIRS post care score / std. dev. of MOIRS pre care scores]. This measurement allowed for expression of the extent to which a post intervention measurement [post MOIRS rating] varied from normal variation around the mean of pre intervention measurements [pre MOIRS rating]. Following the relationship described, a value of 0.2 is taken to mean a small clinical effect, 0.5 is taken to mean a moderate clinical effect, and 0.8 is taken to mean a large clinical effect.[38]

## Results

*Content and Construct Validity and Internal Consistency of the MOIRS Questionnaire*

As presented in the introduction, content validity was initially established by having practitioners participating in the study validate the content of the survey relative to its intended purpose. The content, either adopted from the Oswestry Pain Disability questionnaire or originally developed, was approved unanimously by these practitioners as reflecting the type of disabilities reported by their asthmatic patients. Following the study, practitioners reported that subjects found the questionnaire to be clear and complete, both primary attributes of content validity.[39]

Since construct validity is a process requiring considerable evidence gathered over a period of time through repeated uses of the instrument, no gold standard currently exists with regard to the type of questionnaire administered in this study. However, several initial measures of validity did arise from the present study. First, since the instrument was intended to discriminate "post intervention" effects, its ability to detect statistical differences between pre and post chiropractic care (presented below) attests to its validity in that regard.[40]

Reliability was examined by determining Cronbach's coefficient alpha[41] for the ten questions in the survey instrument before (0.70) and after chiropractic care (0.77). These coefficients reveal a substantial level of internal consistency within the instrument. This level of reliability also contributes to the initial phase of evaluating its construct validity. Further use of this instrument in similar asthmatic populations will be required to continue the validation process.

*MOIRS Ratings Before and After Chiropractic Care*

Significantly lower MOIRS scores of $20.6 \pm 12.1$ were reported 60 days after chiropractic care when compared to the pre-chiropractic scores $32.1 \pm 12.0$ ($p < 0.000$). Within the population of 81 patients, there were 73 (90.1%) reports of decreased impairment. In 4 (4.9%) there was no reported change, and in 4 (4.9%) there were reports of increased impairment (Table 1).

Additional information supplied by patients or parent/guardian revealed that among 24 patients reporting asthma "attacks" in the 30 day period prior to the study, the number of "attacks" decreased from an average of $2.96 \pm 3.30$ incidents per 30 days prior to study, to $1.3 \pm 2.60$ incidents per 30 days during the study. This represented a significant decrease of 44.9% ($p < .05$). Additionally 25 of 81 (30.9%) patients chose to voluntarily decrease their dosage of medication by an average of 66.5%, with a range of 20% to 100% per month.

## Subject Categories

*Self-Reported versus Parent/Guardian-Reported Responses*

Subjects were divided into age ranges according to their

Table 1. Impairment Score Changes* in Bronchial Asthma Pediatric Patients Before and After Chiropractic Care.

| Patient Categories | *Scores* Pre | Post | *Probability †* (p) | *Effect Size‡* |
|---|---|---|---|---|
| A. Total Population | 32.1 ± 12.0 | 20.6 ± 12.1 | 0.000 | 0.96 |
| B. Age Range/Gender | | | | |
| 1-10 years | | | | |
| Males | 30.4 ± 10.5 | 15.8 ± 12.1 | 0.000 | 1.40 |
| Females | 30.8 ± 11.9 | 21.1 ± 12.0 | 0.000 | 0.81 |
| 11-15 years | | | | |
| Males | 30.7 ± 11.2 | 19.4 ± 10.5 | 0.000 | 1.00 |
| Females | 37.4 ± 14.5 | 26.7 ± 12.7 | 0.000 | 0.73 |
| C. Gender | | | | |
| Total Population | | | | |
| Males | 30.3 ± 10.3 | 17.8 ± 11.1– | 0.000 | 1.20 |
| Females | 34.2 ± 13.5 | 24.0 ± 12.5 | 0.000 | 0.75 |

• Impairment rating scores were obtained from the Modified Oswestry Index Rating Scale (MOIRS, see Methods for protocols). Higher Scores represent greater impairment.

† Probability values of less than 0.05 were significant.

‡ Effect size (see Methods) is a measure of clinical effect, where 0.2 is a small effect, a moderate effect, and 0.8 a large effect.

– Compared across (between) groups, post care males scored significantly ($p = 0.02$) lower (improvement) than females. No other comparisons between groups were statistically significant.

apparent ability to complete the questionnaire alone, or requiring a parent or guardian to act for them. The division was made between 1 to 10 years and 11 to 17 years. Although MOIRS scores were lower in the younger age bracket prior to and after care than the higher age group, there was no significant difference between the age categories. This suggested that guardian versus self-reporting elicited the same range of responses. Moreover, in both age groups, MOIRS scores were significantly lower (improvement) following chiropractic care compared to pre chiropractic MOIRS scores ($p < 0.000$).

*Gender Differences*

Girls showed slightly higher impairment scores (34.2 ± 13.5) before chiropractic care than did boys (30.3 ± 10.3). Although both genders reported significantly decreased impairment after care, scores were significantly higher among girls (24.0 ± 12.5) when compared to boys(17.8 ± 11.1), suggesting a more profound clinical effect for males. This possibility was further explored by investigating effect sizes, separately, for the genders.

Effect size, derived from MOIRS scores before and after chiropractic care, was used as a measure of estimating the extent of clinical change. While, overall, the clinical effect was large for the subject population as a whole (0.96), boys demonstrated a higher effect size (1.20) than did girls (0.75), as can be seen in Table 1, thus supporting a proposed larger clinical effect for males.

## Discussion

*The Survey Instrument (MOIRS)*

Due to lack of previous use of the MOIRS, its internal construct validation is in the initial phase. The instrument is administered easily, lending itself to use by parents/guardians as well as self-rating by young adults. It is anticipated that it will continue to be used by chiropractors and other practitioners interested in assessing health outcomes associated with asthmatics. Since the demonstration of internal and external validity for any questionnaire is a process[42] rather than a singular event, it is important that data be gathered from a number of studies for comparison. As a first step in this process, this paper has introduced data which provides a base for comparison. Consequently, while the statistical differences and effect sizes reported in this investigation are compelling, they must be interpreted with caution while awaiting continued evidence regarding validation of the instrument.

*Perceived Changes in Impairment Due to Asthma*

The information collected concerning change in the number of asthma "attacks" during this study needs to be viewed in consideration of the timing of the study (May–September), since some atopic (allergic) asthmatic events may be contributed to by seasonal factors such as exposure to higher amounts of pollen. Additionally, influences due to the incidence of non-atopic (nonreagenic) events and atopic asthmatic events incited by exposure to environmental antigens which can not be related to seasonality, such as animal hair, cigarette smoke, and various chemotoxins, were not considered in the present study. To some extent, therefore, the number of asthmatic "attacks" could be related to these factors. However, the significant reduction in asthmatic "attacks" coupled with the high percentage of respondents (or their parent/guardian) voluntarily reducing medication levels, suggests a more permanent effect. This is based on the logical presumption that asthmatic subjects or parents/guardians would be expected, through their personal experience, to recognize "typical" seasonal or occasional environmental influences related to "attack" frequency.

Although demonstrating significant decreases in scores (improvement) pre to post chiropractic care, the 11-17 year old subjects of both sexes demonstrated a trend of self-reporting higher scores than younger subjects (one–ten years). While these differences were not significant, the trend may reflect some level of variation in perception between those self-rating, as opposed to parents/guardians. As pediatric studies will frequently involve this type of design, this issue should remain an important concern as it impacts on validation of the instrument.

While there were no significant differences in age groups within genders, females reported significantly less post improvement than males. The implication that a more pronounced clinical effect was apparent for males than females, while substantiated by statistical significance as well as effect size, currently lacks explanation. However, some evidence exists which suggests that females tend to report their health lower than males even though they may not exhibit other indicators of a lower state of health. Verbrugge [43] proposes that this could be a reflection of the more frequent utilization of helath care by females. As this information is specific to adult populations it may or may not account for the observation regarding gender differences in the present study, especially considering the fact that responses from approximately half of both the male and female subjects were reported by parents/guardians. Certainly, a follow up study investigating more subjects will be needed to attest to the consistency of this finding. Moreover, evaluation of the inference that the significant reduction in impairment was due to chiropractic care will require a controlled clinical research design to focus on gathering evidence related to cause and effect. Relative to this issue, the diversity of techniques employed by different chiropractors participating in the study could be broadly grouped into six general approaches. While it is not possible from the data collected in this study to ascertain if one technique was more effective than another, it is evident that, overall, subjects or parent/guardians responded similarly, regardless of the chiropractic approach used for correction of vertebral subluxation. Further study, among those advocating specific approaches will be necessary to elucidate any distinctions in efficacy. Moreover, it will be of interest to conduct additional study regarding the consistency of segmental locations which are adjusted among the different approaches, concomitant with reported changes in asthma impairment. Such information could offer considerable insight regarding the range of possible approaches effective in the correction of vertebral subluxation.

## Conclusions

The authors of this study do not suggest that chiropractic care is to be considered a substitute for prudent, proper medical attention for the asthmatic patient. However, it should be noted, that traditional pharmacological approaches to the management of asthma have been shown to represent a risk to the patient,[29 44 45] with several studies calling into question the efficacy of such treatment in the management of asthmatic conditions.[29 30 31 32] Therefore, when considering pharmaceutical agents in the management of asthma in the pediatric patient, the expected benefit must be weighed against the inherent risks. As shown in the present study, chiropractic care, a safe nonpharmacologic health care approach, may also be associated with self-reported decrease in asthma-related impairment to the patient, including the patient's perception of reduced respiratory effort, as well as a decreased incidence of asthmatic "attacks." In view of these findings it is suggested that chiropractic care be further investigated regarding its role in the overall health care management of pediatric asthmatics.

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**Appendix**

# Asthma Research Program

## Quantitative Asthmatic Index

This questionnaire has been designed to give the doctor information as to how breathing difficulty has affected your ability to manage everyday life. Please answer every section and mark in each section the ONE box which applies to you. We realize you may consider that two of the statements in any one section relate to you, but please mark the box which most closely describes your condition

**1) Current difficulties**
- ☐ I have no breathing problems at this moment.
- ☐ I have mild breathing problems at this moment.
- ☐ I have moderate breathing problems at this moment.
- ☐ My breathing problems are fairly severe at this moment.
- ☐ My breathing problems are severe at this moment.
- ☐ My breathing problems are very severe at this moment.

**2) How many times have you ever been hospitalized for Asthma**
- ☐ Never.
- ☐ One Time.
- ☐ Two Times .
- ☐ Three Times.
- ☐ Four Times.
- ☐ Five or more times.

**3) When was the last time you had a severe flare-up or needed treatment for your asthma?**
- ☐ Never.
- ☐ More than twelve months ago.
- ☐ Within the last twelve months.
- ☐ Within the last six months.
- ☐ Within the last month.
- ☐ Within the last week.

**4) Mild Activity**
- ☐ I can walk any distance with no problems.
- ☐ I can walk any distance with occasional problems.
- ☐ I can walk a lot but have frequent breathing problems.
- ☐ I don't walk much because I have frequent problems breathing .
- ☐ I walk rarely because I have frequent and severe problems breathing .
- ☐ I never walk because of severe breathing problems.

**5) Vigorous Activity**
- ☐ I participate in vigorous activity with no breathing problems.
- ☐ I participate in vigorous activity with mild breathing problems.
- ☐ I participate in vigorous activity with moderate breathing problems
- ☐ I participate in vigorous activity with severe breathing problems.
- ☐ My activities are rarely vigorous because of severe breathing problems.
- ☐ I am never vigorous because of severe breathing problems.

**6) In the past 4 weeks how much time have you missed from work, school, or usual activity because of asthma?**
- ☐ None.
- ☐ One to three days.
- ☐ Four days to one week.
- ☐ One to two weeks.
- ☐ Two to three weeks.
- ☐ Three to four weeks.

**7) How often do asthma attacks awaken you at night?**
- ☐ Never.
- ☐ Less than once a week.
- ☐ Once or twice a week.
- ☐ Three or four times a week.
- ☐ Five or six times a week.
- ☐ Every Night.

**8) School / Work**
- ☐ My breathing never interferes with work activity.
- ☐ My breathing rarely interferes with work activity.
- ☐ My breathing moderately interferes with work activities.
- ☐ My breathing interferes very much with work activities.
- ☐ My breathing prevents me from doing most jobs.
- ☐ My breathing prevents me from doing any work.

**9) How much does your asthma interfere with your social activities (family, friends, neighbors or groups)**
- ☐ Never.
- ☐ Rarely.
- ☐ Slightly.
- ☐ Moderately.
- ☐ Frequently.
- ☐ Extremely.

**10) Medication**
- ☐ I never take medication or inhalants.
- ☐ I very rarely take medication or inhalants.
- ☐ I rarely take medication or inhalants.
- ☐ I sometimes take medication or inhalants.
- ☐ I frequently take medication or inhalants.
- ☐ I use my inhaler most days.

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ORIGINAL RESEARCH

# A Retrospective Assessment of Network Care Using a Survey of Self-Rated Health, Wellness and Quality of Life.

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**Abstract —** The present study represents a retrospective characterization of Network Care, a health care discipline within the subluxation-based chiropractic model. Data were obtained from 156 Network offices (49% practitioner participation rate) in the United States, Canada, Australia, and Puerto Rico. Sociodemographic characterization of 2818 respondents, representing a 67-71% response rate, revealed a population predominately white, female, well-educated, professional, or white collar workers. A second objective of the study included the development and initial validation of a new health survey instrument. The instrument was specifically designed to assess wellness through patients' self-rating different health domains and overall quality of life at two "time" points: "presently" and retrospectively, recalling their status before initiating care ("before Network"). Statistical evaluation employing Chronbach's alpha and theta coefficients derived from principle components factor analyses, indicated a high level of internal reliability in regard to the survey instrument, as well as stable reliability of the retrospective recall method of self-rated perceptions of change as a function of duration of care. Results indicated that patients reported significant, positive perceived change ($p < 0.000$) in all four domains of health, as well as overall quality of life. Effect sizes for these difference scores were all large (>0.9). Wellness was assessed by summing the scores for the four health domains into a *combined wellness scale,* and comparing this combined scale "presently" and "before Network." The difference, or "wellness coefficient" spanning a range of -1 to +1, with zero representing no change, showed positive, progressive increases over the duration of care intervals ranging from 1-3 months to over three years. The evidence of improved health in the four domains (physical state, mental/emotional state, stress evaluation, life enjoyment), overall quality of life from a standardized index, and the "wellness coefficient," suggests that Network Care is associated with significant benefits. These benefits are evident from as early as 1-3 months under care, and appear to show continuing clinical improvements in the duration of care intervals studied, with no indication of a maximum clinical benefit. These findings are being further evaluated through longitudinal studies of current populations under care in combination with investigation of the neurophysiological mechanisms underlying its effects.

*Key Words: Network spinal analysis, vertebral subluxation, chiropractic, self-rated outcomes assessment, wellness, overall quality of life.*

## Introduction

Network Care is a health care discipline within the subluxation-based chiropractic model[1] practiced by members of the Association for Network Chiropractic (ANC), nationally and internationally. Building from a base of consistent clinical observations, and repeated anecdotal reports of health benefits, the present study was conducted to fulfill the following three objectives: (1) to characterize the patient population undergoing Network Care; (2) to develop a new survey instrument of sufficient design and scope to allow assessment of a non-medical health discipline, and (3) to assess changes in patients' self-rated health, wellness, and overall quality of life.

