Neurovertebral Influence on Visceral and ANS Function: Some of the Evidence To Date - Part II: Somatovisceral

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ABSTRACT: *Objective:* This paper presents a discussion concerning an element of the chiropractic model. It follows the second link of the Somatosensory-Autonomic-Visceral chain (the SAV Triad) and its integration with manipulative aspects of the manual health sciences. *Design:* It is a cursory overview of the published literature from the four main professions with interest in the topic. *Method:* A search of reference lists from electronic and printed sources was conducted and relevant citations extracted. *Presentation:* The format of presentation essentially denotes the large volume of papers, their professional association, evidential level, as well as variety of topics or conditions addressed. Historical and international features are appended. Conclusion: In the absence of evidence to the contrary, there appears to be extensive if not overwhelming evidence as to the potential for a manual model for positively influencing the autonomic nervous system and through that, internal pathophysiology and symptoms. There does however appear to be a need for further research, both into the neurophysiology of the complex spine-related mechanisms involved, and clinical studies to assess areas of limitations and efficacy.

INDEX TERMS: MeSH: AUTONOMIC NervOUS SYSTEM; CHIROPRACTIC; MANIPULATION, SPINAL; SOMATOSENSORY DISORDERS; Other: SOMATO-AUTONOMIC; SOMATOVISCERAL; VERTEBRAL SUBLUXATION COMPLEX.

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INTRODUCTION

"The term 'autonomic' is a convenient rather than appropriate title, since the functional autonomy of this part of the nervous system is illusory. Rather its functions are normally closely integrated with changes in somatic activities, although the anatomical basis for such interactions are not always clear…...A more realistic notion is that these sets of neurones (Sympathetic NS and Parasympathetic NS -au) represent an integrated system for the coordinated neural regulation of visceral and homeostatic function……Rises in blood pressure and pupillodilation may result from the stimulation of somatic receptors in the skin or other tissues." Standing S. Grays Anatomy[1]

An extrapolation of the above Standing extract from Grays Anatomy could suggest that if such organic structures affecting blood pressure and pupillary dilation can be influenced by *somatic stimulation*, it would seem a reasonable proposition that chronic stimulation in the form of somatic irritation – for instance from nociceptive articular structures – may result in other adverse physiological influences. And further, that removal of this irritation may alleviate the severity, frequency and/or duration of symptoms, or potentially reverse the adversely influenced neuropathophysiology towards normal physiological status.

Following the earlier overview of published neurophysiological papers concerning disturbed somatic influence upon autonomic function and pathophysiological dysfunction[2], this paper presents a further overview of the next link, one of apparent somatovisceral conditions and symptoms via the autonomic-visceral connection. It encompasses papers concerning the relationship of this dysfunction primarily with the manual therapies, both through research and/or clinical observations. This paper is designed to outline examples of the quantity, type and variety of material published so far - it is not intended as an in-depth or meta-analysis-type study.

Essentially, these two papers are aimed at depicting an overview of the literature, citing papers which are concerned with the association between spinal (somatic) dysfunction, disturbance of the autonomic nervous system (ANS) (neuropathophysiology), and the subsequent ANS effect on visceral physiology (pathophysiology). More specifically, they relate to the concept of vertebrogenic influence upon stated pathophysiological conditions and physiological functions. Part I of this theme looked at the common denominator – the neuraxis, namely the spine-related somatosensory-autonomic relationship and its disturbance upon neurophysiology.[2] This next measure is an appraisal of this association of that ANS disturbance with visceral function and dysfunction through afferent and efferent neurological changes, particularly from noxious somatic influences.[3-14] Professor Sato concluded that *"The analysis of neural mechanisms of (somatically induced) reflex responses seems to be very important for clinical application to regulate visceral function by physical treatment."*[15]

The previous paper outlined a literature base of examples of the effects of likely mechanical spinal disturbances and resultant influence upon autonomic function.[2] Significant research on this aspect reflects mechanical irritation through

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facet implication,[16-18] particularly whiplash.[2,19-22] A similar connection exists with the autonomic symptoms associated with migraine and pain.[23,24]

Given that demonstrable changes in aspects of autonomic dysfunction can be positively influenced by manipulative spinal factors,[25] it would be reasonable to hypothesise that the disturbance of the autonomic network may also explain some, if not many symptoms and conditions of visceral dysfunction.

The literature reveals papers at varying evidential levels. These originate from within the chiropractic, osteopathic, medical, as well as the physiotherapy professions. While there appears to be a dearth of research which disproves, or even seriously questions such a role for manual therapies, an ever-increasing number of formal studies, considerable anecdotal clinical feedback, and empirical observations have been reported. Emerging original formal research on this topic is catalogued. This research tends to further document the phenomenon of neurovertebral influence upon internal physiology, and offers greater understanding towards the hypothesis of a spine-related somatovisceral association model centred through the ANS. This author did not locate any neurophysiology research which rejected or cast doubt on such potential.

The papers mentioned here represent a cross section and by no means claim to be a complete list. More and more RCT studies are steadily appearing, but the majority of papers to date are low-level evidence. They nevertheless provide a record of clinical observations upon which deeper research can be justified, and without which both the interest in, and the demand for explanatory understanding can develop.

A primary role of chiropractors, medical doctors, and others involved in this field is to direct attention to the modification or removal of the noxious somatic influence, in order to reverse the effects on the ANS and associated internal structures which may be adversely affected. Chiropractors would assert that they address a physical-mechanical condition influencing the ANS – the subluxation or vertebral subluxation complex - via a physical-mechanical approach (the vertebral adjustment - a specific form of the more generalised manipulation) in order to address disturbances in the somatosensory-autonomic-visceral triad (SAV Triad) - rather than a chemical approach to address a physical mechanical situation. That is, by correcting the somatic component of the SAVT and thereby aiming to ameliorate an associated localised pathophysiological condition.

HISTORICAL

Initially, Palmer's innovative concept of chiropractic health care was based on health and healing – not on back pain.[26] His first successfully adjusted patient had been deaf for 17 years and his second patient suffered "heart trouble."[27] The profession's involvement with musculoskeletal pain appears to be a more recent development to those early cases.[26]

Although in recent years there has been far more published on the orthopaedic aspects of chiropractic health care, this paper seeks to summarise the availability of numerous journal papers relating to the Somatosensory-Autonomic-Visceral connection, the SAV Triad (SAVT). These are derived primarily from the chiropractic, osteopathic, and medical profession, as well as some from the physiotherapy profession.

Early chiropractic texts on manipulative management of spine-related somatovisceral disorders include those published by Firth in 1921, Janse, Houser and Wells in 1947, and Homewood in 1963.[28-30] These reflected the profession's interest in that area at the time. More recently, Masarsky *et al*., have also published a text exclusively on the topic of somatovisceral conditions.[31]

Interestingly, as if aware of the relationship of sophisticated neural physiology, pathophysiology and noxious neural insult through to such future terminology as neuroplasticity, neuropraxis, dysafferentation, and neurodystrophy as well as neural irritation and stimulation, Palmer maintained that rather than nerves being *"squeezed or pinched"*, neural energy was *"…accelerated,…the volume and force is augmented."*[32] His astute observation may well prove to be incredibly prophetic – way ahead of its time. A manipulative role for chiropractic as a musculoskeletal therapy for certain conditions then also evolved. In a detailed paper, Seaman and Winterstein offer the term dysafferentation in relation to increased nociceptive impulses and reduced mechanoreceptor discharge - a form of neuropraxis.[4]

In chiropractic research last century, BJ Palmer conducted studies on a variety of somatovisceral conditions based on an extensive collection of case histories. For instance, in 1949 he monitored pre-adjustment (pre-SMT) and post-adjustment (post-SMT) changes in urological pH values in over 2000 patients.[33]

A medical text by the orthopaedists Goldthwait *et al*, expounded on a number of mechanical-postural distortions related to visceral conditions and diseases.[34] The text underwent at least five editions from 1934 until 1952. These medical orthopaedic authors associated a wide variety of visceral conditions with poor body mechanics. Goldthwait first published on the topic in 1907[35] followed by a second paper in 1915.[36] Other postural studies by Carrick explore the complex neurology of the wider ramifications of this basic human mechanism.[37,38] Troyanovich called these "abnormalities of posture" - "global subluxations", and linked them to the following elements within the subluxation complex:[39]

- Histopathology,
- Myopathology,
- Neuropathophysiology, and
- Kinesiopathology.

Other early medical papers explored the segmental vertebral associations with a variety of apparent specific somatovisceral conditions. In 1921 dissection studies by Winsor associated visceral disease with scoliotic changes.[40] In two further papers in 1933 and 1940, Ussher examined scoliotic changes associated with visceral disturbances.[41,42]

In 1958 Kamieth reported radiographic findings suggesting an association between scoliotic orientation and either gastric or duodenal ulcers. He noted that

> *"the percentile distribution of right-sided and left-sided scolioses coincided with the percentages of duodenal and gastric ulcers…*(and further that)*…all the scolioses involved vertebral segments corresponding to the stomach and duodenum, that is, T6 to T9."*[43]

McDowall noted that prior to that in 1827, Harrison had advanced observations and hypotheses which are similar to those of chiropractors and osteopaths.[44] Other medical doctors who have published on the somatovisceral concept include Smith in the US (1913).[45] He listed a number of conditions reportedly responding to *"manual adjustment."* In the UK in 1919, the medical manipulator Cyriax, listed *"inhibition of the intestinal peristalsis" leading to constipation*.[46] In 1926, Murphy cited cases of asthma responding to *"osteopathic adjustment."* [47] Mennell recognised the wider application for manipulation when he stated in 1934 that *"…it is beyond dispute that some cases of asthma derive benefit from manipulative treatments."*[48] However some 100 years earlier, a degree of medical recognition of somatovisceral conditions was expressed by Riadore and Player.[49,50] A number of visceral conditions were reported as *"amenable to"* manipulation by Marlin in 1931; he listed dyspeptic symptoms, menstrual pains, metrorrhagia and asthma in this paper.[51]

In 1967, Hembrow recognised the term subluxation in a somewhat chiropractic sense.[52] He stated:

> *"Although the term originally meant 'partial dislocation', it has been allowed to refer to the situation where the bones of the joint are not completely in their normal physiological relation, being held in incorrect apposition by some irregularity or peculiarity in shape. The joint is limited in movement in certain directions due to tension in the ligaments. It is not in the power of the patient to replace the bones so that a painful impairment of range ensues. Often the symptoms occur with abrupt onset when there would have been no time for adhesions to develop. The tension in certain parts of the capsule often gives rise to a dull ache or muscle spasm, as in acute torticollis. Subluxations usually yield to traction. The wrist and the neck are common sites for this condition."*

Over some 20 years from 1953 to 1975, Braaf and Rosner published at least seven papers on the topic of cervicogenic headaches. Their studies were cited in the statement that *"more than 90 percent of recurring headaches can be traced to a mechanical derangement of the cervical or neck portion of the spine produced by injury."*[53] In a prospective study in 2007, Couch *et al*. found that in a non-clinical population, only 15% of chronic daily headaches were related to head and neck injuries. However, they found that the lifetime risk of such headaches increased with an increase in the number of that type of injury.[54]

In other evidence of a postural influence on the body, a correlation between tension-type headaches and a *"straightened cervical spine"* was found by Nagasawa in 1993.[55]

In further evidence of a spine-related organ association using radiographic studies, Schey, published a paper on *"vertebral malformations and associated somatovisceral abnormalities."* His findings indicated a high rate of congenitally anomalous vertebrae and congenital visceral abnormalities.[56]

Medical interest in this area of autonomic importance was also implied when the journal *Acta Neurovegetativa* became the *Journal of Neuro-Visceral Relations* in 1968. In 1972 it became the *Journal of Neural-Transmission*. The title of the latest version suggests more technical neurophysiology topics than the 1968 publication.

Following Still's initiating concepts of osteopathy in 1874,[57] significant research within that profession has been conducted over a number of years by such dedicated researchers as Beal,[58] Coote,[59] Denslow,[60] Korr,[13] Wright[61] and Wyke.[62] Louisa Burn's *et al's* 1948 text entitled *Pathogenesis Of Visceral Disease Following Vertebral Lesions,* provided considerable early insight into the physiology underlying the hypothesis of neurovertebral-related visceral conditions.[63]

A recent study by Henley *et al* further demonstrated an association between osteopathic manipulation (OMT) and heart rate variability through somatic-autonomic influence. On this occasion the OMT was a cervical muscle release technique.[64]

In 1975, the US Department of Health, Education, and Welfare conducted an extensive workshop into The Research Status of Spinal Manipulative Therapy. The resultant monograph included a chapter on The Treatment of Visceral Disorders by manipulative therapy. It was primarily based on a study of chronic obstructive pulmonary disease (COPD).[65] In this paper, Miller states that *"The relationship of the musculoskeletal system, the soma, and the viscera forms an interdependence recognized by all physicians. Disorders of the neuromusculoskeletal system, at times, and in some instances, may be a factor in visceral disorders and disease. The literature is replete with discussions on disturbances in the neuromusculoskeletal system as a factor in visceral disease."*

In 1989 an osteopathic sponsored international symposium took place, its theme was based on somatovisceral and viscerosomatic interactions.[14] It followed a 1987 symposium based on the *Neurophysiologic Implications in Manipulation*. Both these crystallised the osteopathic concepts of the time, and followed the 1975 submission by Miller to the US Government study. The osteopaths Kuchera,[66] Barral and Mercier[67] have also published on the topic of manual influence upon the function of internal visceral structures.

In Europe, medical interest in vertebrogenic organic disorders has been shown by a number of medical authors. (Appendix A) Medical doctors in Denmark showed an interest in SMT and how it reflected on audiograms.[68] These do not appear to have penetrated the English-speaking medical literature very deeply at this stage. It seems grossly contradictory if not unscientific, for the members of the medical profession in some countries to embrace aspects of a spinal manipulative model, while colleagues in other countries appear actively, if not adamantly opposed to similar hypotheses in such a natural model in health care - particularly in the absence of research to defend such opinion.

However, Australian medical interest at least in cervicogenic headaches appears to have changed in recent

times. In 1995, Hinderaker, Bogduk and colleagues stated in relation to such headaches that they found, *"no significant correlation between the location of the axis (C2/3-author's note) and the response to diagnostic blocks. Previous false-positive assertions appear to be due to insufficient attention to the precision and reproducibility of the techniques used to determine IAR's (Instantaneous Axis of Rotation)."*[69] However, in 2001, Bogduk stated that *"The possible sources of cervicogenic headache lie in the structures innervated by the C1 to C3 spinal nerves, and include the upper cervical synovial joints… Experiments in normal volunteers have established that the cervical muscles and joints can be sources of headache."*[70] He explored this through the injection of steroids into the upper cervical region.