Network Care is founded on the premise that individuals free of the complex of factors precipitating from, or leading to, vertebral subluxation experience a greater range of inherent adaptability and, hence, a greater sense of relative health or wellness. In a large percentage of individuals, Network Care evokes spontaneous self-perpetuating contractions of the paraspinal musculature.[1] The movements may be subtle, barely perceptible, or very

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obvious and may involve the arms and legs. Over a period of several months, physiological and psychological changes have been observed clinically, including increased flexibility of the spine, increased range of motion, improved mood and sense of relaxation, self-reported "wellness," and greater capacity to cope with stressful situations. These observations provide a basis for considering that Network Care involves body-mind interactions.

Consistent with the definition of health offered in 1958 by the World Health Organization,[2] as being "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity," overall improved health is one of the clinical objectives of Network Care. Until recently, methods to assess health changes relative to this definition have been unavailable.

However, with the advent of new outcome measurements for physical, mental and social well-being, as well as a greater awareness of the need to provide patient-centered outcomes, many disease treatment modalities are beginning to evaluate the effectiveness of their intervention in regard to the more holistic WHO definition of health.[3-4] Ironically, while this adds a greater understanding of "holistic" health to the medical perspective, this approach is not yet widely adopted in the area of health care where it would be most applicable, i.e., non-medical practices that have as their primary clinical goal the enhancement of overall health. This is perhaps due to the disease-specific orientation found in most recently developed surveys.[5]

A more thorough investigation of the efficacy of non-medical approaches is also confounded by a confusion of terms arising from the changing medical perspective. This new lexicon developed to accommodate the increased public and scientific interest and utilization of various practices considered outside of orthodox (allopathic) medicine. Terms such as "complementary" and "alternative" medicine, while useful in categorizing practices which treat disease but are outside of orthodox medicine (e.g., homeopathy, acupuncture), fail to differentiate those practices (non-medical) whose clinical objectives do not involve direct intervention in symptom alleviation or the treatment of disease.

By grouping all health care disciplines considered "outside" orthodox medicine under the umbrella of "complementary/alternative medicine," and then requiring that acceptance of these modalities be preceded by an evidence base derived from randomized clinical trials substantiating disease-treatment efficacy, the non-medical objective of certain disciplines (e.g., subluxation-based chiropractic) is ignored. For example, a specific practice may not be effective in improving the symptoms of arthritis, although it may be effective in improving other aspects of health such as physical, mental, or social well being. Consequently, dismissal of a given practice based on its lack of medical efficacy, without appropriate attention to its non-medical effects, does little to identify why it is being utilized or how it is important in the evolving holistic concept of health.

An example can be seen within chiropractic, where one school of thought views musculoskeletal manipulation as a means of treating certain diseases and/or dysfunctions.[6] Chiropractic practiced under this objective would qualify as a drugless, but palliative (symptom-based) therapy. Consequently, it could be argued that its allopathic objective renders it a form of complementary or alternative medicine and thus could be readily assessed using research methodologies commonly employed in medicine. In contrast, another school of thought within chiropractic (to which Network Care aligns) views correction of the condition of vertebral subluxation as a means of enhancing the body's inherent adaptive abilities, thus improving overall health.[6] This objective, identified with chiropractic since its inception[7] and recently re-emphasized by the Association of Chiropractic Colleges,[8] differentiates it from the clinical objectives of medicine. Consequently, it seems imperative that more appropriate methods be developed to assess the outcomes of such non-medical modes of health care.

Studies now suggest that global self-ratings of health, as well as being highly predictive of such fundamental outcomes as mortality or longevity,[9-10] are also an effective and justifiable means of measuring broader health outcomes (i.e., not just the presence or absence of disease or symptoms).[4] However, the psychometric survey instruments currently available were developed predominantly to assess general health and quality of life relative to medical interventions,[5] and were found lacking for the purposes of the present study. For example, among the 21 most relevant instruments reviewed and evaluated by McDowell and Newell,[5] none are appropriate to measure changes in a population of patients likely to be presenting for care already in relatively good health (an assumption based on numerous informal interviews with Network Care patients and practitioners). This was an important consideration in the present study as problems exist with "ceiling" effects in many of the instruments reviewed which limit the ability to measure improvement in an already healthy population. Additionally, their lack of breadth or excessive detail,[5] led to the development of a new instrument that would more directly reflect the WHO domains of physical, mental, and social well-being, without being cumbersome.

As with any new survey instrument, the first step involved tailoring the design of the items and scales for the particular condition (wellness) being tested, and beginning the validation process by examining the ability of the instrument to detect change (i.e., responsiveness) in a particular setting.[11] The subscales of the wellness questionnaire items were formulated to reflect aspects of the broad WHO definition of health; including the domains of physical and mental/emotional state, and intra/inter-personal life enjoyment indicative of physical, mental and social psychological well-being. In addition, the wellness domain termed "stress evaluation" (ability to cope with the demands of the environment), reflected aspects of functional ability incorporated into broader contemporary definitions of health. These domains, as well as the combined wellness scale, were compared to a standardized overall quality of life instrument[12] to assist in the process of validating the new instrument.

Typically, changes in outcome parameters are assessed with an "over-time" study design to meet a requirement for establishing causality (the cause must precede the outcome in time). However, longitudinal data (multiple measurements for the same individual over time) is costly and time-consuming, and the design is predicated on knowledge of the relevant time-frame. Cross-sectional studies of large populations are the appropriate first stage, and provide the opportunity to examine other ran-

domly distributed factors which may influence the outcomes. Without longitudinal data, suggestive evidence of change (and causality) must rely on the retrospective recall of respondents. The use of measurements of this form is limited, since merely asking respondents for current health ratings is ambiguous regarding the necessary cognitive frame of reference (e.g., compared to who/when). Moreover, merely asking for degree of change or improvement in health does not provide information on current levels of wellness (or the levels most common among individuals entering Network Care). Thus, the method of asking respondents to rate their level of health and wellness both "before Network" and "presently" was developed, with the difference between these two scores representing "perceived change." This method provided a richer and more explicitly circumscribed format of response, allowing the respondents to clearly recognize an attempt was being made to elicit their perceived degree of change in wellness.

The new instrument was considered, overall, as a *"wellness survey,"* yielding a *"wellness coefficient"* (reflecting perceived change) derived from the retrospective assessment of the *combined wellness scale.* The instrument was also designed to derive sufficient data to indicate the extent of its internal and external validity for continued use in evaluating Network Care, as well as for potential use in assessing medical and other non-medical health care approaches.

## Materials and Methods

*Practitioner population*

Network Care is currently practiced by licensed chiropractors recognized through their membership in the Association for Network Chiropractic (ANC), an international organization. In this first stage of sampling, the membership of the ANC was designated as the pool through which the patients were surveyed. All offices were solicited regardless of size, and regardless of full- or part-time practice. Because of the number of ANC practitioners, the census was conducted in two parts. The first survey-questionnaires were distributed in November, 1994 to 145 ANC practitioners with a request to have them completed by their patients and returned by December 30, 1994. The second survey distributed identical questionnaires to the remaining 185 ANC practitioners in March, 1995 with a return request of April 30, 1995. A telephone "tree" was established following each mailing to contact offices at least once, to encourage participation, answer questions, and determine reasons for non-participation.

From the 330 registered practitioners in the United States, Canada, Puerto Rico, and Australia, telephone follow-up revealed 9 were not practicing, leaving a total of 321 eligible to participate. From these, responses were obtained from 156 offices, yielding a practitioner participation rate of 49%.

*Patient population*

In the patient sampling stage, respondents were solicited through these 156 practices according to the following inclusion criteria: 1) under care for 1 month or more as of the survey date, and 2) 18 years of age or older. University of California, Irvine institutional human subject approval was obtained for the study which required respondents to provide verbal consent to participate in the study. Practitioners were also instructed to sample accordingly: "all practice members [patients] under Network Care for longer than one month [as of the survey date] are to be included in this study. If there are more than one hundred (100) practice members in your practice, and it is impossible to include them all, then simply include all those who are in the practice on a particular day or days (if possible, include at least 80 members)." The practitioners returned the completed questionnaires which were entered into a database for analysis.

*Response rate*

Survey research literature indicates that studies of national scope designed for multiple subgroup comparisons (e.g., by gender, age, duration of care, etc.) typically require sample sizes of 1500-2500.[13] A total of 2,818 completed questionnaires were received from these 156 practitioners. In a community study of this size it is difficult to obtain an accurate rate of return because there is no central registry of patients undergoing care. Thus, one purpose of this study was a first attempt to estimate the size of this population. This was done as follows: *First,* the average size of Network practices was estimated with data from 77 participating ANC doctors completing a question on a "Doctor's Survey" regarding total number of patients in their practice. This information was supplemented with an additional survey of 59 ANC practitioners attending a regional ANC training session. Both of these samples reported a median practice size of 40. Within the 156 participating offices, the total number of patients under care was thus estimated to be 6,240. *Next,* this total was corrected to estimate the sub-sample meeting the inclusion criteria by age and duration of care. This was accomplished with data from a sub-sample of thirty randomly selected offices, which provided sociodemographic information about total patient population. An estimated 5-7% of patients were ineligible because they were younger than 18 years, thus excluding 312-427 patients from the total patient population. Data on duration of care across all patients indicated that 15-17% of the total population was ineligible because they were under care less than one month at the time of the survey, excluding 936-1061 patients. *Finally,* the size of the eligible population was adjusted for sampling techniques employed by the larger practices. Since an estimated 12.4% of offices included more than one hundred practice members, the selection process excluded a projected 771 otherwise eligible patients from the pool. Within these parameters, the estimated range of the eligible population of patients from the 156 participating offices is 3972-4221, corresponding to an estimated response rate of 67-71%.

*Procedures and measures*

In this cross-sectional study, participants completed a one-time self-report questionnaire, consisting of a total of 87 questions (some containing sub-questions). The first objective, to characterize the patient population, was addressed through thirty-two questions eliciting information concerning: 1) patient sociodemographic characteristics [13 questions], 2) general health and health care history [8 new questions], 3) chiropractic care history [6 new questions], and 4) physical responses to Network Care [5 new questions]. The second objective of this

study was the development and evaluation of an appropriate outcome instrument. Therefore, patients were also asked to complete 55 questions, listed in the *Appendix,* concerning self-perceptions of general health, wellness, and quality of life. These questions were developed with reference to previously used measures, and in consultation with a psychometrician. They were designed to elicit self-reported changes in health, wellness, and quality of life using perceptions of scores "presently" against the explicit comparison of retrospectively recalled perceptions "before Network."

Serving as a point of comparison, 14 of the 55 items were taken from a psychometrically grounded "overall quality of life" instrument used by Woodruff and Conway (1992),[12] and adapted from the original landmark studies of Andrews and Withey (1976),[14] and Caplan et al. (1984).[15] In this instrument, to assess quality of life in a wide variety of areas, item responses were presented in a 7-point scale in Likert format[16] with choices scaled from 1-7 as "terrible," "unhappy," "mostly dissatisfied," "mixed," "mostly satisfied," "pleased," and "delighted."

A battery of 41 original items were partly adapted from a standard instrument assessing psychological status, "Structured Clinical Interview for DSM-III-R-Non-patient Edition."[17] Among these was one set of 10 items for evaluating stress (perceived ability to cope with the demands of the environment) relative to several spheres (e.g., family, work, etc.), using a 5-point Likert scale with choices ranging from 1-5 as "none," "slight," "moderate," "pronounced," and "extensive." An additional set of 11 original items assessed what was labeled "life enjoyment," wherein respondents were asked to rate their feelings and experiences contributing to a broad sense of inter- and intra-personal enjoyment on a degree scale of 1-5. Choices included "not at all," "slight," "moderate," "considerable," and "extensive." Finally, using a frequency scale of 1-5 representing "never," "rarely," "occasionally," "regularly," and "constantly," respondents were asked to rate their physical state (symptoms) and mental/emotional state (feelings, satisfaction) with a set of 10 items each.

Scale items were reverse coded, as necessary, to consistently reflect a higher score as indicative of better health. The items within each of the four domains were used to construct the indices assessing self-rated health.[16] In order to facilitate comparison across scales varying in number of items and response codes, each was re-scaled so that the theoretically lowest scores (i.e., those in which a respondent gave the lowest possible response to all items) were coded 0 and the theoretically highest scores were coded 1.[a] If a given individual answered at least half of the items within a scale, a missing (non-response) value was replaced with their mean response score for the questions they answered.[18] Finally, a *combined wellness scale* was constructed by summing the four wellness domains of physical state, mental/emotional state, stress evaluation, and life enjoyment, and then re-scaling in the 0-1 metric range. Respondents with missing values (n = 222) on any of these four scales were excluded from further analyses.[b]

*Statistical analyses*

The first concern, dealing with the development and initial validation of wellness-specific outcome measures, was to determine how well the item indicators (specific questions) and summated health domains indices, represented the theoretical concepts they purported to measure. That is, to what extent did the items/scales serve as valid measures of self-rated wellness and quality of life. Because reliable measurement is a necessary condition in building a case for validity, the first step involved analyses of reliability (essentially repeatability), or the extent to which the measures consistently yield the same results on repeated trials, free of "random error" or chance fluctuations. The more direct test-retest approach not only requires multiple measurements on the same individuals over time, and the often untenable assumption that the trait itself is stable, but is also entangled with any true differences in health associated with treatment (e.g. Network Care). Thus, the more commonly accepted analysis of internal-consistency reliability[19] was used as an indicator of how well the individual items (questions) within a scale reflected a *common* underlying health domains construct. This analysis is based on the logic that confidence can be increased, that the underlying theme of health/wellness is reliably measured by using multiple measuring instruments (questions), and gauging the extent to which the item scores are interrelated beyond random fluctuation. Chronbach's coefficient alpha is the most often used statistic,[19] and the most conservative test, because it is based on the assumption that all questions contribute equally to the measurement of the single wellness theme. This stringent requirement of "parallel measurement" means that alpha is a lower bound for the reliability of a multi-item scale.

A closer estimate of true reliability is coefficient theta, which relaxes the assumption of parallel measurement. This is considered a maximized alpha coefficient. Also, within the construct of internal-consistency reliability, theta is calculated from the results of principle components factor analyses, which are methods for discovering clusters of interrelated variables. The analysis essentially evaluates the extent to which the items share variability in concert with one another; this "shared variance" represents the underlying construct which, in this case, is the wellness theme of the measures.[20] The primary portion (principle component) of the shared variance among the items (eigenvalue) is a summary of how well the scores on given items account for, or predict, the scores on all other items (factor loadings). Calculation of the reliability coefficient theta is based on the magnitude of this principle component. Both alpha and theta coefficients are a product of the number of items and the strength of their intercorrelations, ranging from 0-1.00, with a cut-off of greater than 0.7 as the widely accepted rule of thumb for demonstrating internal consistency.[21]

In addition to its use in the reliability analysis, factor analysis is also a useful tool for assessing the validity of empirical measures.[20] The pattern of residual co-variation among the variables and factors, after accounting for the common variability in the principle component, was inspected to investigate how well the individual items support the theoretical theme (i.e., wellness domains). In addition, the convergence of the health domain scales and the psychometrically validated overall quality of life index was considered (i.e., reliability, inter-scale correlations, and associations with other available data such as spinal injury, etc).