The depth of interest would seem to have varied from country to country, and from one medical doctor to another, with notable support from European physicians.[71-77] It may suggest further, that in some instances the opinions may be based more on personal philosophy or political bias rather than on scientific or clinically based findings. Indeed, it also portrays a disregard or denial of published *medical* literature on the topic, as Appendix A would suggest. In English speaking countries, the lack of formal assessment studies other than selective reviews, and opposition by some in medicine, would appear to have caused the somatovisceral concept and interest in it, to wane. Perceived scepticism of a chiropractic neurovertebral model would appear particularly inconsistent, when criticism is not also levelled at those individual medical specialists who have adopted similar forms of the concepts under the title of *manipulative medicine,* and especially in the absence of hard research evidence. *Opinion* would hardly constitute even anecdotal evidence.

The relevance of historical medical papers (Appendix C) in this presentation, is based on the adoption of manipulation in some early medical circles. It is difficult to find evidence in the literature as to why medical interest in SMT waned during the 1800's.

The reasons for ignoring or rejecting a manipulative model in the face of evidence of persistent, independent, and clinical success, which in turn brought further patient demand, would seem to be preconceived, territorial and/or political ones, rather than ones which are scientifically or evidence based. As a drugless model, industrial interests may also have played a part, with government and commercial funding being very limited to the drugless health sciences.

But it must be asked, why does it have to be seen as either one model or another? Why can there not be united co-operative, inter-professional efforts in support of research and optimal health care for the benefit of patients – without the politics?

METHOD

As with the preceding paper on somato-autonomic influences,[2] the intention has not been to analyse the strength or levels of evidence from the literature through a form of meta-analysis. It was proposed however, to present the literature in order to provide an overall picture as to the volume, variety and formats of material that has been published relating to SAV conditions. In addition, the two papers were designed to depict the literature relating to the wide range of spine-related visceral conditions in which the manual sciences have demonstrated interest. (Table 1 – see also full version Appendix B).

The format of Table 1 has been designed to depict the topics or condition which could be classified under this SAV Triad. By citing a number of papers under a particular topic, it also reflects the weight of interest in that particular condition or system. There is an overlap of categories, authors, and journals, as these can be interchangeable across the four professions due to the inter-professional nature of journal selection and authorship of papers published. The year of publication has been included here to show that clinical interest in the hypotheses has been available for many decades and has not been a passing phenomenon.

Evidential support for the association of a neurovertebral influence upon visceral symptoms, function and dysfunction does exist in the referenced literature. This includes the higher levels of evidential assessments, and would seem to negate claims that there are no formal research studies in the manipulative sciences(Table 2). Furthermore, there would seem to be reasonable scientific support in medical literature for such neurovertebral hypotheses, sufficient to justify grounds for ongoing research and clinical studies.

This paper associates the neurophysiological influence of segmental spinal pathomechanics and the somatovisceral association through the autonomic nervous system. Many of the studies mentioned have been reported as being managed through chiropractic vertebral adjustments - the more specific form of spinal manipulative therapy (SMT). It is submitted that vertebral adjustments are not only directed at localised pain symptoms [657] and intersegmental mechanical dysfunction, but particularly at afferent and efferent neural impulse flow at specific neurological segmental levels. The paper has not sought to address the more holistic chiropractic model that may include such regimens as diet, exercise, and nutritional supplements as well as general health management and advice. Chapman-Smith noted in Hawk *et al's* recent study, that: *"…there is now sufficient evidence to support the conclusion that chiropractic care – meaning the entire clinical encounter rather than for example spinal manipulation only – 'provides benefits to patients with asthma, cervicogenic vertigo and infantile colic.' The evidence is promising, but not yet as strong, for potential benefit 'for children with otitis media and elderly patients with pneumonia'."* [658]

Over the past century, much anecdotal evidence on this topic has been reported in the literature by all four professions – chiropractic, osteopathy, medicine and physiotherapy. This paper also notes both early and more recent anecdotal evidence that is now being explicated by way of formal clinical studies and advanced neuro physiological research.

The citations presented come from a number of different sources, including The Index to Chiropractic Literature (www.chiroindex.org) and Medline (PubMed). The Pubmed source is limited in that it only lists six chiropractic journals and one of these is essentially a newsletter. The primary sources though, were initially extracted from the reference lists of previously published papers and textbooks. These were examined, and relevant papers obtained where possible. The local chiropractic and osteopathic library sections at RMIT University – Melbourne featured prominently in extracting

these papers. A major contribution was also gleaned from the four volumes of the Chiropractic Research Archive Collection (CRAC) index series published by the Canadian Memorial Chiropractic College between circa 1980 and 1990.[659-662] Other comprehensive web sites from which a selection of papers was extracted, were that of the ICA Council on Chiropractic Pediatrics - (http://www.icapediatrics.com/reference-articles.php) and the Chiropractic Resource Organisation (http:/chiro.org/about-us/sitemap.shtml) – under *"Research", "Journals", "Abstracts", "Case Studies"*. At times, it was necessary to utilise abstracts when complete papers were not accessible.

In addition to Google, two osteopathic electronic indexes were also accessed. These were: The Osteopathic Index – research web (www.osteopathic-research.com), and the osteopathic literature database:- http://www.ostmed-dr.com:8080/vital/access/manager/Index

Apart from various medical, osteopathic, and chiropractic journals and textbooks, the papers presented at a number of inter and intra-professional conference proceedings, were also sources of references concerning the manipulative sciences. There was however one minor complication, in that almost weekly, new papers would appear which would be appropriate inclusions on the subject matter. However it was not practicable to keep adding papers.

The author's own database compiled over some years, comprises more than 1200 citations on specified *non-orthopaedic* spine-related conditions. It also includes neurophysiology references on what may be regarded as neurovertebral-influenced conditions. These citations are further divided into the different professions, and list some 120-plus different pathophysiological and organic disorders.

This presentation aims to depict the wide range of reported spine-related neurogenic models of pathophysiology – a somatosensory-autonomic-visceral one. It includes a few references which are somewhat contrary to some of the presented clinical material.[121,611,653,654,663]

REVIEW

Kimura and Sato stated that *"The elucidation of the neural mechanisms of somatically induced autonomic functions, usually called somato-autonomic reflexes, is essential to develop a truly scientific understanding of the mechanisms underlying most forms of physical therapy, including spinal manipulation and traditional as well as more modern forms of acupuncture and moxibustion."* These authors reviewed the *"…somato-autonomic reflex responses in the cardiovascular, including cerebral and peripheral nerve blood flow, digestive, urinary, endocrine and immune systems following somatic sensory stimulation in animals anesthetized to eliminate emotional factors."*[664]

Upon gathering the data, it comes as some surprise to note the large number and diversity of papers which have been published in the chiropractic, medical, and osteopathic literature. The author (PLR) estimates that in the chiropractic literature alone, there would be over 5000 papers published relating to so-called somatovisceral conditions. Published evidence consists of empirical observations, anecdotal studies and case reports, through to inter-professional neurophysiological laboratory research papers. The variety of conditions in this literature ranges through all body systems, including the more recently developing field of the neuro-immune response. (See Immune System Table 1 & Appendix B, and Table 4[2] & Table 5[2])

The published evidence emanating from within the primary manipulative professions concerning spine-related visceral conditions, has been in existence for many decades.[30,43,665-669] Ligeros stated that *"The basic principles and the principles of chiropractic which have been developed from it, are not new. These axioms, rediscovered and known as Chiropractic, were also practices by Aesculapius and his followers 420 years(BC)."*[670] However, a Pubmed search indicates that the terms *"manual medicine"* and *"manipulative medicine"* first appeared in the recent literature in the 1960's. Older medical journals also record bone-setting dating back into the 1800's (Appendix C).

As noted, more recent papers have been published at various evidential levels of scientific classification. While this appears to be consistent with all health professions as they evolve, formal papers on this particular topic seem to have been comparatively slow to surface. Perhaps this is partly due to the lack of financial research support from governments, and a lack of interest-value from related industries, both of which seem to be afforded to some other professions. This may also be partly due to medicine's close political association with government bodies and large companies - also likely to be a factor is the fact that there is only minimal industry association related to the natural and drugless therapies.

The Index to Chiropractic Literature lists some 40 chiropractic journals and publications, many of which carry a range of studies, reports and research of various conditions that have been clinically managed by members of the manipulative professions. Although the majority of papers in these journals would be regarded as covering a musculoskeletal topic, a minority could be referred to as addressing a spine-related neuromusculoskeletal topic – as well as various other subjects, such as general health and well being, sociological studies, and education.

In their neurology text, Cramer and Darby offer a brief but lucid review of the neurophysiological rationale of somatovisceral disorders. They conclude that;

> *"…experiments show that a stress applied to the spine initiates reflex arcs resulting in changes in heart rate, blood pressure, and activity in the sympathetic efferents to the kidney and the medulla of the adrenal gland. Based on this evidence, the neural components of this type of somatovisceral reflex do exist, and spinal manipulation may stimulate somatic afferent fibers to create similar somatovisceral reflex responses. Pathologic processes affecting the spine may also result in reflex changes in visceral activity."*[671]

Also of note is the original research contributed by Carrick, whereby he demonstrated alterations in brain activity by mapping ocular blind spots, and the modulation in these blind spots following cervical vertebral adjustments.[25] He was able to draw a direct association between cervical spine influence and brain function. His findings may be augmented

by another relatively recent discovery, that of the Shimizu Reflex, a muscle-stretch reflex which has been put forward as a means of assessing myelopathy in the upper cervical cord (C1-C3).[672,673]

Carrick also opined that the vertebral adjustment is possibly one of the most powerful sources of a controlled neurological stimulus to make input into the nervous system. This would be accomplished by the mere firing of so many joint mechanoreceptors.[674] Since the joint mechanoreceptors (JMR's) comprise small (SDA) and large diameter afferents (LDA), the input is greater than small diameter afferents alone. In nerve conduction velocity, the largest myelinated fibres are the faster, and therefore have greatest chance of summation. In regards to the velocity, the 1a afferents (LDA's) sit at the top of the sensory nerve tree, with an impulse velocity of up to 120m/sec compared to Group III or the unmyelinated Group IV afferents (SDA's) ranging from up to 30 m/sec down to 0.5 m/sec respectively.[675]

Interestingly, in relation to receptor classification, Cramer and Darby state that *"The classification of receptors by location overlaps with the classification by stimulus type, such that nociceptors can also be exteroceptors, and mechanoreceptors can also be proprioceptors."*[676]

As an indication of a more central neurological role, it has been found that visceral conditions do not necessarily have to originate in localised organic tissue. Johnson and Spalding mention that *"Acute ulceration of and hemorrhage from the stomach and duodenum can be produced in experimental animals by lesions in the hypothalamus....They have been attributed to autonomic disturbance."* [677]

From a manipulative viewpoint, Pickar and McLain found that in cats there was a 'graded sensitivity' of mechanosensitive endings, particularly Group III and IV afferents in the lumbar spine, in the direction of facet motion/ manipulation.[678] This finding would seem important as to the specificity of manipulation and subsequent efficacy. They, and others also suggest that this network of unmyelinated Group IV small diameter neurons 'may contribute to somatic and autonomic reflexes.[679]

Bolton found that in animals, vertebral displacements and putative vertebral subluxations may modulate activity in Group I to IV afferents, adding further to the concepts of direct neural input from vertebral articulations.[16]

LeBoeuf-Yde and colleagues cite a number of neurological based symptoms which they note may occasionally appear as a result of spinal manipulative therapy (SMT).[680] While an association would seem evident, it would be reasonable to conclude that manual modification or correction (by vertebral adjustments) of related VSC's in such cases, could have the potential to reverse or ameliorate similar spine-related symptoms presenting in patients.

In a case report, Hart attributed the onset of cardiac arrhythmia in a patient to the neurological effect from what he classified as an *incorrect* atlas adjustment. However the subsequent application of a *correct* C1 adjustment reversed that finding. In a further instance of apparent vertebrogenic neural influence, he also cites Palmer, who in 1951 published a report of 1,500 cases of ECG responses associated with specific spinal adjustments.[98] Leach cites 1931 osteopathic research by Chirrill and others who noted an association between spinal lesions with a lymphocyte count and production of immature plasma cells in the bone marrow.[681]

Of particular note however, is the recognition of somatovisceral implications as a result of the research by Sato and colleagues. They have published comprehensively on the spine-related neurophysiological foundations and the extensive ramifications of this powerful biological controlling influence.[12]

The French medical orthopædist Maigne, stated that *"… patients manipulated for lumbar pain frequently report that their habitual constipation disappears or that certain digestive pains are suppressed. Others report that they have no more palpitations after mobilisation of the neck…It is well known that a number of patients suffering from asthma are helped by costal vertebral deblocking…occasionally we could cure or improve mastodynia and several times pseudo-ulcers in patients with dorsal pain."*[72]

The medical professor Karel Lewit devotes a relatively large section of his text to somatovisceral conditions.[71] While discussing and referencing a variety of so-called organic conditions, it is surprising that his profession in English speaking countries seems to overlook or ignore this material. As examples, Lewit discusses the following organs and conditions as observed and treated with manipulation in clinical practice:-

- Duodenum
- Gall bladder
- Gynaecological disorders
- Heart,
- Kidneys
- Liver
- Lungs
- Pleura
- Stomach
- Tonsils

It is submitted that in this somatovisceral model, the normal aspect of physiological spinal integrity is optimal intersegmental function. It is further contended that with intersegmental mechanical dysfunction (joint pathophysiology, hypermobility, vertebral fixation) – the VSC has significant influence upon spinal reflexes through neuronal disturbance or neuronal irritation of these closely associated structural spinal elements.[3,5,678,682-684] The major source of pathophysiological sensory neural influence, both afferent and efferent (noxious), appears to lie in the form of hyper-stimulation, or at other times, the inhibition of the receptor reflexes, depending on the nature of the lesion. These noxious impulses enter the spinothalamic tract in the spinal cord primarily to spinal cord laminae VII/VIII.[685] They reach the intermedius nucleus of the medulla (InM) which is associated with the *"nucleus tractus solitarius (NTS) which is located within the dorso-medial medulla, and is the site of termination for primary afferent fibres originating from a wide variety of peripheral organs and tissues and is essential in the integration of autonomic*

nervous system functions."[686] In further integration of the neuroanatomy, Edwards and colleagues note that the InM sends both excitatory and inhibitory projections to the NTS.[687]