Using these newly developed health domain scales, the third

objective of this study was the evaluation of retrospectively perceived changes in health and quality of life for patients while under Network Care. This was accomplished with bivariate comparisons of self-rated health scores "before Network" and "presently." The statistical significance of this difference was determined using two-tailed, paired sample t-tests, which tests the null hypothesis that any differences between individuals' paired "before Network" and "presently" scores result from chance fluctuation. Insofar as this evaluation involved the use of multiple scales, the usual alpha level of 0.05 was divided by the number of scales (5) to correct for multiple comparisons, yielding p=0.01 at a 99% confidence interval.[22] When the "p" value of this probability did not exceed the 0.01 cut-off, the null hypothesis was rejected, indicating that the difference is statistically significant. That is, at this level, only 1% of the time would the results be due to chance alone, or 99% of the time would the same pattern be found in the population from which the sample was drawn.[c]

In addition, difference scores were calculated within each of the four health domain indices between "presently," and "before Network," to determine a patient's perceived change. Summation of all health domain index scores represented a *combined wellness scale* for both "presently" and "before Network." The difference score of the *combined wellness scales,* herein referred to as the *"wellness coefficient,"* ranged from -1 to +1, with zero representing "no change," positive values indicating improved health, and negative values a worsening.

While the large size of this sample assures that a statistically significant effect will not be missed (due to sample error introduced by small sample size), statistical significance alone does not provide insight into the strength of a bivariate relationship or effect. Thus, measures of clinical significance, or size of "treatment" effect, are commonly reported.[24-25] In this regard, effect size was used to measure the magnitude of clinical or meaningful change in the present study. Effect size represents a standardized "benchmark" measuring the magnitude of clinical change.[26] Cohen (1977) provided the widely accepted definition of an effect size of 0.20 as small, 0.50 as moderate, and 0.80 or greater as large, with large being a change of magnitude at least four-fifths of a standard deviation of the baseline measure.[27] The most commonly accepted formula was used for calculating effect size: $(M_2 - M_1)/S_1$, where $M_1$ and $M_2$ are the group means at time one ("before Network") and two ("presently"), and $S_1$ is the standard deviation at time one.[24] This statistic compares the average differences in individuals' scores "presently" to the amount of deviation across the scores of all respondents "before" beginning care, with the idea that meaningful variations should be valued against the normal range of the majority of individuals' initial scores.

To better visualize the extent and meaning of clinical effects (effect size) in the sample, the percentages of patients whose perception of health/wellness worsened or improved more than 0.5 standard deviation, or remained stable, were calculated. The specific cutoff values for improvement thus vary as a function of the distribution and variability of each index, and generally reflects a conservative moderate effect size. These cut-offs were superimposed on histograms of the difference scores (perceived change) for each index.

Finally, to investigate if the interval between "before Network" and "presently" varied across respondents according to the duration of Network Care, the characteristics and associations of this parameter were examined. To capture meaningful time-bound differences in wellness, this continuous variable was categorically re-scaled to 1-3 months, 3-12 months, 12-36 months, and greater than 36 months. The categorization was based on the assumption that the influence of the length of time since beginning care does not operate in a linear (one-to-one) fashion with regard to either retrospective recall or the potential wellness related influence of care. Focusing on the validation of the retrospective recall approach, these four duration groups were compared in terms of the internal-consistency reliability of the self-rated health and quality of life indices, as well as other potentially relevant health characteristics. The connection between duration of care and the magnitude of retrospectively perceived changes in self-rated health and quality of life (score for "presently" minus the score for "before Network") was then examined using analysis of variance (ANOVA).[28] This statistic compares variation across the group means (defined by length of time under care) to the average variation within those groups; the resulting probability indicates the extent to which differences across groups are real or due to chance. In addition, measures of the clinically meaningful variation in wellness, i.e., effect size, are particularly well suited for comparing differences across these treatment duration groups.

## Results

*Patient Sociodemographic and Health Care Characteristics*

The sociodemographic characteristics of the study population are presented in Table 1. The average age of respondents was 43 ± 12 years (mean ± SD) with a range of 18 to 95 years (U.S. mean age = 35 years). There was an over-representation of female (73%) compared to male (27%) respondents, and white ethnicity (94%), with the population reflecting only 1% black and less than 5% representation of all other ethnic groups. Socioeconomic characteristics of these respondents tended to be skewed toward higher education levels (79.6% college or graduate school), professional/white collar (69.8%) occupations, and higher income (Table 1).

A summary of the health histories for the population is given in Table 2. The majority of respondents self-reported their current physical and emotional health as good (64%-68%) or excellent (23%-28%), and only a few rated their physical/emotional health as poor (4%). Not surprisingly, in view of the wellness perspective of Network Care, the population had a low utilization of orthodox medical services, even though there was a relatively high incidence of persistent ailments (58%) and prior injury to the spine (47%). In this regard, only 28% of respondents reported seeing a physician for other than routine physicals; the last visit to a physician averaged 15 ± 30 months previous to completing the questionnaire. Fewer than half of the respondents (38-41%) reported taking any prescription or non-prescription medications currently, or for a duration of at least 2 months at any time in the past.

Patients had been under regular Network Care for an average of 21 ± 27 months (Table 2). The frequency of Network

Care was consistent across offices ranging from an average of 2.7 ± 1.3 times/ week during the first 2-3 months, to 2.4 ± 1.3 times/ week 3-6 months after initiating care, and further reducing to an average of 2.1 ± 1.2 times/ week after 6 months of care. Also consistent across offices, the vast majority of patients (75%) had been under previous chiropractic care for an average of eight years (96 ± 112 months) prior to beginning Network Care. In regard to Network Care, 95% of respondents reported that their expectations had been met, and 99% reported that they would continue care.

Table 1. Sociodemographic Characteristics of Patients undergoing Network Care

| | | |
|---|---|---|
| Number of respondents: | | 2,818 |
| Age (years): | | 43.4 ± 11.5 (2770) |
| Gender: | | (2799) |
| | Male | 26.6% |
| | Female | 73.4% |
| Ethnicity: | | (2750) |
| | White | 94.1% |
| | Black | 1.2% |
| | Asian | 1.2% |
| | Hispanic | 1.7% |
| | American Indian | 0.4% |
| | Other | 1.4% |
| Marital status: | | (2551) |
| | Single | 31.1% |
| | Married | 46.5% |
| | Divorced/Widowed | 22.3% |
| Number of children: | | (2615) |
| | None | 46.3% |
| | One | 15.6% |
| | Two | 21.3% |
| | Three or more | 16.8% |
| Occupation: | | (2689) |
| | Blue collar | 7.5% |
| | White collar | 22.2% |
| | Professional/technical | 47.6% |
| | Student | 6.5% |
| | Homemaker | 5.9% |
| | Retired | 5.7% |
| | Unemployed | 1.6% |
| | Self-employed | 3.0% |
| Education : | | (2785) |
| | High school | 12.3% |
| | Other (avocational) | 8.1% |
| | College | 50.3% |
| | Graduate school | 29.3% |
| Income: (median = $25-34,999) | | (2542) |
| | < $24,999 | 40.0% |
| | $25-34,999 | 18.9% |
| | $35-44,999 | 13.5% |
| | $45-59,999 | 12.6% |
| | > $60,000 | 14.9% |

Table 2. Self-reported health history of patients undergoing Network Care.

| | | |
|---|---|---|
| I. MEDICAL | | |
| 1. Current physical state: | | (2794) |
| | excellent | 25.0% |
| | good | 71.0% |
| | poor | 4.0% |
| 2. Current emotional/mental state: | | (2786) |
| | excellent | 29.0% |
| | good | 66.0% |
| | poor | 5.0% |
| 3. Persistent ailments: | | (2684) |
| | | 58.0% |
| 4. Physician visits (other than routine): | | (2787) |
| | | 28.0% |
| 5. Last medical visit (months): | | (2324) |
| | | 15.0 ± 29.6 |
| 6. Currently taking medications: | | (2214) |
| | | 41.0% |
| 7. Medications taken for at least 2 months in past: | | (1916) |
| | | 38.0% |
| II. CHIROPRACTIC | | |
| 1. Spinal injury: | | (2737) |
| | | 48.0% |
| 2. Time since spinal injury (yr.): | | (1075) |
| | | 15.5 ± 17.4 |
| 3. Duration of Network Care (mo.): | | (2510) |
| | | 21.4 ± 27.0 |
| 4. Prior chiropractic care: | | (2774) |
| | | 75.0% |
| 5. Duration of prior care (mo.): | | (1506) |
| | | 93.2 ± 111.6 |
| 6. Frequency of Network Care: | | |
| (appointments/wk) | initial 2-3 mo. (2240) | 2.7 ± 1.2 |
| | initial 3-6 mo. (1812) | 2.5 ± 1.4 |
| | > 6 mo. (1539) | 2.2 ± 1.1 |
| 7. Expectations met with Network Care: | | (2367) |
| | | 95.0% |
| 8. Number choosing to continue Network Care: | | (2770) |
| | | 99.0% |

*Self-Rated Health, Wellness and Quality of Life Scale Item Analyses*

In this study, the efficacy of Network Care was assessed in terms of several newly developed self-rated health indices, as well as the overall quality of life index, which were rated by the respondents both "presently" and retrospectively recalled "before Network." The means and standard deviations for the four domains of health, overall quality of life, and combined wellness scales (indices) "presently," and "before Network" are presented in Table 3. The re-scaled means of the four self-rated health domain scales "presently," ranged from 0.67-0.70, corresponding to a rating of about 70% of the maximum possible in the 0-1 metric. Mean scores "before Network" hovered around the mid-

Table 3. Reliability Coefficients and Means for Self-Rated Health, Wellness and Quality of Life Scales (N ≥ 2596)

| INDEX | "Presently" | | | | "Before Network" | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Internal Consistency | | | | Internal Consistency | |
| | | | Chronbach's | | | | Chronbach's | |
| | Mean | St Dev. | Alpha | Theta | Mean | St Dev. | Alpha | Theta |
| Combined Wellness | .678 | .100 | .8949 | .9110 | .507 | .138 | .9230 | .9342 |
| A. Physical State | .701 | .121 | .7418 | .7539 | .558 | .154 | .7581 | .7670 |
| B. Mental/Emotional State | .666 | .136 | .8210 | .8310 | .494 | .190 | .8612 | .8680 |
| C. Stress Evaluation | .674 | .155 | .8176 | .8336 | .483 | .199 | .8392 | .8528 |
| D. Life Enjoyment | .669 | .135 | .8367 | .8490 | .502 | .145 | .8309 | .8360 |
| Overall Quality of Life | .700 | .142 | .9297 | .9396 | .542 | .171 | .9447 | .9504 |

point of 0.5, or about 50% of maximum in the same metric, corresponding to perceptions of "moderate/occasionally" in the original response scale. Across the separate scales, respondent variability (standard deviation) was approximately 10% greater "before Network" than "presently," as would be expected given the cognitive complexity of such recall. The mean for the overall quality of life index is higher on average (with similar variability), but not dramatically different than those of the separate health domains indices for "presently" or "before Network," or the *combined wellness scale* (summation of all health indices).

The results of the scale item reliability analyses are also presented in Table 3. For all indices, both "before Network" and "presently," Chronbach's alpha coefficients are clearly above acceptable levels (i.e., > 0.7), indicating strong internal consistency, that is, an interpretable underlying theme for the scale items of each wellness domain and overall quality of life. Only for the stress evaluation scale did further inspection result in the deletion of an item (stress associated with school) to optimize reliability. For the remaining 54 items, the deletion of any variable resulted in lower reliability for the respective scale, indicating that each provided uniquely important information. Moreover, given that the alpha for the *combined wellness scale* was substantially higher than the coefficients for the separate domains, it is apparent that this overall collection of questions meaningfully reflects a single theme labeled "wellness." The alpha coefficient for the *combined wellness scale* (as well as those for the separate health domains) compares favorably to the expected higher alpha for the established overall quality of life index.

To further explore the reliability and validity of these scales, principle components factor analyses of the respective items was conducted. Based on resulting calculations (derived from the first eigenvalue [Methods] ), in all cases coefficient theta indicated that the items in all scales were roughly parallel (equal) and that factor weighted scaling was not necessary as it would not produce substantially more reliable scales. The set of items in each scale met the established criteria supporting the measurement of a single underlying phenomenon. The first component theme accounts for a large proportion of the variability in the items (as indicated by the magnitude of theta) with gradual decreases across subsequent components. In addition, all items had factor loadings (item contributions to the overall theme measured by the scale) of greater than 0.4 (exceeding a 0.3 cutoff) on the first component. Moreover, factor loadings of the items indicating their contribution to subsequent components, were less than the contributions to the primary (principal) factor.[19]

To address the relationships between the scales, inter-scale Pearson correlation coefficients both "before Network" and "presently" were examined. Coefficients for the separate wellness domains of physical state, mental/emotional state, stress evaluation, and life enjoyment revealed moderate to substantial correlations, ranging from 0.15 (between physical and enjoyment "before Network") to 0.67 (between stress and emotional state "presently"). All scales showed slightly weaker inter-scale correlation in the "presently" than the "before Network" scores. Overall, the magnitude of these correlations suggests that while the separate domains are meaningfully related, they were not redundant items/scales. The correlations between the overall quality of life scale and the four health domain scales ranged from 0.34 (with physical state) to 0.58 (with life enjoyment) "presently," with a similar pattern of higher values "before Network" (0.42 - 0.68). The correlations between the overall quality of life and combined wellness scale were 0.74 "before Network" and 0.66 "presently," again suggesting that they are meaningfully related but not redundant.

To further explore the characteristics of this *combined wellness scale,* both "before Network" and "presently," factor analysis combining all items from the four health domains was conducted. The results support the conclusion that the combined set of all items measured a single phenomenon or "wellness theme" with factor loadings consistently exceeding 0.3 (criteria described above); this conclusion also derives from the fact that the theta reliability of the *combined wellness scale* is higher than the reliability of the separate health domain scales. However, further inspection of the factor scores did reveal a pattern wherein the items within the respective domains tended to cluster together identifiably after removing the primary variance. Thus, even though the *combined wellness scale* is slightly more reliable and more strongly in accord with the overall quality of life index, additional information is available by considering the (sub-) scales separately. In addition, there is some statistical evidence, in the magnitude of the second factor scores, that the life enjoyment scale may represent a second theme somewhat distinct

Table 4. Perceived Changes (Difference Scores) in Self-Rated Health/Wellness and Quality of Life Scales Between "Before Network" and "Presently" (N ≥ 2596)

| INDEX | Difference Scores | | | Paired t-test | Effect |
|---|---|---|---|---|---|
| | Mean | St Dev | Improved* | p value | Size |
| Combined Wellness | +.171 | .136 | 76.4% | .000 | 1.24 |
| A. Physical State | +.144 | .128 | 63.9% | .000 | 0.94 |
| B. Mental/Emotional State | +.173 | .163 | 64.3% | .000 | 0.91 |
| C. Stress Evaluation | +.194 | .196 | 66.2% | .000 | 0.98 |
| D. Life Enjoyment | +.167 | .164 | 68.9% | .000 | 1.15 |
| Overall Quality of Life | +.158 | .168 | 58.9% | .000 | 0.93 |

* Positive change greater than ± 0.5 standard deviation, corresponding to a moderate or greater effect size.

from that shared by the physical state, mental/emotional state, and stress evaluation constructs. Accordingly, results are presented for both the separate health domains and the *combined wellness scale* in the remainder of this report.

*Retrospective Outcomes Assessment.*

These scales were used for the evaluation of retrospectively perceived changes in self-rated health and quality of life for patients under Network Care (Table 4). For each individual, perceived change was calculated as the difference between "presently" and "before Network" scores. For every outcome measure, the mean difference score was positive, indicating that for all scales, on average, there was reported improvement with care. The perceived change (difference) in scores of the *combined wellness scale ("wellness coefficient")* indicated an average of + 0.17 in a range of -1 to +1. This was interpreted as an overall increase in wellness as the value was consistent with statistically significant differences in the scale scores and positively (+) signed (numerically closer to +1 than -1). In regard to the separate health domains, the differences between "presently" and "before Network" were also all positive and in the same range as the *wellness coefficient* (Table 4). The magnitude of these perceived changes varied from +0.14 to +0.19, which compares to a +0.16 increase for the overall quality of life index.

The results of two-tailed paired sample t-tests indicate that these perceived changes (i.e., differences between "presently" and "before Network" scores) were statistically significant for all outcomes ($p<0.000$); demonstrating that the differences in scores were not due to chance fluctuations. The effect size statistics further showed that these improvements (ranging from 0.91 to 1.15 across the separate scales) were above 0.8, indicating that a large positive clinical outcome had occurred across all domains. In addition, there was notable correspondence between the separate health domains derived for the purpose of this study and the standardized overall quality of life index (Table 4).

The advantage of retaining the separate domains of physical state, mental/emotional state, stress evaluation, and life enjoyment, as well as the *wellness coefficient,* becomes apparent in comparing range of effect sizes for these outcomes. Retrospectively perceived changes associated with physical state, mental/emotional state, and stress evaluation are comparable in magnitude with overall quality of life assessments (range=0.9-1.0). In contrast, the change in life enjoyment is notably greater (1.15). Moreover, when all scales are combined in the *combined wellness scale,* the effect size calculation shows a large (1.24) positive clinical effect associated with Network Care (Table 4).

To better visualize clinical improvement in outcomes, Figure 1 illustrates the self-perceived change histograms for each index, with each data point in the histogram representing the difference score for an individual. The cut-offs for the categorization of each respondent as worsened, no change, or improved are shown superimposed, and ranged from ± 0.07 for life enjoyment to ± 0.10 for mental/emotional state and stress evaluation. Across all scales, 4% or less of respondents reported decreased levels of self-rated health, wellness, and quality of life, and between one-fourth and one-third did not change beyond one-half standard deviation within the scale. In contrast, as also noted in Table 4, the majority of respondents reported at least a moderate clinical improvement across all outcome assessments. In spite of the conservative cut-off values, 59% improved on the overall quality of life index, and about two-thirds of respondents showed clinical improvements in physical state, mental/emotional state, stress evaluation, and life enjoyment indices, with over 76% perceiving improvement in the wellness coefficient.

*Analyses of Outcomes by Duration of Care*

While the variable representing length of time since beginning Network Care in months, i.e., duration of care, was significantly skewed toward the lower range, the re-scaled version representing duration intervals of 1-3, 3-12, 12-36, and 36+ months was normally distributed (i.e., not significantly skewed). Table 5 presents the means, standard deviations, and effect sizes "presently" and "before" Network Care for each of the four health scales, the *combined wellness scale,* and overall quality of life, for the four duration of care intervals.

ANOVA results showed that the mean "presently" scores differed statistically ($p<0.003$) across the duration groups for all self-rated health and quality of life scales, as well as the *combined wellness scale,* indicating that increasing duration of Network Care is significantly associated with increasing levels of perceived health and wellness. Although this pattern is meaningful in itself, the retrospectively recalled "before Network" scores in the four health domains, the *combined wellness scale,* and overall quality of life also provided the opportunity to examine the relationship between possible perceived changes in health and wellness and length of time since starting care; i.e., how stable is the

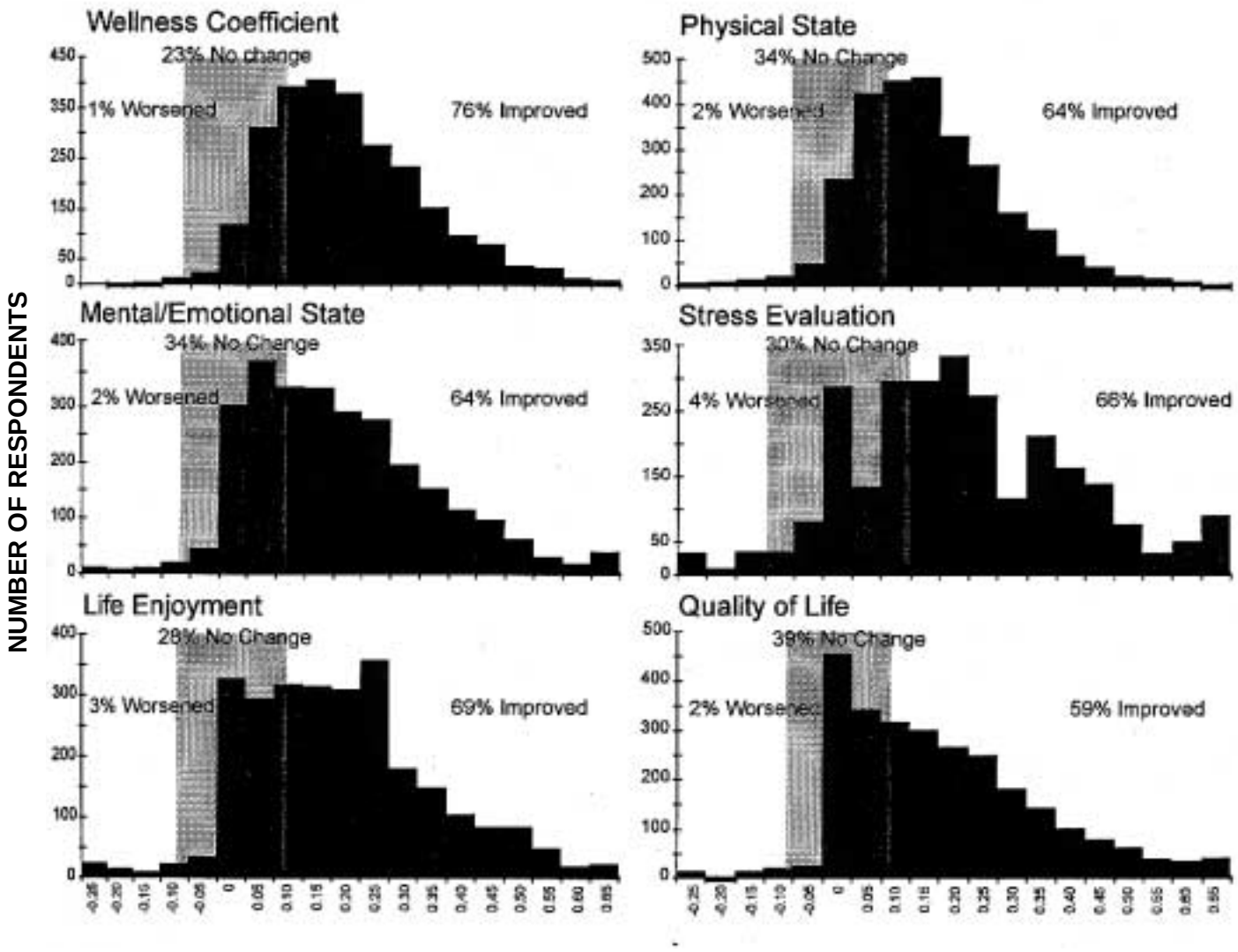


**Figure 1** illustrates the self-perceived change histograms for the wellness coefficient, each health scale, and overall quality of life. Data points in the histogram represent the difference scores for each individual (e.g. difference between "presently" and "before Network") for each scale. The percentages of patients who worsened or improved more than one half of the standard deviation (± 0.5 SD.), or had no change (stippled areas in figure) are superimposed over each histogram. The specific cutoff values for improvement thus vary as a function of the distribution and variability of each index. The cut off values ranged from ± 0.06 for physical state to ± 0.10 stress evaluation.

reliability of retrospective recall of one's health given varying time intervals?

To begin to address the validity of the retrospective recall strategy, the within group variation (standard deviation) in "before Network" scores in all scales was examined (Table 5). This differed only minimally across these duration groups, and showed no pattern of increased variability with increased duration of care (i.e., length of recall). Moreover, the reliability coefficients were strikingly similar across duration groups, varying in magnitude by 1% or less for all scales (except physical state at 2.5%), and showed no trend toward lower reliability associated with increased length of retrospective recall. Thus, a longer interval since "before Network" is not associated with increased random error in the measurement of quality of life, self-rated health, or wellness in these data.

ANOVA results indicated that the mean "before Network" scores for overall quality of life, stress evaluation, life enjoyment, and the combined wellness rating were significantly different across the duration groups ($p < 0.003$ ). In each instance, the "before Network" wellness scores were lower with longer intervals in care.

The *wellness coefficient,* being the difference between "presently" and "before Network," reflected in one measure the incrementally lower "before Network" wellness ratings concomitant with the progressively higher "presently" scores, observed with longer intervals in care. Moreover, the self-rated health scales, *combined wellness scale,* and overall quality of life across the duration groups showed significant positive differences (improvement). As is readily apparent in Figure 2, respondents within groups, defined by increasingly longer duration of care, report-

Table 5. Duration of Network Care Reliability Analyses for "Before Network" and "Presently" Self-Rated Wellness and Quality of Life Scales (N ≥ 2330).

| | "Presently" | | "Before Network" | | | Effect Size |
|---|---|---|---|---|---|---|
| | Mean | St Dev | Mean | St Dev | Alpha | |
| Combined Wellness | | | | | | |
| In Care 1-3 mo. | .665 | .102 | .526 | .136 | .953 | 1.03 |
| 3-12 mo. | .669 | .096 | .517 | .135 | .951 | 1.13 |
| 12-36 mo. | .680 | .099 | .495 | .139 | .956 | 1.33 |
| > 36 mo. | .702 | .098 | .482 | .139 | .954 | 1.54 |
| A. Physical State | | | | | | |
| In Care 1-3 mo. | .691 | .123 | .568 | .152 | .773 | .81 |
| 3-12 mo. | .695 | .115 | .562 | .153 | .747 | .87 |
| 12-36 mo. | .705 | .119 | .551 | .156 | .841 | 1.00 |
| > 36 mo. | .717 | .124 | .555 | .154 | .754 | 1.08 |
| B. Mental/Emotional State | | | | | | |
| In Care 1-3 mo. | .650 | .144 | .508 | .187 | .859 | .76 |
| 3-12 mo. | .653 | .135 | .497 | .185 | .856 | .84 |
| 12-36 mo. | .673 | .134 | .489 | .191 | .867 | .97 |
| > 36 mo. | .686 | .130 | .476 | .196 | .858 | 1.09 |
| C. Stress Evaluation | | | | | | |
| In Care 1-3 mo. | .670 | .153 | .514 | .196 | .834 | .79 |
| 3-12 mo. | .668 | .152 | .497 | .196 | .838 | .89 |
| 12-36 mo. | .667 | .156 | .462 | .199 | .841 | 1.10 |
| > 36 mo. | .698 | .150 | .462 | .199 | .838 | 1.24 |
| D. Life enjoyment | | | | | | |
| In Care 1-3 mo. | .646 | .135 | .517 | .150 | .847 | .85 |
| 3-12 mo. | .656 | .138 | .516 | .143 | .836 | 1.00 |
| 12-36 mo. | .677 | .135 | .489 | .143 | .838 | 1.13 |
| > 36 mo. | .700 | .128 | .478 | .139 | .816 | 1.59 |
| Overall Quality of life | | | | | | |
| In Care 1-3 mo. | .670 | .147 | .561 | .177 | .942 | .61 |
| 3-12 mo. | .693 | .136 | .566 | .165 | .942 | .78 |
| 12-36 mo. | .704 | .145 | .524 | .174 | .948 | 1.00 |
| > 36 mo. | .735 | .134 | .518 | .168 | .943 | 1.31 |

ed incrementally higher positive *wellness coefficients.* That is, not only were the changes between "presently" and "before Network" scores statistically significant for all outcomes, but the extent of that change in the *wellness coefficient* is positively associated with the duration interval of care. Moreover, the percent of respondents exhibiting a greater than moderate clinical effect also increased with increased duration of care.

To further explore the association between wellness and duration of care, two-tailed paired sample t-tests were conducted on the change between "presently" and "before Network" scores for the *combined wellness scale,* and overall quality of life, separately within each duration of care group. Regardless of the time interval since beginning Network Care, the mean combined wellness improvement was statistically significant. Additionally, progressively higher effect sizes were evident across the four categories of duration of care in nearly proportional increments; 1.03 for 1-3 months, 1.13 for 3-12 months, 1.33 for 12-36 months, and 1.54 for 36+ months of Network Care. A similar pattern was obtained for the overall quality of life index (Table 5).

These proportionally increasing effect sizes (about 0.1 per year of care) suggest that these particular intervals are meaningful time categories, perhaps connected to the accrued benefits of care. Thus, even for respondents who began care within three months of completing the survey, the statistic is well above the 0.8 value indicating a large clinical treatment effect; for those in care more than 3 years, the effect size is nearly double this benchmark. This systematic difference reflects clinically meaningful retrospectively perceived improvements in self-rated

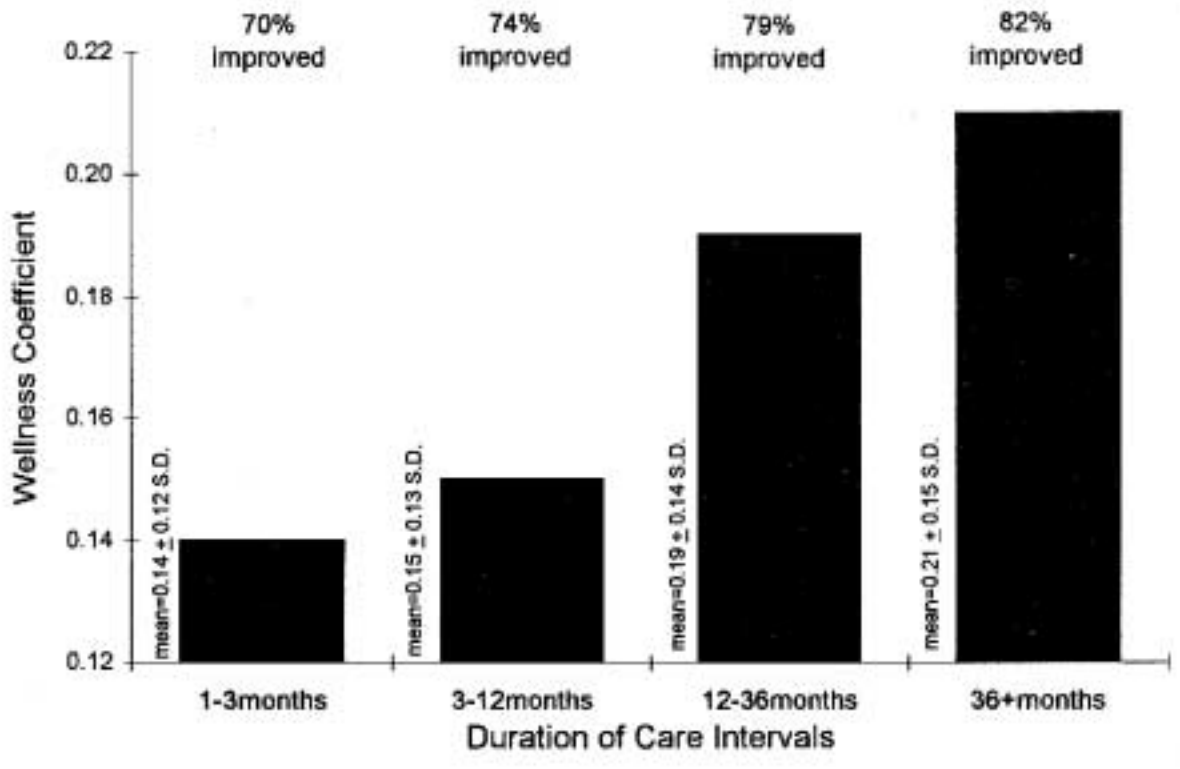


**Figure 2** shows mean wellness-coefficients versus duration of care. Respondents within each group, defined by increasingly longer duration of care, reported incrementally higher, positive wellness coefficients. The percent of "improved" respondents, defined as those greater than one half of the standard deviation of each duration of care category, are also indicated; note that the percent "improved" also increased in each of the duration of care intervals. These percentages represented a greater than moderate clinical effect.

health, wellness, and overall quality of life, associated with Network Care.