However, as well as nociceptive influence, some physical compromise of neural integrity would also appear to be possible on occasion. In their 1998 study, Lu and Ebraheim noted the possibility of direct mechanical insult of the C2 nerve root ganglion in being *"vulnerable to entrapment."*[688] In an histopathological study, Giles explored the potential for *"compression of neurovascular structures"* within the spinal canal and intervertebral foramen, due to stenosis caused by osteophytic formation.[689]

As the result of a degenerative process from localised trauma to ligamentous structures of articulations and/or the outer margins of the vertebral bodies, osteophytic hypertrophy evolving from this soft tissue damage into calcific density would naturally be a gradual formation. As the hypertrophy would already be "space occupying" from the repairing soft tissue, the resultant stenosis is likely to have been present for a considerable time[690] before it becomes symptomatic. It is this writer's opinion that in many cases of resultant canal stenosis in subsequent years, symptoms may then develop as a result of a further mechanical disturbance of the compromised segment which has already been rendered vulnerable by the osteophytic encroachment. This may also take the form of an inflammatory response with localised tissue swelling. Consequently, other than a further discal bulge or prolapse, radiographic evidence of osteophytic stenosis may appear virtually identical on films taken before and after the onset of symptoms. That is, unless there is additional tissue damage. So at least initially, it would be the disruption of the osteophytic segment(s) causing symptoms, rather than the osteophyte(s) as such.

The role of alleviating pain through spinal adjustment is that of relieving a neurological symptom. As pain can be essentially a protopathic neurological phenomenon, it can be but one of the symptoms which may be used as a guide to diagnose, localise, and monitor aspects of mechanical or functional articular changes. Baliki, Apkarian and colleagues have demonstrated that chronic pain can *"…impact on overall brain function…and may underlie…cognitive and behavioural impairments..."* as well as lead to atrophy of brain neocortical gray matter (5%-11%) and they suggest that *"… the pathophysiology of chronic pain includes thalamocortical processes."*[691,692] This would indicate that the alleviation of pain has far wider neurological ramifications than just the immediate area of localised joint disturbance.

Chiropractors may adjust a vertebra in a patient's spine for a variety of mechanical reasons, these can include segmental facet release, general mobilisation, and correction of joint derangement. In normalising segmental vertebral function, the focus of that procedure is still essentially upon the influence of the nervous system. Assessing symptoms and signs may involve common clinically observed presentations such as pain and muscle weakness, as well as such paresthesias as numbness, prickling, tingling, formication and heightened sensitivity (allodynia). It is virtually impossible to consider a clinical presentation or procedure that does not reflect on neural involvement in one form or another. It is submitted that sensory input modification, be that stimulatory or inhibitory, may at times be addressed by manual segmental adjustment with the aim of normalising central neural reflexes by establishing normal neurovertebral function.

The adjustment may also involve the modification of proprioceptive input, noxious impulses, mechanoreceptor firing, and muscle spindle reaction. This would also incorporate a number of muscle structures including alpha and gamma motor neurons, 1A afferents (muscle spindles) and Golgi tendon organs.[3,4] Similarly, this diminution in the normal neural sensory input, as noted for instance in hypoaesthesia,[684] has the potential to deprive the neuraxis of its normal physiological feedback mechanisms, thereby effecting homeostasis.[95,309] Jänig stated that *"The body's motor activity and behaviour are only possible when its internal milieu is controlled to keep the component cells, tissues and organs (including the brain and skeletal muscles) maintained in an optimal environment for their function."*[693]

Allopathic models of health care would not normally consider or address vertebrogenic possibilities. It is submitted that if this model does have significant credence, the practice of applying a pharmaceutical chemical to address a physical-mechanical lesion (the VSC) is overlooking the vital neuro-mechanical spinal component. A 1989 paper compared the health of children whose parents were chiropractors with those of allopathic paediatricians. The study concluded *"that there is validity in the premise that chiropractic has a positive effect on the health status of individuals."*[215]

No claim is made here for a vertebrogenic panacea for all conditions, but it may well be one of the factors in many, and the key element in others. Unless addressed, it is suggested that there would be less than optimal patient response in such cases.

Neurologically, Bolton, Budgell and Haldeman all acknowledge that although not yet conclusive, there is now sufficient formal scientific evidence published in the chiropractic, medical and osteopathic literature to support a model of spine-related visceral condition.[16,300,694] The weight of evidence is such that it would justify further exploration of the potential for, and neurological ramifications of, the vertebral subluxation within this somatovisceral model (Tables 1 & 2). However, there is still a need for further additional formal clinical studies and underlying neurophysiological research to be explored on this subject.

Sato encapsulates the concept when he states that, *"Manipulation performed by chiropractors excites somatic afferent fibers in the musculoskeletal structures of the spine. These afferent excitations may, in turn, provoke reflex responses affecting skeletal muscle, autonomic, hormonal, and immunological functions. An understanding of spinal reflex physiology is, therefore, fundamental to comprehending the effects of manipulation."*[695]

DISCUSSION

"In fact, somatoautonomic reflexes are well established both on the basis of clinical phenomena and from basic physiological experiments in animals and humans. A close examination of basic scientific studies shows that many of the clinical observations of chiropractors are eminently sensible and deserving of further investigation. In particular, it is

perfectly reasonable to propose that noxious stimulation of the spine may disturb visceral function and that the relief of spinal dysfunction may have a therapeutic effect on the behaviour of internal organs. Additionally, there is growing evidence to support the hypothesis that dysfunction at particular levels of the spine may preferentially provoke symptomatology in specific organs…Numerous investigations have revealed that both innocuous and noxious stimulation of somatic tissues evokes reflex responses in autonomic efferent nerves and in the organs which they serve. [696]

Evidential support for the hypothesis of an association of a physiological and pathophysiological neurovertebral influence upon visceral function does exist in the health professions. This evidence consists of empirical observations, anecdotal reports, through to blinded randomised controlled trials and pure neurophysiological research (Table 1 and 2). On the other hand, Budgell also stated that *"…while there is little clinical evidence in favour of chiropractic management of visceral disorders, there is little evidence of any sort to argue against it….it is largely unproven rather than unproved,."* and further "*… the absence of evidence is not evidence of absence."* [696]

A number of neurophysiology studies involving members of the chiropractic profession have been conducted. This includes formal research by Budgell, Bolton, Brennan, Haavik-Taylor, Kokjohn, and Pickar.[2] Table 2 of this paper highlights some of the more formal studies as distinct from the anecdotal reports. Results of their research studies in this field have been published in various refereed journals, not chiropractic journals alone.

In the case of general paediatrics, a US study by the Council of Chiropractic Guidelines and Practice Parameters (CCGPP) extensively assessed the literature from various chiropractic, osteopathic, and medical sources. It assessed and categorised 215 articles into ten evidential levels. This covered:-

Expert opinion – 30 papers

Case series – 26 papers

Case reports - 97 papers and,

Design studies - 62 papers.

This last category was subdivided into a further seven categories from *"Descriptive cross-sectional studies (predominately surveys)"* through to RCT's comprised of 6 papers, only one of which was a purely orthopaedic paper.[697]

Dorlands[698] defines *'viscus'* (singular) as: *"Any large interior organ in any one of the three great cavities of the body, especially the abdomen,"* and a *'visceral cavity' as: "one of the cavities of the body containing important organs, such as the cranial, thoracic, abdominal, or pelvic cavity."* It is assumed that "abdominal, or pelvic" is to be read as "abdominal or pelvic" – without the comma! Apart from the generally accepted abdominal and thoracic organs, it is noted for clarification that by including the cranial cavity, the definition would therefore include the brain as a viscus – and therefore intracranial headaches must then be defined as a somatovisceral condition.