## Discussion

A primary objective of this study was the evaluation of retrospectively perceived changes in self-rated health and quality of life for patients undergoing Network Care. The results from analyses of 2,818 respondents has provided compelling evidence for the beneficial effects of Network Care. This population of patients undergoing Network Care self-rated their status "presently" at a level of 0.7 (70%) in a metric of 0 - 1.0, and were "mostly satisfied" with their quality of life. This was a statistically significant increase over their self-reported wellness "before Network" which averaged about 0.5 (50%), and, on average, had "mixed" satisfaction about their overall quality of life. Over 76% of respondents reported positive, clinically significant *wellness coefficients,* incorporating perceived changes in physical state, mental/emotional state, stress evaluation, and life enjoyment. Categorizing patients in terms of duration of care revealed progressively higher reported effects with time under Network Care.

The precise mechanisms underlying these effects are uncertain, but it is hypothesized to be, in part, associated with changes in levels of circulating factors released by the pituitary-adrenal cortical axis. While this hypothesis will be tested in subsequent studies, by analogy, such changes have been associated with the relaxation response during meditation[29-30] and stress-reduction programs.[31-38]

*The Survey Population*

This first census of active practitioners of Network Care realized a 49% participation by ANC practitioners. Given the practitioner participation rate, coupled to the strong statistical power of the findings, conditions contributing to a positive bias could be operational. However, respondents to a separate practitioner survey (conducted during the same time frame) indicated that among 116 respondents, 97% followed the suggested protocols outlined for Network Care. This implies that Network Care is practiced consistently. Moreover, since the patient responses were received from 156 different practices, widely distributed across the range of practice locales, there is no prevalent rationale which would suggest that practitioner participation was biased. Nevertheless, further study investigating the impact of

practice style on patient outcomes will be necessary to better understand this issue. On a practical note, if indeed the sample is biased towards results obtained by practitioners more committed to health care delivery, then the present results should be viewed as a "benchmark" against which new practitioners could set practice goals and objectives.

Based on population parameters and inclusion criteria, the estimated survey response rate of 67-71% is generally considered to be "very good" particularly for mail surveys.[39] Although the overall response rate is in the acceptable range, it is important to ascertain as much information as possible regarding non-respondents in order to detect other systematic bias. The telephone follow-up with practitioners confirmed some reluctance to participate on the part of patients for reasons of time constraint, privacy and/or disinterest in the study, but not for reasons that might bias the results (e.g., only the best patients, or those receiving the greatest amount of care, etc.). It is difficult to estimate the number of patients declining to participate for reasons of adverse reactions or poor outcomes. However, among those responding, there was a small number (n = 29, 1%) who indicated that they would not be continuing Network Care. Those choosing not to continue care reported the smallest (but still significant) improvements in the indices for physical state and mental/emotional state, although no significant change from base line was detected in this group with regard to the remaining three indices (stress evaluation, life enjoyment, and quality of life). While it is believed that "self selection" bias is not a significant feature of the present study due to its wide range of participating practices, a longitudinal study is currently underway to assess patients from the onset of care through a specified time period. This approach will provide the opportunity to ascertain if only those receiving positive benefits from care "self select" as survey respondents by evaluating non-respondents, as well, relative to their clinical benefit status.

The first objective of this study was to characterize the population under Network Care. The vast majority of the population studied are from offices within the United States (93.5%), with a small representation from Canada (4.6%), Australia (1.0%), and Puerto Rico (0.8%). Given the international scope and other inclusion criteria defining this population, it is difficult to relate directly to the U.S. population. Although the age of respondents appears to be normally distributed, the average of 43 years is higher than the national mean (35 years),[40] and is likely because of the exclusion of patients less than 17 years of age as well as the lower incidence of health care utilization in early adulthood. There were clearly more female than male respondents, and the population was predominantly white. Socioeconomic characteristics of these respondents tended to be skewed toward higher education levels, professional/technical occupations, and higher income. These patterns have also been noted in studies of alternative/complementary medicine in the U.S. and Europe,[41-43] as well as studies of chiropractic care.[44-45] Whether or not the results of this study extrapolate to the general population awaits further investigation.

A more interesting challenge is to attempt to understand the factors contributing to the uniqueness of the population under Network Care. The cost of care may be one factor. There is a high incidence of self-pay with patients undergoing Network Care. The fee for an office visit varies greatly depending on practice size, location, pay plan (individual, family, monthly, weekly, etc.), but ranges from approximately $15-$50 per visit. Given the frequency of care, i.e., ca. 2 times/week (Table 2), this amounts to about $120 to $400 per month. While this is consistent with the approximate amount paid by Americans for health insurance and out-of-pocket expenses for alternative/complementary care,[41] other studies document the strong negative correlation between family income and access to health care,[46] and by analogy, cost may restrict access to Network Care. In terms of ethnicity, the lower family incomes among ethnic minorities may account for the limited access of these groups to the health care structure in general.[47] Other factors such as cultural attitudes and health belief structures are strong determinants of access to health care,[48-49] and need to be examined within the context of Network Care. Finally, the high incidence of females in the present population (73%) relative to the general population (51%) is consistent with health care utilization patterns in general[50-51] and is currently undergoing further study.

*Study Design*

Although there are a number of objective criteria for assessment of vertebral subluxation such as surface electromyographic recordings and thermography, which may be applied to the analysis of patients under Network Care, these objective criteria do not take into consideration the overall health and wellness status of the patient. For this reason, it was important to assess the broader issues by use of self-rated health, and overall quality of life (see Introduction for details).

Self-rated health measurements are used with increasing frequency as measures of primary and secondary outcomes in clinical studies, and in a growing number of studies, have been shown to be an impressive, independent predictor of outcomes, including mortality and longevity.[10] All self-reported survey data is subject to potential response effects, such as when respondents provide socially desirable responses, or are inclined to respond similarly to all items (common method variance). In the present data, these issues do not appear to be particularly problematic; arguing against socially acceptable responses is the observation that actual responses included the range of possible scores, and the issue of common method variance error is negated because summated scales showed greater variability than the separate original items. Also, analyses of cases with missing values on the outcome assessments did not reveal non-response to be a systematic biasing factor.

In the present study, self-rated health was used as an evaluative instrument to measure perceived change in patient perceptions, "presently" relative to "before Network." The patients' self-reported assessments of their prior status before initiating Network Care allowed analysis of perceived trends over time, but not specific cause-effect relationships. Although the cross-sectional design holds advantages for the purposes of this study, longitudinally collected data is necessary to verify time-related changes (e.g., with duration of care).

The ability of an evaluative instrument to detect change (i.e., responsiveness) can be compromised by floor/ceiling effects in which patients with the best scores may continue to improve

(beyond the scope of the response range), or the health status of patients on the low end of the scale continue to worsen. No floor effects were encountered. Although examination of the data revealed potential operation of ceiling effects, further investigation showed less than 2% of cases could be considered suspect (>95% of maximum), with trivial attenuation of outcomes.[d] Thus, this wellness survey demonstrates sensitivity for measuring improvements in an already healthy population.

*Validation of survey instrument*

The second objective of the study was the development and validation of a wellness-specific survey instrument. Reliability analyses showed high levels of internal consistency for the physical state, mental/emotional state, stress evaluation, and life enjoyment scale items, indicating that each scale represents a dependable and interpretable measure of its respective theme. The notably, but not problematically, lower alpha coefficient for the physical state scale is not unanticipated given the relatively greater substantive diversity of questions in this scale; it is not necessarily expected that the presence of allergy, for example, will co-occur to a great degree with flexibility of the spine. Moreover, the high reliability of the *combined wellness scale* suggests that efforts to formulate a broad and coherent wellness assessment reflecting the WHO definition of health were realized. The reliability coefficients obtained in this sample for the overall quality of life scale were comparable to values obtained in prior studies with this instrument.[12, 52]

*Validation of retrospective recall*

The strategy developed in this study of asking respondents to retrospectively recall their level of health and wellness before initiating Network Care as well as "presently," represents an integration of the classic pre-post study design with the increasingly recognized importance of assessing health interventions in terms of "patient-centered" outcomes. The differences between the standard deviations and reliability coefficients for the "before Network" scales compared to those for the same scales measured "presently," do not appear to be substantial, suggesting only the increased complexity of the cognitive process involved in recalling prior levels against the standard of present experiences. Moreover, the scale properties across the duration of care groups showed no trend toward greater variability or lower reliability associated with increased length of retrospective recall.

*Retrospective Outcomes Assessment*

The third objective of the present study involved a retrospective outcomes assessment using the data derived from the survey. Results show that statistically and clinically significant changes occurred within the respondent population regarding self-rated health outcomes and quality of life "before Network" and "presently." In this regard, the 70-76% of respondents reporting moderate to large improvement in the four scales of health assessment, and 59% of respondents reporting such improvement in overall quality of life, and effect sizes about 0.9 (clearly exceeding the benchmark for large clinical significance for every measure), substantiate the health promoting premise of Network Care.

Exploration of these perceived health improvements over given time intervals yielded suggestive evidence for the long-term benefits of Network Care. Across the four duration of care groups, progressively higher percentages of respondents (70%, 74%, 79%, 82%) reported clinically meaningful improvement in every measure. Moreover, clinical effect sizes across the four durations of care, averaging a range of 0.8 to 1.2 for the four domains of health assessment, and 0.6 to 1.3 for overall quality of life, attest to perceptions of consistently greater benefits of care as a function of duration of care. This finding also has implications in regard to the concept of maximum clinical benefit, which presupposes a "leveling off" effect.[11] On the contrary, the current findings regarding Network Care suggest that clinical benefits accrue over time, with no indication of a maximum in excess of three years of care.

Similarly, the *"wellness coefficient,"* representative of the difference between the *combined wellness scale* ratings "before Network" and "presently," increased systematically as a function of duration of care. This indicated a continuum of improvement in overall "wellness" while under Network Care, initiated even among those respondents who began care within three months of completing the survey. Even more striking were the proportionally increasing clinical effect sizes across the four duration of care intervals (about 0.1 per year of care), indicating improvement in every index of health measured in this study.

This continuum of improvement in the *"wellness coefficient"* not only reflected the progressively higher "presently" ratings across the four duration of care intervals, but also a progressively lower self-rating of "before Network" scores. This might suggest that those respondents who remained in care longer were in poorer health before initiating Network Care. However, other available information does not support this conclusion. In particular, the overall ranking of health (Table 2, Item I.1) and whether or not the respondent had ever injured their spine, or experienced a physical or emotional trauma, was not significantly associated with duration of care group.

What then accounts for the downgrading of self-reported health status as a function of the duration of retrospective recall? It appears that these broad, patient-centered health measures detect advancements in wellness such that respondents have a new standard against which to gauge their recalled "poorer" levels of health. The interesting exceptions to this pattern were the "before" scores for physical and mental/emotional state which were not significantly different across the four duration of care intervals. Perhaps these more concrete domains are less susceptible to perceptual shifts, and/or are perceived as less relevant to the overall experience of wellness. Further research in regard to the broad concept of health, expressed in the WHO definition, will need to examine the content validity, or differences and relationships between the various domains of health contributing to experienced wellness.

*Construct Validity*

In regard to self-reported health, as with other outcome measures such as pain, quality of life, and depression, there is no "gold standard,"[5] or universe of content accepted as totally adequate to define the quality being measured.[19] Thus, the process of instrument validation "requires a pattern of consistent find-

ings involving a number of different researchers using different theoretical structures across a number of different studies."[19]

While ongoing longitudinal studies will assess the present instrument on a more global basis, the process of estimating its construct validity has begun through the development of a conceptual basis for measuring the theme of "wellness." This was accomplished by incorporating aspects of the WHO definition of health including physical, mental, and social well-being. As anticipated, individuals provided a broad base of information by retrospectively assessing their health "before Network" relative to their present status under Network Care. This permitted conclusions to be drawn regarding perceived change in health through a *"wellness coefficient,"* representing the retrospectively perceived difference in the combined domains of all four reported health scales, which were shown to representatively support and validate a principal theme. Nevertheless, the results from factor analysis suggest that the life enjoyment domain (representing the most understudied aspect of the WHO definition) is somewhat unique in these data, and the effect size for this scale indicates that life enjoyment may be a particularly important aspect of health contributing to perceived wellness. Overall, the *wellness coefficient* as an outcome of Network Care demonstrates clear internal validity.

Since the instrument was comprised of scales surveying established indicators of health status, as well as incorporating a reference scale assessing quality of life, a basis for further evaluation of its external reliability and construct validity was provided. The *combined wellness scale* demonstrated convergent validity with the overall quality of life scale. That is, these separate and combined self-rated health scales produced results comparable to the overall quality of life scale, while the reported reliability coefficients are consistent with those for this same scale applied to a wide variety of subjects in other studies.[12, 14, 15, 52]

While validation of the survey instrument will require its continued application in a variety of settings, initial findings indicate the instrument has a high level of sensitivity in measuring the central theme of "wellness," is reliable, and exhibits internal and external construct validity.

## Summary and Conclusions

Findings of the present study elaborate the importance of characterizing and investigating the efficacy of this non-medical health care practice in accord with its specific objectives. In that regard, evidence is provided which shows that Network Care:

1. Is utilized by a unique population, with socioeconomic, gender distribution, and educational characteristics similar to those seeking other forms of health care different from orthodox medicine.
2. Is associated with significant "retrospectively recalled" improvement in self-rated perceptions of health, wellness and overall quality of life.
3. Results in a large (>0.9) positive clinical effect in every health-related domain investigated.
4. Is associated with significant improvement in self-rated perceptions of "wellness," positively correlated with length of time under Network Care.

Within the boundaries of the study design, these findings provide substantial evidence that Network Care should be included among those practices with established health benefits.

Results of this study have been presented in a manner which permit comparison with data to be derived from continuing longitudinal study of Network Care, as well as future studies of other non-medical health related approaches. Moreover, the newly developed survey instrument, which has initially shown a high level of validity in measuring an underlying "wellness" theme, is an important contribution to further study of the holistic definition originally proposed by the World Health Organization. Repeated use of the survey instrument, or its component scales, by both the non-medical and medical communities, will serve to test its validity as a means through which information can be acquired linking self-rated perceptions of wellness to a variety of health issues.

These initial findings show that Network Care is associated with significant improvement in all indicators of health evaluated, and demonstrate a strong association between Network Care and self-reported, positive change in overall health/wellness. Although these findings are supportive of Network Care, they must be interpreted within the boundaries of a cross-sectional study, i.e., lack of test-retest responses and no control population. For this reason, longitudinal studies, with repeated measures should be undertaken to provide a more thorough assessment of changes over time. The next phase of research underway, involves a longitudinal study to provide such long-term assessment of patients and controls to evaluate dynamic behavior and perceptions of patients under Network Care. This longitudinal study will be combined with laboratory research involving EMG analysis, changes in stress-related hormones, immuno-chemical profiles, computerized platform posturography, and mathematical modeling to further elucidate the neurological/physiological mechanisms underlying Network Care.

## Endnotes

[a] The re-scaling involved simple linear transformations. Each index was created by first summing the equally weighted items (ranging from 9-14) scores to yield composites with theoretical ranges between n (number of items) and n times p (the number of points on the Likert scale — 5 or 7). The transformation was of the form $I_{trans} = (I - n)/(pn - n)$, where I is the index in its original metric and $I_{trans}$ is the transformed index.

[b] Using this conservative strategy, approximately 8% of cases were considered missing on this all domains wellness scale, with most missing on more than one sub-scale. While this is not a problematically high percentage, nevertheless, non-responders were compared to responders in terms of all otherwise available information. No significant differences were found in sociodemographic, health, or health/chiropractic care characteristics which would systematically bias the results of the outcomes assessment.

[c] In addition, because of a perceptible degree of positive skewness in the items/scales, which would violate the statistical assumption of normality, non-parametric versions of all bivariate statistics were also obtained. In every case, the numerical results were highly similar, and substantive results identical.

Based on a desired probability of 0.95 to find a 20% before/presently difference (with a standard error of 2%) to be statistically significant at the 99% confidence interval, calculations indicate a minimum of 21 cases were required.[23] Clearly the bias of small sample size is not an issue in this investigation.

[d] The individual items making up the summated scales show some tendency toward positive skewness on the response code metric (mean scores above the

midpoint of the range), opening the possibility for the operation of these ceiling effects, which can attenuate the difference scores and thus the empirical magnitude of Network Care effects. One advantage of scaling the set of items is that the procedure can diminish this deviation from normality by capturing additional variablity across the set within each individual's scores. Among the "before Network" summated scales, only physical state and quality of life show this above midpoint mean; although all of the "presently" scales are more positively skewed toward wellness, the mean is nevertheless well below maximum. Moreover, the number of potentially affected cases (i.e., those with summated scale scores above 80% of maximum "before Network") was estimated to be at or less than 5.7% of respondents for the individual scales, and only 1.4% (36) cases for the all domains wellness scale. While the mean wellness change score was clearly lower for these small groups than for the sample overall (indicating the operation of ceiling effects), the number of these cases at the maximum presently score (0.95+) was less than 1% , with less than 2% of the overall sample scoring at or above this upper level on present wellness.

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## APPENDIX

Self-Rated Health Scales: The following domains and items were used to assess health, wellness and overall quality of life.

I. Physical State

"Rate the following questions on a frequency scale of 1 to 5, with 1 = never, 2 = rarely, 3 = occasionally, 4 = regularly, 5 = constantly."

1. Presence of physical pain (neck/back ache, sore arms/legs etc.)
2. Feeling of tension or stiffness or lack of flexibility in your spine.
3. Incidence of fatigue or low energy.
4. Incidence of colds and flu.
5. Incidence of headaches (of any kind).
6. Incidence of nausea or constipation.
7. Incidence of menstrual discomfort.
8. Incidence of allergies or eczema or skin rashes.
9. Incidence of dizziness or lightheadedness.
10. Incidence of accidents or near accidents or falling or tripping.

II. Mental/Emotional State

"Rate the following questions on a frequency scale of 1-5, with 1 = never, 2 = rarely, 3 = occasionally, 4 = regularly, 5 = constantly."

1. If pain is present, how distressed are you about it.
2. Presence of negative or critical feelings about yourself.
3. Experience of moodiness or temper or angry outbursts.
4. Experience of depression or lack of interest.
5. Being overly worried about small things.
6. Difficulty thinking or concentrating or indecisiveness.
7. Experience of vague fears or anxiety.
8. Being fidgety or restless; difficulty sitting still.
9. Difficulty falling or staying asleep.
10. Experience of recurring thoughts or dreams.

III. Stress Evaluation

"Evaluate your stress relative to the following, with 1 = none, 2 = slight, 3 = moderate, 4 = pronounced, and 5 = extensive."

1. Family.
2. Significant Relationship.
3. Health.
4. Finances.
5. Sex Life.
6. Work.
7. School.
8. General well-being.
9. Emotional well-being.
10. Coping with daily problems.

IV. Life Enjoyment

"Rate the following questions on a degree scale of 1-5, with 1 = not at all, 2 = slight, 3 = moderate, 4 = considerable, 5 = extensive."

1. Openness to guidance by your "inner voice/feelings."
2. Experience of relaxation or ease or well-being.
3. Presence of positive feelings about yourself.
4. Interest in maintaining a healthy lifestyle (e.g., diet, fitness, etc.).
5. Feeling of being open and aware/connected when relating to others.
6. Level of confidence in your ability to deal with adversity.
7. Level of compassion for, and acceptance of, others.
8. Satisfaction with the level of recreation in your life.
9. Incidence of feelings of joy and or happiness.
10. Level of satisfaction with your sex life.
11. Time devoted to things you enjoy.

Overall Quality of Life (Woodruff and Conway, 1992)

"Evaluate your feelings relative to the quality of your life with 1 = terrible, 2 = unhappy, 3 = mostly dissatisfied, 4 = mixed, 5 = mostly satisfied, 6 = pleased, 7 = delighted."

1. Your personal life.
2. Your wife/husband or (significant other).
3. Your romantic life.
4. Your job.
5. Your co-workers.
6. The actual work you do.
7. Your handling of problems in your life.
8. What you are actually accomplishing in your life.
9. Your physical appearance - the way you look to others.
10. Your self.
11. The extent to which you can adjust to changes in your life.
12. Your life as a whole.
13. Overall contentment with your life.
14. The extent to which your life has been what you wanted it to be.

TECHNIQUE

# Network Spinal Analysis: A System of Health Care Delivery Within the Subluxation-Based Chiropractic Model

*Donald Epstein, D.C.*

**Abstract** — The theoretical basis and clinical application of Network Spinal Analysis (NSA) is described. NSA delivers health care within the subluxation-based chiropractic model and seeks to contribute to the distinction of the various techniques and methods within the profession by describing and discussing its major characteristics. In this regard, clinical observations relative to the application of the Network Protocol have been described in relation to the monitoring of patient and practitioner outcomes. Relevant research from a separate Network Care retrospective study, which impacts on its characterization, profiles the patient population as predominantly female. Other data indicates that Network Care is widely and consistently practiced. Additionally, patients report significant, positive changes in health-related quality of life measures linked to certain clinical components of Network Care.

*Key Words: Network Spinal Analysis, Chiropractic, Alternative Health Care, Outcomes Assessment, Vertebral Subluxation.*

## Introduction

Chiropractic is rich in its diversity of approaches,[1-2] variously referred to as techniques, methods, or specialties. As the wide range of approaches have certain principles in common, it is important for each to describe and document its tenets. This is both beneficial to the inquiring public, and informative to practitioners and the scientific community at large; assisting in distinguishing chiropractic approaches from one another, as well as from other forms of health care.

There has been a dramatic shift in public perception of health care as evidenced by the recent emergence into the mainstream, of many different types of alternative health care; [3] some emphasizing wellness care as the objective, while others focus on the objective of alleviating symptoms and treating disease, thus representing unorthodox or complementary medicine. [4] The reported increase in public participation in these programs[5] increases the importance and need for developers of each chiropractic approach to describe their rationale, objectives, protocols, and report outcomes. This allows for scrutiny of any given approach while increasing, in general, public awareness of chiropractic and its many benefits.

The level of scientific evidence which addresses each of these topics will assist in the evaluation of the validity of a given chiropractic approach. While it is understandable, and expected, that newer approaches will draw from a smaller body of evidence than the more well established approaches, it is incumbent upon proponents to conduct on-going programs of research designed to investigate its theory, application and methods. It is also expected that well-established approaches will have on-going research programs to continuously expand and refine understanding and affect positive modifications in patient care.

Ongoing inquiry is also driven by the need to guarantee public safety and professional reliability, as well as demands by state and federal oversight committees. In this regard, it is important to demonstrate that an approach is being administered consistently among its practitioners who adhere to the same objectives, methods and professional guidelines.

This paper presents a characterization of Network Spinal Analysis (NSA), also referred to as Network Care. Its objective, subluxation hypothesis, and clinical application are described. Pertinent outcomes which 1) reflect Network Care methods, 2) assess its general acceptance, 3) report consistency of care, and 4) indicate wellness benefits, are reported elsewhere (Blanks RH, et al, in preparation; Dobson M, et al, in preparation) in conjunction with an on-going research program.

### *Description and Objective*

NSA is an approach to health care, utilizing certain long-standing chiropractic methods and employing certain principles of quantum mechanics,6 neuroanatomy and neurophysiology, [7-9] psychoneuroimmunology,10 and changing perspectives in health care. [11-12] The clinical practice of NSA involves a specific system of classifying vertebral subluxation, which was originally developed in 1982, and administered as Network Chiropractic. In 1985, a clinical Phasing System was added. In 1994, the Phasing System was formally organized into three specific Levels of Care. The system of vertebral subluxation classification and

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Phasing System is referred to as the Network Protocol. Although the rationale, theory, and sequence of adjustments within the Phasing System has remained the same, the introduction of Levels of Care resulted in Network Chiropractic being supplanted by Network Spinal Analysis. Consequently, in this paper, in all areas except reference to the clinical aspects of the Levels of Care, Network Chiropractic and NSA (Network Care) are used interchangeably, or collectively as the Network Approach.

The objective of NSA is to assess and correct two classes of vertebral subluxation; facilitated subluxation and structural subluxation, using safe, "hands on," low-force adjustments of the spine and its contiguous structures.

*Subluxation Hypothesis*

The clinical application of NSA is based on an expansion of the traditional description of vertebral subluxation13 and later development of the vertebral subluxation complex, [14] in which vertebral subluxation arises from a provoking or deleterious stimulus which produces a sequence of events; specifically 1) misalignment of adjacent vertebrae, 2) narrowing of the intervertebral foramina, 3) subsequent tissue or fluid-related pressure on the nerve root, and 4) a resulting interference to the "flow of mental impulses," [13] or otherwise described as "nerve interference"14 in the vertebral subluxation complex model. While considerable direct evidence supports the first three components of this model, [15-25] the fourth component is not readily measurable. While the boney subluxation is assessed by clinical, neurological, and chiropractic procedures, [26-27] it remains to be demonstrated how these assessments are linked to the "nerve interference" component of subluxation. Indeed, the term "mental impulse" currently lacks strict scientific description, and the term "nerve interference" is also vague. Nevertheless, investigation regarding neuronal axoplasmic flow[28-30] and the re-framing of neurotransmission as the flow of neuropeptides and other "informational substances"[31] lends credence to the fourth component, and opens promising avenues for research and greater understanding of this component of vertebral subluxation.

Using this model, the rationale for NSA is that the minimum four components of vertebral subluxation may arise in any sequence, depending on the provoking stimulus which can be physical, emotional, and/or physiological events impacting the body. More specifically, when these events exceed the limits of the adaptive response of the nervous, meningeal, musculoskeletal and humoral systems, a sequela is initiated which leads to the formation of vertebral subluxation. These relationships are presented in Figure 1.

The basis for this rationale has been recently provided by Panjabi who describes three "subsystems" 1) passive/ligamentous, 2) active/musculotendenous, and 3) neural control. [32] When functioning within their adaptive limits, these three subsystems act synergistically to provide overall stability to the spine. Panjabi further states that loss of stability to the spine can result when any of the "subsystems" succumbs to injury, degeneration, and/or disease. Further, various deficiencies are perceived by the neural control subsystem which then attempts to compensate through the active/musculotendenous subsystem. Even though short-term spinal stability may be maintained by the neural control and active/musculotendenous subsystems, the long-term effects are often deleterious to the spine (e.g., accelerated degeneration of spinal column components, muscle spasm, injury, and/or fatigue). Panjabi emphasizes that over time the consequences of long-term adaptation may be chronic dysfunction, pain and loss of spinal stability.

NSA recognizes the dysfunction scenario described by Panjabi as also giving rise to two categories of vertebral subluxation. One of these is the traditional structural subluxation and the other is a facilitated subluxation. While both subluxations manifest the same minimal components (osseous misalignment, foraminal encroachment, nerve root pressure, and nerve interference), they differ in the way in which they are initiated and as to which component is primary.

The Class A, or structural subluxation, is thought to be initiated by a mechanical or physical stress imposed on the body. In this type of subluxation, the vertebral misalignment is the initial event, and nerve interference is a secondary consequence.

The Class B, or facilitated subluxation, is thought to be initiated by the phenomenon of adverse mechanical (meningeal) cord tension, first described by Breig. [7] NSA proposes that adverse mechanical tension in the spinal cord is promoted by, or arises from, acute or chronic facilitation. Thus, in Class B subluxation, nerve root pressure associated with adverse mechanical tension in the spinal cord is primary, and the osseous misalignment component is a secondary result of adaptive neuromuscular changes.

Facilitation occurs when a number of subthreshold stimuli (which may be noxious stressors such as cord tension, toxins, or microtraumas) are synchronously activated by any single threshold stimulus. This results in an abnormal sensory and motor response which is disproportionate in magnitude to the initiating stimulus. The spine is in a hyperactive or over-responsive state when it exhibits facilitation. [33]

The importance of chronic facilitation, which elicits hypermotor responses to a buildup of

subthreshold sensory input, is that it may affect spinal integrity, or stability. Spinal integrity is at risk if the motor activity elicited by facilitation promotes hyperactivity of paraspinal musculature leading to osseous misalignment, or through dural stretching leading to elongation or torquing of the spinal cord, directly or indirectly compressing the nerve root. [8] Either or both of these situations may be involved in the formation of facilitated vertebral subluxation.

In order to effectively reduce vertebral subluxation, NSA is first concerned with reducing facilitation arising in the spinal cord. If unresolved, this state gives rise to recurring Class B vertebral subluxation, despite frequent corrective adjustments by the practitioner. Once facilitation has been reduced or resolved, then Class A, (structural) subluxations, if present, are more easily corrected. Overall, the ability of the practitioner to distinguish and address these two types of subluxation is important to effective short- and long-term management of the patient. Since the condition of vertebral subluxation is postulated to diminish the body's adaptive abilities, with a subsequent loss of natural health including healing or repair, the clinical goal of NSA to reduce this condition, is supportive of the health seeking trend evident in today's society.

**Methods: Clinical Application of NSA**

In Network Spinal Analysis, the Network Protocol has two clinical aspects, the subluxation classification system, and the Network Phasing System. The first, involves the characterization of Class A (structural) and Class B, (facilitated) subluxation. The two categories of subluxation can exist alone, or simultaneously, overlapping at the same segmental level. Furthermore, a Class A subluxation can exist at one segmental level and a Class B subluxation at another. Figure 1 illustrates the etiologies of both classes of subluxation.

The second aspect is concerned with identifying the osseous segment(s) to be adjusted. The system has five Phases, each correlated with specific osseous segments and spinal cord tension. Biomechanical and palpatory findings, combined with other clinical observations, serve as indicators to guide the practitioner in the determination of which Phase is presenting in the patient. Once these correlations are determined, contact on specific osseous segments is made, with appropriate applications of low force to affect an adjustment. This often induces movements of the spine which reduce facilitation within the spinal cord. These movements also promote correction of the misalignment component of the associated vertebral subluxation, which is adaptive to, or in complex with, the spinal cord tension.