The role of a manual approach as a means to influence the autonomic nervous and somatovisceral systems, although present for many decades, has remained questionable in some quarters.[699] However, critics once levelled a similar uncertainty at the effectiveness of a manual approach to musculoskeletal conditions such as low back pain, yet this is now widely acknowledged and accepted (and in fact adopted by sections of professions which were once sceptical) as a recognised procedure both clinically and in the literature.[213]

While clinical aspects of SAV *dysfunction* of internal organs may be objectively and subjectively recognised through signs and symptoms, a neurovertebral association with a *frank pathological* state may not be as well corroborated or documented as other conditions currently seen by manipulative practitioners. It may however be reasonable to hypothesise that in some conditions, spine-related organic dysfunction may *predispose* certain tissue to eventual organic pathology. An example of a neurogenic visceral condition may exist in cases of chronic indigestion, which may predispose some patients to gastritis. Detection or diagnosis of changes in normal spinal function and associated visceral processes – gastrointestinal is one example,[43] could then potentially become an initial level of indication for impending pathology, and ultimately, and hopefully, a form of prevention.[188-202] Apart from spinal manipulation, other measures such as exercise, diet and life style advice are becoming a part of the overall health management under chiropractic health care.[7,700,701]

There is arguably more published evidence in favour of chiropractic involvement in the management of a number of visceral conditions than there is for many musculoskeletal conditions managed by manipulative therapy. The exception would be for neck and lower back pain (LBP) pain - and perhaps cervicogenic headache. Despite impressive results clinically, it would seem that both pure and applied research studies in the field of spinal related visceral conditions, could be compared to the level and standard of published evidence which exists in the literature in relation to the manipulation of knees, elbows, costovertebral joints and even the VSC's of vertebrogenic dorsal pain. These are all essentially musculoskeletal conditions for which manipulative procedures are generally accepted and successfully applied, regardless of comparatively minimal supportive published research on those topics. Yet the management of somato-ANS related visceral conditions remains somewhat contentious, even though there would appear to be a similar degree of anecdotal efficacy, patient acceptance and satisfaction – as well as the more formal research.

It must be recognised though, that other etiological factors can also be associated in certain cases, or that somatosensory-autonomic influences could be more of a predisposing, or secondary factor in some pathophysiological processes.

It has also been published that visceral reflexes would be involved in the presentation of simulated conditions.[702] Mechanisms of *viscerosomatic* reflexes may present as trunk or neck pain [14,41,58,202,703,704] and present as muscle guarding or splinting in acute visceral conditions. [705,706] Conversely, It would be reasonable to assume that *somatic disturbance* may also have the potential to influence visceral physiology through the "reverse" - somatovisceral reflexes.

It is suggested that a similar dearth of supporting research for the manual management of acute LBP existed when current older practitioners first entered the manipulative professions decades ago. This did not appear to deter patient demand or development of the chiropractic and osteopathic professions. Chiropractors were successfully managing acute LBP when there were few if any double-blinded placebo controlled studies on back pain. The apparent positive clinical results then attributed to manipulative management of low back pain would seem to have been primarily anecdotal and patient-generated evidence. Since then, the profile has risen, partly due to other professions adopting key aspects of the clinically successful spinal manipulative model.

Attempts have been made to classify conditions addressed by spinal manipulation into Type M (musculoskeletal) and Type O (organic).[707] However it seems that this is the only area in the health sciences where such a classification has been suggested. If categorisation is necessary at all, then virtually all conditions should be basically 'Type- N' (neurological) as nominated by Leach, as essentially all conditions would have a neurological element.[708] If this classification is adopted, then not only is the importance of the nervous system to the hypotheses emphasised, but the weakness of a Type M/Type O classification renders it superfluous, if not meaningless. A *"Type N"* designation would highlight the importance of total body considerations in such an extensive and integrated model of health care, as well as the encompassing influence and the *integrative action of the nervous system*.[685,709] Consequently, it would seem logical to pay attention to somato-ANS-related effects upon the body generally by considering all structures, functions and systems.

There are currently welcome signs of inter-professional co-operation, with many of the citations in Tables 1 and 2 containing chiropractic authors in medical journals, and medical authors published in chiropractic journals - as well as collaborative joint authorship and research. A further example of this inter-professional acceptance is shown by a WHO organisation. In supporting the World Federation of Chiropractic's 1996 application to the World Federation of Neurology, the WFN president Lord Walton stated that *"The relationship between the medical and chiropractic professions world-wide has become increasingly one of mutual respect and collaboration."*[710]

Noxious neurological influence via stimulation or irritation from peripheral somatic structures, may also influence visceral physiology.[3,11-15,17,18,696,711-714] The recent paper by Edwards et al further suggests that cervical muscle spindle activity may also be a significant influence on autonomic (sympathetico-autonomic) activity, particularly in relation to cardiorespiratory changes.[687] One could hypothesise that such aberrant muscle activity may also have the potential to exacerbate some pre-existing cardiac pathophysiology through noxious sensory input.

The main area of interest in this somatosensory-autonomic-visceral model of organic dysfunction, is the potential for pathophysiological influence of the spine upon the nervous and neurovascular systems and associated viscera.[12,20,66,123,181,193,202,562,563,577] Clinical examples exist in the cases of manual resolution of the vascular component of cervicogenic headaches,[715] as well as in the positive influence upon a dysfunctional lumbar spinal segment associated with PMT or dysmenorrhea.[716] These conditions could be regarded as more of a physiologic *dysfunction* (pathophysiological) rather than pathological.[88,100,101,560-563,568-571] Other readily recognised clinical examples notably include such organic *dysfunction* as spine-related indigestion, bed wetting, colic and paralytic ileus.[696] (Table 1 & Appendix B)

The ANS is thought to be the key element here as it essentially controls all the smooth muscle in organs, blood vessels and other tissues.[717]

Cervicogenic headaches have long been a diagnosis within the manipulative health sciences. As an indication of its recognition and acceptance, the World Health Organisation's *International Classification of Diseases* (ICD-10) lists the diagnosis as code G44.841 – *"Headache associated with biomechanical lesion of cervical spine (M99.1)."*[718] The M99.1 code in the ICD-10 refers to the *"Subluxation Complex (vertebral)."* The International Headache Society has also now established C*ervicogenic Headache* as Code 11.2.1 in its *International Classification of Headache Disorders (ICHD-II)*.[719]

THE VERTEBRAL SUBLUXATION COMPLEX (VSC)

As with multiple definitions with words in general use, the term subluxation has different connotations within the medical and chiropractic professions. This should not matter if one defines the term to establish a record of understanding. There are at least 300 synonyms and metaphors[720] and at least two texts exclusively addressing this clinical entity.[721,722]

An understanding of the hypotheses concerning the VSC phenomena is contained in great detail in three comprehensive texts by Gatterman, Haldeman and Leach.[7,8,312] Suffice to say that this brief comment relates only to a limited aspect of the theories. It is anticipated that ongoing research will further define this VSC lesion and identify the bearing it may play in biological influence.