*Levels of Care*

The Phasing System is administered sequentially through three levels of care. A fourth level is currently being investigated. Each level is designed to coincide with a specific set of desired clinical outcomes combined with the patient's assessment of functional status and indicators of health-related quality of life.

A flow chart depicting the clinical scheme of patient evaluation, plan of care, and assessment is presented in Figure 2. All Levels of Care utilize aspects of contemporary chiropractic adjusting techniques and share the following features:

(a) Assessment of the patient's spinal health through a case history and chiropractic examination;

(b) Determination of progress through physical re-assessments and questionnaires to monitor patient and practitioner outcomes; and

(c) Modification of any level of care, deemed to be ineffec-

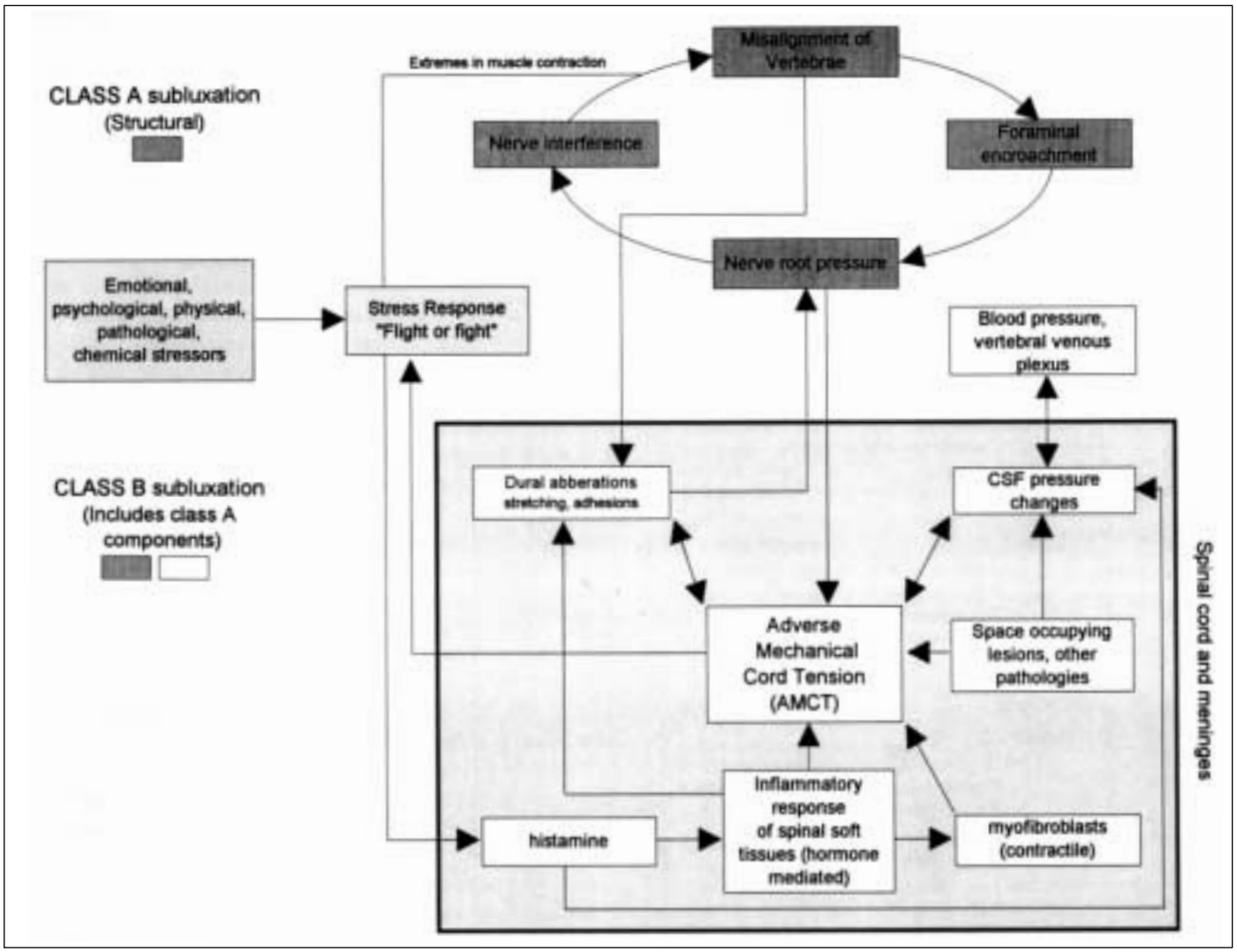



**Figure 1. Relationship between Class A (Structural) and Class B (Facilitated) subluxations in regard to physical, physiological, and emotional factors. The arrows suggest that these factors may promote either or both of the two types of subluxation, either of which may then promote the formation of the other. (Source: Epstein D. Position Paper on the Theoretical Basis and Clinical Application of Network Spinal Analysis (NSA) 1995, Longmont, CO. Innate Intelligence, Inc.).**

tive or inappropriate, to a level which more accurately parallels changes observed in the patient.

**Level One (Basic Care):**

*Description and Objective:*

Level One care is introductory care for new patients, or re-initiation of care following trauma or other periods of stress. The objective is to reduce facilitated (Class B) subluxation to the extent that adaptive muscle contraction patterns are relaxed. This allows the spine to be more flexible in its range of motion, thereby alleviating previous postural maladaptations. Clinical observation indicates that Class B, facilitated subluxations, return frequently in patients who have not experienced substantial reduction of facilitation in the spinal cord.

*Clinical Observations:*

The practitioner notes changes in objective and subjective signs of vertebral subluxation. The assessments and clinical indicators most commonly used in determining the presence of vertebral subluxation and its further characterization are found in Table 1.

Figure 3 is a flow chart of the clinical Phasing System. Since the chart represents all currently observed possibilities, the pathways leading to identification of two common clinical phases are outlined to illustrate how decisions are handled in the Phasing System. The first test in all instances is the leg check. The first patient illustrated presents with a short leg (right bold line, Fig. 3) and other findings. Contacts were taken to correct an anterior-inferior sacrum with the final result (•), resolution of indicators, being achieved. The second patient illustrated presents with balanced legs (left bold line, Fig. 3). Additional testing led to a contact made at C2/sacral apex resulting in a resolution of indicators (•). Positive indicators are assessed post-adjustment to determine the efficacy of the corrective force applied.

Clinical notations are also made of regions of the spine that stretch or spontaneously move with the adjustment of other segments. For example, adjustment in the cervical region is often accompanied by movement in the lumbar or sacral regions of the spine. This is manifest through muscular and bony movement as subluxated segments related to spinal cord tension receive a self-directed corrective force.

Reduction of spinal facilitation is often accompanied by a smooth, rhythmic muscular movement, which is synchronized with deep respiration. When fully developed, this movement emanates from the sacrum to cranium, segment by segment, exhibiting muscular expansion along the axial and anterior/posterior planes simultaneously, and is referred to as a "Respiratory Wave."

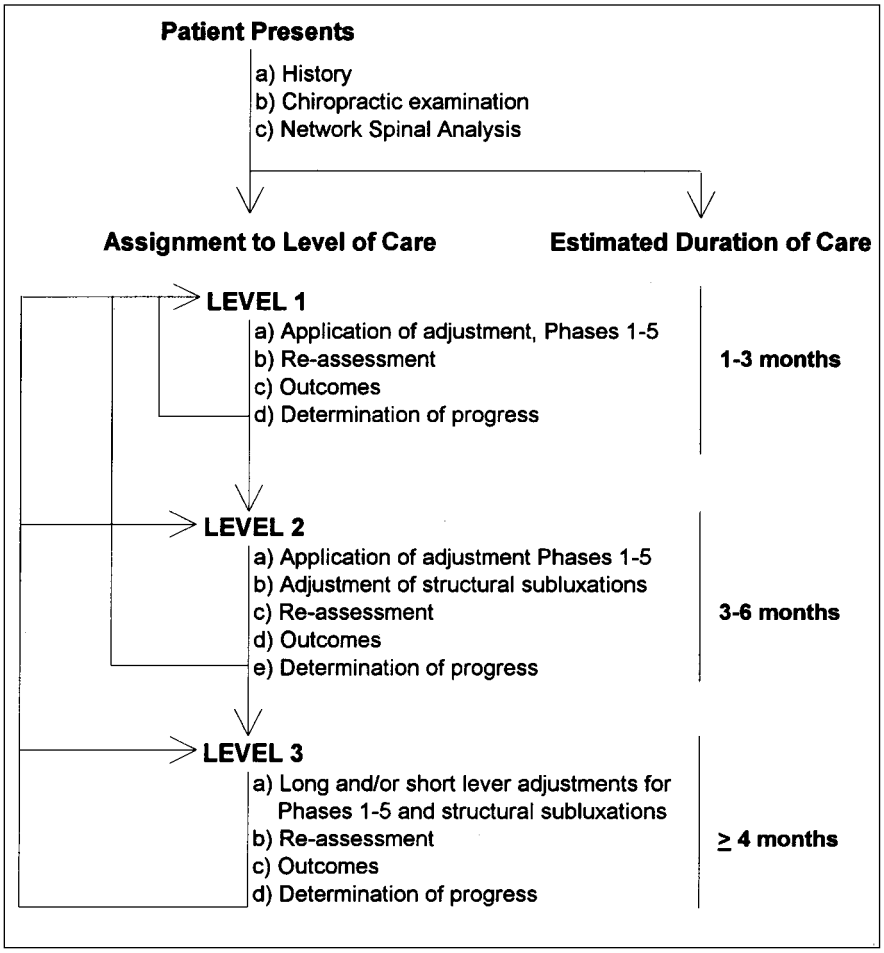



**Figure 2. Network Spinal Analysis Plan of Care in regard to patient assessments, re-evaluations, outcomes, and estimated duration of care. The schematic represents the progression of patient assessments through the three current Levels of Care. Evaluation of outcomes at each level determines if the patient will remain in that level, return to the previous level for intermittent care, or move to the next highest level of care (as indicated by the arrows).**

*Duration of Care and Clinical Assessments:*

Level One care generally requires one to three months, with recommended visits of three time per week. During this level of care, a "spinal health" education program is made available to the patient. The program discusses the normal spine and its functions in contrast to a spine exhibiting vertebral subluxation. Concepts such as facilitated subluxation, and signs of improved spinal function such as; the importance of spinal flexibility, respiration, and natural tone associated with spinal integrity, are presented verbally, and supplemented with take-home literature.

A re-examination is performed no later than eight weeks under care, to determine the patient's progress. During this level of care, the practitioner also records findings and maintains information to evaluate the plan of care. Additionally, a questionnaire is given to the patient at the beginning of care and at the re-examination period to assess their personal progress, health related quality of life, and lifestyle changes. If the spine has recovered from the subluxation patterns formed by chronic facilitation, there will be a demonstrable enhanced range of motion, with improved synergistic movement between vertebrae and associated musculature. This is accompanied by an improved muscle tone, deeper respiratory rhythm, and early signs of

quality of life changes (e.g., reduced stress, increased energy).

The end of Level One care is signaled when chronic facilitation is substantially reduced in the spine. At the end of Level One care the patient should have an appreciation of the movements and natural rhythms of their spine.

**Level Two (Intermediate Care):**

*Description and objective:*

Patients beginning Level Two of care (Figure 2) will have recovered substantially from the presenting patterns of spinal cord facilitation, and restricted movements, etc. Often, new areas of facilitation arise due to any number of physical, physiological, or emotional variables. However, since new areas of facilitation have not had time to produce secondary (accumulative) maladaptive patterns, the associated vertebral subluxations are more likely to resolve quickly under Level Two care due to improved synergy of spinal components.

Class A (structural) subluxations, which may arise from environmental trauma (Figure 1), are first addressed in Level Two of care, since the body is more accepting of structural adjustments in the absence of chronic underlying facilitation. Any number of adjusting techniques can be utilized. [1] However, the force applied is minimal to moderate, never extreme. The objective of Level Two is to achieve correction of facilitated and structural subluxation and, if only temporarily, the elimination of any "new" or acute facilitation which produces Class B subluxation.

*Clinical Observations:*

A spontaneous movement of the body, found in NSA, may begin during this level of care. This movement, is referred to as a "Somatopsychic Wave." When fully developed, it is observed as a coordinated wave motion of the major muscle groups, primarily of the back and spine. The wave may originate in the sacrum or occiput and progress to the opposing end of the spine. It may also involve only the neck, or may encompass several regions simultaneously or synchronously such as the arms, legs, and shoulders. As described above for the Respiratory Wave, it is believed to be corrective in nature, gently rocking the affected segments through their range of motion. Even though these waves are not induced consciously, they may be consciously ceased at any time. Although the Somatopsychic Wave may be restricted, during Level Two of care, to a gentle rocking of the spine, the Respiratory Wave (described in Level One of care) will be experienced fully throughout the spine.

*Duration of Care and Clinical Assessments:*

Level Two care currently requires three to six months, with recommended visits of a minimum of two times per week. The same indicators used in Level One care are used for the identification and/or characterization of the vertebral subluxation (Table 1).

Assessments in this level may be complemented with instrumentation (Table 1), such as surface EMG[34] or thermography, [35] in order to gain a complete, objective profile of spinal patterns. The practitioner performs a re-evaluation of the patient and plan of care at two months into Level Two care. Re-evaluation is repeated in two month intervals until a determination is made in regard to progression to Level Three. In two month intervals, patients are asked to self-report various items, dealing with their perception of changes in their body, using a questionnaire format. They are also asked to comment on occurring traumas, and lifestyle changes.

Level Two of care is considered complete when there is; 1) no consistent re-appearance of facilitated subluxation, 2) a coordinated Somatopsychic Wave, 3) a Respiratory Wave manifested as muscular movements (expansion in the AP and axial planes) synchronous with respiration throughout the spine, 4) spinal contours which are flexible and segments that appear to move in a coordinated fashion without intermittent segmental fixation, 5) effective elimination of vertebral subluxation following corrective adjustment, and 6) exempting any traumatic events, no return of vertebral subluxation in a compensatory cycle.

**Level Three (Advanced Care):**

*Description and Objective:*

This level of care is administered to individuals who present with spines free of generalized facilitation (and associated spinal cord tension) or to those exhibiting compensatory structural subluxation. Generally, patients who are in Level Three seek care as a means of enhancing their overall health, not for the alleviation of symptoms or a cure for a particular ailment; consequently, they are referred to as "practice members," as opposed to "patients."

Individuals under Level Three of care present with a spine that is consistently flexible and, as a result of less frequent recurring segmental fixation, exhibit greater segmental synergy. In Level Three care the body has coordinated the Somatopsychic

**Table 1**
Spinal Assessments for Vertebral Subluxation*

| Assessments (Recommended) | Instrument Assessments (Optional) |
|---|---|
| **1. Hard Tissue Palpation** | **1. Physical Analysis** |
| a. Restriction | a. Plumb Line |
| b. Fixation | b. Photography |
| c. Misalignment | c. Moire photography |
| d. Hypermobility | d. R.O.M. measuring devices |
| e. Postural shifts | e. Cine radiography |
| **2. Muscle Palpation** | f. Bilateral weight scales |
| **3. Phase Indicators** | **2. Physiological/Neurological** |
| f. Short Leg Syndrome (Derifield) | g. Temperature patterns |
| g. Heel tension | h. Imaging |
| h. Elevated leg | i. Surface EMG |
| i. Cervical syndrome | j. Biochemical profiles |
| j. Ankle Eversion Stress | k. EEG |
| k. Leg adduction/abduction | l. Muscle testing |
| l. Z-flick | |
| m. Leg crossover (positive ilium) | |
| n. Sacrotuberous ligament tension | |
| o. Sacral/thoracic correlation | |
| p. Respiration changes | |
| **4. Observation of Respiratory & Somatopsychic waves** | |

*The assessments and indicators currently used in NSA have been observed to be adequate to fulfill its objective; but are not intended to exclude other assessments or indicators which may be of equal value in the evaluation and characterization of vertebral subluxation.