Gatterman[7] discusses four general categories of models of the subluxation –the biomechanical, neurologic, trophic and psychosocial models. Leach[8] explores a number of theories, and places emphasis on the pathophysiology and neurodystrophic aspects. One suspects that if a definitive hypothesis is eventually possible, it may prove to be a combination of a number of the theories outlined in those texts and elsewhere.[723,724]

This discussion on the VSC is not based or offered here as a panacea. It is recognised that many conditions may fall outside the hypotheses as they could be pathologically advanced or be genetically compromised. However even some of these cases may well benefit from inter-professional co-operative care. While a vertebrogenic factor may be an etiological key in a number of clinical conditions, it would also seem to play a mediating role in a range of signs and symptoms. When present, and unless the VSC is addressed, it is suggested that there could be a less than optimal patient response in such cases.

The importance of this clinical entity – the VSC, is worthy of separate mention. In a comprehensive dissertation, Seaman and Winterstein offer the term Joint Complex Dysfunction, as

a means of encompassing the relationship of sensory receptors to afferent input *"…and to describe the possible symptoms that can develop in response to enhanced nociceptor input and reduced mechanoreceptor input…"*[4]

The vertebral subluxation has been recognised by the World Health Organisation (WHO) in its publication, *World Classification of Diseases (ICD-10),* which classifies *"Biomechanical lesions, not elsewhere classified"* as item M99. It further sub-classifies the VSC as item M99.1 – "Subluxation complex (vertebral)." Item M99.0 is designated *"Segmental and somatic dysfunction."* These come under the broader heading of *"Diseases of the musculoskeletal system and connective tissue"* - (M00-M99), and *"Other disorders of the musculoskeletal system and connective tissue"* - (M95-M99).[725]

The WHO has also utilised the word *neuromusculoskeletal*, another common chiropractic term which adequately covers much of the profession's concepts. Chapter 7 of the *International Classification of Functioning, Disability and Health (ICF)* is titled "*Neuromusculoskeletal And Movement-Related Functions. This chapter is about the functions of movement and mobility, including functions of joints, bones, reflexes and muscles*." [726] However, the term *neuromusculoskeletal* is used in a more general context in the ICF. While it is in reasonably widespread use in the literature, it is a term that is relatively difficult to locate in on-line medical dictionaries. Although no longer published, the Journal of the Neuromusculoskeletal System was a chiropractic profession-based publication from 1993 until 2001.[727]

The original chiropractic concept centred on the principle that dysfunction in parts of the nervous system caused by segmental articular disturbance could affect internal physiological function therefore is a factor in pathophysiological dysfunction. The hypothesis was based on the premise that the neurovertebral system could be adversely influenced via disturbed spinal segments (the vertebral subluxation - VS). In turn, this could adversely affect the autonomic nervous system and consequently influence internal structures (VSC). Further, correction of the articular pathomechanical component of the VSC - by external manual means, (a specific vertebral adjustment) may positively influence an associated pathophysiological condition. This naturally depended on such a detectable lesion being present at a predictable and specific location. This manual influence upon pathophysiology through neural mechanisms – primarily afferent and efferent somatosensory-autonomic reflexes involving the vertebral subluxation complex, was deemed to reverse adverse effects when involved in certain cases. Being empirically based at the time, the original hypothesis apparently developed because of patient response and clinical observations.

The term VSC is significant, as it can be defined to include all the affected structures and functions at the segmental level. This would especially include neural and articular elements, as well as the muscular, ligamentous and vascular components, and not just the mechanical or physical disruption of the osseous segments. Without consideration of all these structures associated with vertebral intersegmental physiology, it is submitted that there would be only a limited focal point of influence – the articulation - and only limited irregular influence upon the ANS.

In reference to this segmental neurospinal dysfunction – the VSC, it is important to appreciate that at least for the purpose of this paper, a vertebral subluxation is not just a strictly mechanical displacement. A significant component in this complex is intersegmental articular mechanical dysfunction. This may comprise aberrant movement, fixation (hypomobility) or hypermobility between adjacent facets, as well as articular, muscular and ligamentous changes triggering or suppressing neural firing of mechanoreceptors, proprioceptors, and particularly stimulating nociceptive noxious input, with or without actual joint displacement. That is, a dysfunction within the normal paraphysiological range of motion.[728] The VSC would then include disturbances of these structures and their function, especially their effect upon articular physiology (function) and the integral neurophysiology. Inflammatory and circulatory disturbances of the inter-articular environment would also be associated. It is to this total pathophysiological complex that would provide the opportunity through which manual expression by way of a vertebral adjustment seeking to correct the dysfunction, may be directed in order to influence internal body physiology.[257] It is submitted again that in this particular model, segmental dysfunction more than osseous displacement, may be the primary physical-mechanical feature involving any associated neural aberration. However, that is only one part of the complex. Only a dry skeleton could have osseous disruption without more complex ramifications - somewhat akin to considering a dislocation without ligament, neural and other soft tissue effects.

It should be mentioned here that mechanoreceptors being Group I and II afferents, are not strictly nociceptors under normal situations. The activation of mechanoreceptors can inhibit nociception via a segmental adjustment. Nociceptors are essentially associated with injury or tissue damage and trigger Group III and IV receptors. Kaufman *et al* state that *"Stimulation of group III and IV muscle afferents has been shown to have important reflex affects on both the somatic and autonomic nervous systems."*[729] The articular adjustment would, among other actions, lead to an alteration in joint mobility and proprioception through the mechanoreceptor activity.[730]

In a discussion on the term *physiology*, it is noted that this term not only includes normal cellular tissue activity, but also the function and movement of articulations – "*the physiology of joints*."[731] In the physiology of joint movement – the mechanics, and especially the segmentally associated neurophysiology, plus the vascular and connective tissue function, are referred to in this paper by the phrase *functionally altered* or *dysfunction*. To that extent, the term *functionally altered* is also referred to as *pathophysiological – "the physiology of disordered function."*[732]

Bakkum and colleagues found that vertebral hypomobility, (fixation or partial fixation, restriction) at the lumbosacral (L4-L6) level in the rat *"…affects synaptic density and morphology in the superficial dorsal horn of the L2 spinal cord level."* Such a finding provides an insight into the pathoneurophysiology of the VSC, In their example it involves the dysfunctional component of the mechanical

aspect.[733] Further research by Henderson and colleagues into segmental fixation-induced hypomobility should *"allow researchers to produce and study spine lesions with the cardinal biomechanical features of the chiropractic subluxation: fixation (hypomobility) and misalignment."*[734,735] It was further found that segmental fixation could lead to intervertebral facet degenerative changes in rats.[736] These findings tend to indicate more than just the mechanical aspect of a VSC – at least in rats.

Other research by Song and colleagues, investigated inflammatory and tissue pressure changes at the L4 and L5 intervertebral foramen in rats. They demonstrated that spinal manipulation reduced pain and sensitivity (and other manifestations), as measured in the dorsal root ganglion.[657,737]

It is appropriate to quote further from the work of two of the world's leading neurophysiologists, Kimura and Sato who stated further that their "…paper concerns somato-autonomic reflex responses in various visceral organs following somatic sensory stimulation in animals anesthetized to eliminate emotional factors. Various forms of somatic sensory stimulation can produce different autonomic reflex responses, depending on the visceral organs and which somatic afferents are stimulated. Some responses have a dominant sympathetic efferent involvement, whereas others have predominantly parasympathetic efferent involvement. Some responses have propriospinal and segmental characteristics, while others have supraspinal and systemic characteristics in their reflex nature. These somato-autonomic reflex responses may be functioning during physical therapy including acupuncture." [664]

Somato-visceral reflexes associated with this model have been recognised. Neurologically, four responses associated with noxious input were discussed by Budgell and Sato in 1996.[738] These are:

> The axon reflex ("No direct autonomic involvement.")
>
> The spinal reflex (Noted for ("segmental organisation.")
>
> The medullary reflex ("Integrative function.")
>
> The supramedullary reflex ("sweating, hormonal secretion, cerebral blood flow.")