*Source: Epstein D. Position Paper on the Theoretical Basis and Clinical Application of Network Spinal Analysis (NSA). Longmont, CO: Innate Intelligence, Inc. 1995*

Wave from sacral to cranial ends of the spine. Respiratory and Somatopsychic Waves radiate through the spine and/or extremities in synchronous, longitudinal, and coherent patterns.

A distinguishing feature of this level of care is the means by which subluxation correction is addressed. Frequently, the approach is to use an extremity as a long lever, or the head as a short lever, to position the spinal contours and optimize the "waves" thereby enhancing self-correction of the vertebral subluxation. The force of adjustments administered in Levels One and Two is also modulated in Level Three care.

*Clinical Observations:*

The practitioner observes and notes subluxation patterns using the indicators presented in Table 1. Effects of the Respiratory and Somatopsychic Waves are also observed and noted with regard to the efficacy with which subluxation patterns are corrected by these movements.

*Duration of Care and Clinical Assessments:*

Although the duration of care for Level Three is projected to be at least four months, the exact duration is yet to be determined. This uncertainty arises since Level Four care will involve those who no longer exhibit generalized facilitation within the spine and have developed coordinated Respiratory and Somatopsychic Waves to the extent that self-correction is consistent. Currently, even the most advanced recipients of NSA have intermittent periods when Level One and Level Two care is required. Only continued application of NSA to its current pool of recipients will permit a more meaningful determination of the duration of care for Level Three.

The practice member, during this level of care, is educated and encouraged to refrain from conscious interference to the body's natural movements. Since the wave phenomena can be consciously over-ridden at any time, it is important for the practice member to understand what the body is attempting to achieve. In this sense, the practice member is encouraged to "act in harmony" with the self-induced movements.

The practitioner evaluates the spine closely during this Level to assess whether the spine is maintaining its integrity or reverting back to a state requiring Level One or Level Two of care. This assessment is important as a duration of care for this level is yet to be determined; ultimately resting on the length of time required for practice members to consistently maintain the level of spinal stability with which they entered into Level Three care.

**Table 2**
Effect of Awareness of Somatopsychic Wave Movements or Respiratory Wave in Network Patients' Wellness Index Outcomes.

| Index | Somatopsychic Wave: Aware (mean ± S.D.)** | Somatopsychic Wave: Not Aware (mean ± S.D.) |
|---|---|---|
| Physical State | 0.65 ± 0.45 | 0.40 ± 0.51 * |
| Mental/Emotional State | 0.75 ± 0.67 | 0.45 ± 0.56 * |
| Life Enjoyment | 0.73 ± 0.68 | 0.42 ± 0.54 * |
| Stress Evaluation | 0.88 ± 0.83 | 0.53 ± 0.73 * |
| Quality of Life | 1.07 ± 1.03 | 0.54 ± 0.82 * |
| | **Respiratory Wave** | |
| | Aware (mean ± S.D.) | Not Aware (mean ± S.D.) |
| Physical State | 0.65 ± 0.56 | 0.40 ± 0.49 * |
| Mental/Emotional State | 0.76 ± 0.20 | 0.38 ± 0.47 * |
| Life Enjoyment | 0.74 ± 0.67 | 0.33 ± 0.49 * |
| Stress Evaluation | 0.88 ± 0.83 | 0.47 ± 0.65 * |
| Quality of Life | 1.05 ± 1.03 | 0.53 ± 0.75 * |

* Statistically significant using Mann-Whitney one way analysis of variance (P<0.001).

**Mean scores (±S.D.) are composite scores derived from indices measuring wellness-related parameters in Blanks et al. (in preparation). A higher score indicates greater reported change between "Before" scores and scores "At Present."

## Outcomes

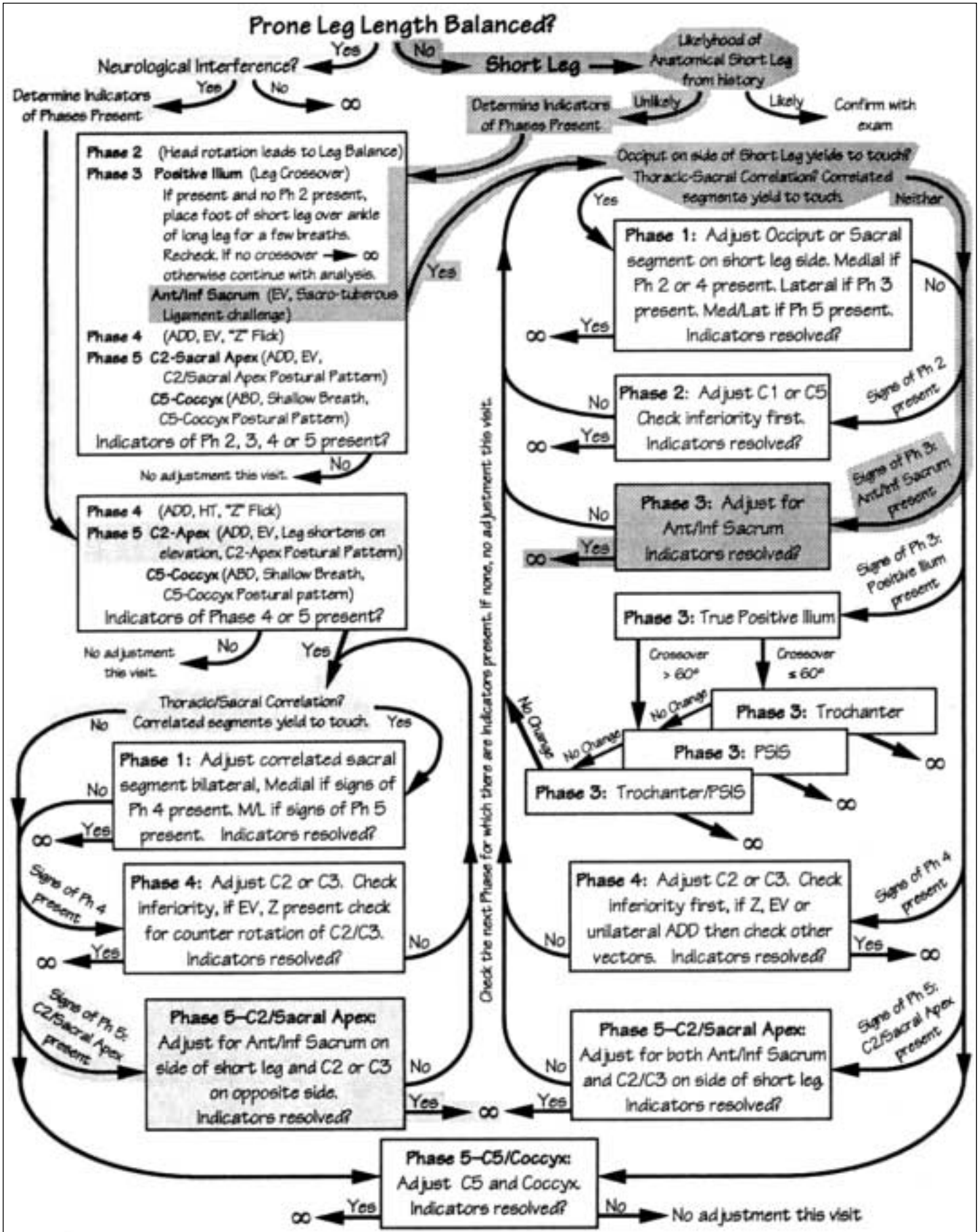
Proponents of the Network Approach have considerable interest in several issues relating to its theoretical basis, practice as a health care discipline, and its effects within the recipient population. The following questions have been addressed as a first step in elucidating this approach to the correction of vertebral subluxation:

1. How wide spread is the Network Approach?
2. What are the demographics of recipients under care relative to age, gender, ethnicity, occupation, education, and income etc?
3. Is the Network Approach practiced consistently across geographic regions?
4. What is the occurrence and time of onset of the Respiratory and Somatopsychic Waves?
5. Are recipients satisfied with the care?
6. Are there wellness benefits?
7. Do the Respiratory and Somatopsychic Waves influence the outcomes of care?
8. What aspects should be studied next?

## Findings

A retrospective study was recently conducted by Blanks et al. (in preparation) between November, 1994 and April, 1995 among an estimated 13,200 patients receiving Network Care. The study results which provided information relative to the questions posed above, were based on 2,818 responses, or 22% of the estimated pool of recipients. Additionally, the study reported five variables, as they related to five wellness indices.

**➞ Figure 3. (On page 57) Vertebral subluxation phases determined by leg length and other indicators. This flow chart represents the full range of combinations of major indicators of facilitated subluxation currently used in NSA. However, not all indicators may be present. Facilitated subluxations are identified in five Phases, each being a combination of specific segments linked to specific patterns of adverse spinal cord tension observed through indicators of musculoskeletal aberrations or dysfunctions. Two typical pathways are shaded as examples of the "logic tree" employed in determining the presenting vertebral subluxation phase.**
**ABD - Stress upon prone passive abduction of leg(s); ADD - Stress upon prone passive adduction of leg(s); EV - Stress upon prone passive eversion of heel; HT - Stress upon prone passive flexion/extension of heel; Z - "Z" Flick occurs upon prone head rotation if there is a flicking movement of one or both legs; Leg Crossover -The prone short leg becomes long during passive bending of legs at knee; Ph 5: C2/Apex Postural Pattern - Elevated shoulder and/or hip. Torso flexed from thoracics sitting.; Ph 5: C5/Coccyx Postural Pattern - Flat or reversed cervical curve in prone position.**
**∞End point of evaluation, indicators have resolved.**




*(Source: Epstein D. Position Paper on the Theoretical Basis and Clinical Application of Network Spinal Analysis (NSA) 1995, Longmont, CO. Innate Intelligence, Inc.)*

While the specifics of methodology and findings of the retrospective investigation will be reported in a separate paper, some general aspects of the study and other information not included in the Blanks et al. manuscript are reviewed in this paper.

Patients participating through questionnaires were randomly generated from the offices of practitioners representing 34 states in the U.S., and Puerto Rico, as well as two foreign countries, Australia and Canada. Female patients predominated. Interestingly, this finding is consistent with reports over the last several years demonstrating a distinct gender bias in conventional and unconventional medicine. [36-37] The gender bias in this study has been further investigated by Dobson et al., (in preparation) for comparison with these other reports.

From the 330 practitioners contacted, 116 also responded to a Doctor's Questionnaire. Eighty-three percent of these practitioners reported using the Network Approach exclusively. Of this group, ninety seven percent performed an analysis for the presence of vertebral subluxation on every visit, and an average of 95% routinely used the indicators recommended in the Network Approach (Table 1). These finding suggest that the Network Approach is applied consistently over the range of practices responding.

Since the wave phenomena observed in patients are believed to be associated with the correction of vertebral subluxation, as well as a process involved with diminution of facilitation in the spine, it was of interest to evaluate "wave awareness" relative to wellness benefits. This hypothesis was tested by evaluating the 5 wellness indices as a function of those experiencing or not experiencing the Respiratory and/or Somatopsychic Waves. A significant increase in positive self-reporting in all five indices was shown for those experiencing the wave phenomena, as opposed to those who had not (Table 2).

Additionally, practitioners were asked whether they had observed significant (positive) changes in vertebral subluxation indicators in patients that had not experienced the wave phenomena as opposed to those who had experienced either the Respiratory Wave and/or the Somatopsychic Wave. Ninety-five percent of practitioners reported that the greatest change in indicators was observed in patients who had experienced only the Respiratory Wave, while (91%) observed changes in subluxation indicators in patients that had experienced both phenomena. Fewer (64%) observed changes when only the Somatopsychic Wave had been experienced.

The significance of the practitioner responses with regard to positive changes in subluxation indicators in patients experiencing the Respiratory Wave, or both of the "Waves", as opposed to experiencing only the Somatopsychic Wave, will have to be determined from additional study.

In summary, it is apparent that changes which suggest resolution of subluxation to the practitioner, are more evident in patients that have experienced the Respiratory Wave and/or the Somatopsychic Wave. This parallels the higher ratings in wellness measures by the patients actually experiencing the waves (Table 2). These collective responses clearly indicate the significance of these phenomena relative to an enhanced perception of wellness as determined in wellness measures. It is of interest, therefore, to pursue these findings as they impact with other factors believed to influence individual health.

**Discussion**

These findings are supportive of the positive benefits of the Network Approach to health care using the subluxation-based chiropractic model. It will be of interest to follow the population of patients under NSA care to re-examine the demographic distinctions and wellness outcomes which characterized the population in the retrospective study by Blanks et al.

The strong gender bias also observed in the retrospective study was found to be consistent with other studies which report similar findings in conventional and unconventional or alternative medicine. [36-37] In this regard, Dobson et al. ( in preparation ) provide an interesting insight on the significance of gender in reporting health care outcomes, as well as possible explanations for why a gender bias exists in the patient population receiving Network Care. This information has also served as an alert to Network practitioners to recognize that males and females apparently have different reasons and needs for seeking care, as well as the fact that they report differently in regard to wellness outcomes. Future research will need to address the issue of gender to achieve realistic clinical goals and to improve the wellness care delivery with NSA.

From the retrospective studies conducted, it is apparent that the Network Approach is practiced widely and consistently. However, more definitive confirmation as to the efficacy of NSA awaits the results of longitudinal, clinical trials providing more specific data on outcomes. In this regard, it will also be necessary to conduct follow-up questionnaires to evaluate the influence of administering the Phasing System through specific levels of care to ascertain effects on the various parameters of practitioner and patient outcomes, and to further demonstrate consistency in its application.

Future studies will be aimed at characterizing the biological basis of the wave phenomena, as they have been shown to positively impact on self-reported wellness indicators. Additional study is underway to investigate physiological changes in subjects under care. The positive responses derived from the retrospective study suggest that an improved ability to cope with stress is a positive benefit of care. Relative to this finding, a longitudinal study is scheduled to commence which investigates changes in stress-related hormones of the pituitary-adrenocortical axis. Although other forms of health care also report enhanced stress adaptation, little has been done to evaluate the physiological events which accompany these observations. Consequently, it is imperative to link anecdotal reports of wellness outcomes to substantive physiological measurements in order to clarify the processes through which these benefits occur.

The research conducted to this date, along with the ambitious research program planned for the immediate future, has been designed to accept the challenge of stating and studying the theoretical basis of NSA, describing its benefits, and rigorously reporting patient outcomes. The objective of this type of investigation is to provide the scientific community and public at large with a body of knowledge concerning NSA which permits an evaluation of its value in the health care area; ultimately determining the extent of its utilization.

## NSA Training

NSA is currently taught to doctors of chiropractic and chiropractic students at the postgraduate level. Seminars are offered across the U.S. and abroad several times per year. The complete program of seminars is presented under the auspices of the Innate Intelligence, Incorporated. In 1997, only candidates successfully completing practical and written examinations will be certified to practice NSA.

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