In addition, they state *"Health practices such as acupuncture and spinal manipulation frequently employ stimulation of somatic tissues in the treatment of visceral symptomatology. The efficacy of these practices may well be based in somato-autonomic reflexes. An understanding of how afferent input modulates autonomic function, therefore, has considerable meaning beyond its academic interest."* [730]Kent has summarised a number of models of the vertebral subluxation, and notes that Lantz nominates nine components.[724] It leads one to wonder about the resolution of this complex enigma, and whether that answer will ultimately prove to be even more multifarious. It would seem that substantive foundation evidence is to hand, it just has yet to be fully explored to explain the phenomena.

Interesting areas of future research might involve VSC influence associated with the severity of the initiating trauma or physical stressor, the duration since onset of that disruption, and the type or nature of the resultant VSC.

THE VERTERBAL ADJUSTMENT

"Vertebral Joint Stimulation.

In anesthetized rats, lateral stress stimulation of the spine at the lower thoracic (T10-13) or lumbar (L2-5) level with 0.5-3.0 kg force produced initial decreases to about 90% of control levels, followed by gradual increases in adrenal sympathetic nerve activity to about 120% of control levels. These stimuli produced clear and consistent decreases in blood pressure and renal nerve activity. After baroreceptor denervation, only initial decreases in adrenal nerve activity were observed following mechanical stimulation of the spine. Cutting the dorsal roots below L3 had no effect on the response to lower lumbar stimulation; however, severing roots T10 to L2 bilaterally totally abolished all responses."[739]

Vertebral adjustments are deemed to be a particularly specific and refined form of the more general spinal manipulation or spinal mobilisation.[740] It can be seen as a manual/physical/mechanical approach to release an articular fixation, and address associated neural dysfunction (VSC).

This current paper is designed to depict a number of other references based on this neurovertebral or Somatosensory-Autonomic-Visceral Triad (SAVT) model. Many of the listed spine-related conditions have been managed by addressing a neuromodulation component of the vertebral subluxation complex - the VSC (subluxation or segmental spinal dysfunction), utilising means of influencing the ANS through manual spinal adjustments of vertebral segments.

It is worthy of note that Bolton and Budgell found that general spinal mobilisation influences a different axial sensory bed to that of manipulation.[741] This difference appears to be based on the honed specificity of the technique used, and the difference in the firing of the sensory beds in larger superficial muscles; as opposed to those sensory beds of the shorter and deeper intrinsic muscles.

It is submitted that the foundation of the chiropractic hypothesis is based upon the importance of this neurological influence and the integrity of neurological function, as discussed in a succinct paper by Lynch and Boone.[742] This was the basis of Part I of this paper and forms the essential foundation for the presented principles in that paper.[2] The conceptual basis for a controlled and directed spinal adjustment is towards the normalisation of specific articular physiology, including neurological disturbance. As such, it must be accepted that a vertebral or spinal adjustment is a localised segmental correction of a specific neuro-mechanical complex, rather than the administration of a broad, general manipulation of multiple articulations in the one process. It may be noted that virtually any musculoskeletal disturbance, especially a spinal articular one, must by its nature bombard the neural elements with prolific impulses. This includes sensory input from associated inflammatory response[743] at that level, as well as the noxious input from disturbed nociceptors and mechanoreceptors.

In this model, the alleviation of pain through manual segmental vertebral adjustment is often seen as that of relieving the cause of a symptom rather than alleviating the symptom itself - as in a chemical analgesic. The neurological signal of pain is but one of the associated signs and symptoms which may be used as a guide to diagnose, localise, and

monitor aspects of functional physiological change. No studies could be found which examined the effect upon the ANS from chronic subliminal noxious firings associated with the VSC – possibly an area of major interest, especially over extended periods of time.

It has been well established that the noxious input from acute and chronic pain has a noted effect on the sympathetic and autonomic nervous system.[350,362,744,745] Manual alleviation of that sensory noxious bombardment would seem to be a natural means of accessing the ANS and influencing or modifying other associated neurological disturbance(s). It should also be noted that nociception is but one of the forms of massive receptor firings which may have further neurological ramifications. However, it would be through associated neural reflexes that research into the somatovisceral response (or somatoautonomic, somatosympathetic or sensorovisceral effects) from such neurological irritation could be monitored for clinical purposes, with the potential to ameliorate those reflexes through the vertebral adjustment.

Research by Salamon and colleagues into the positive therapeutic effects of osteopathic manipulation (OMM) on vascular and neural tissues was conducted in an investigation using nitric oxide as an agent to simulate the *"fluidic motions"* involved in those manual procedures.[746] They opined that their study may assist in providing "*... a dynamic theoretical framework to explain the therapeutic…*" benefits of such manipulation.

As one means of monitoring such changes the Shimizu reflex may be of some clinical benefit. In searching for a neurological reflex for high cervical lesions (C1-C3 spinal cord segments), Shimuzi *et al* noted that the Scapulohumeral (Shimizu) Reflex *"… is of extreme clinical importance because alterations in its intensity and character may be among the earliest and most delicate indications of disturbance in nervous functions."* [673] Davies reports cases of paediatric patients with non-stenotic plagiocephaly. As part of their management and successful resolution, upper cervical adjustments were monitored via this reflex.[672] This reflex is noted to be different to the Scapuloperiosteal Reflex which tests lower cervical segments from C5 inferiorly and involves the rhomboid muscles. It also differs from the pectoralis reflex (pectoralis jerk) associated with the C2-C4 segmental levels, but which is seen only in patients with spinal cord compression at those levels.[747]

THE SOMATOSENSORY-AUTONOMIC-VISCERAL TRIAD (SAV Triad)

"Stimulation of a visceral receptor can cause reactions in the viscera themselves, can send afferent impulses to the medulla and higher centres, and can affect the somatic musculature….Stimulation of the somatic afferents similarly can have a widespread effect on sympathetic outflow to the viscera." [748]

In this triad, the minimalist hypothesis submitted here stands on the basis of the four integral steps being linked. They are:-

- That there can be sufficient somatic disturbance to alter the normal sensory input at that segmental level. [696]
- That this aberration would primarily consist of a bombardment of noxious somatic sensory input, and resulting in modulation of normal autonomic (ANS) activity,
- That resultant altered efferent somatovisceral activity may then interfere with the physiology of the innervated structures(s) involving that reflex level. This may be via central processing, neurologically directly onto that structure – or other mechanisms.[696]
- That in the case of that structure being an organ, such interference may be in the form of physiologic dysfunction, with associated symptoms, simulated disease of that organ, or possibly degrees of, or predisposition to pathology.

It has been recognised that sensory disturbance such as ocular, auditory, and vestibular can have effects beyond their immediate anatomical location. As suggested by Seaman & Winterstein, the somatosensory system would also seem to have that propensity. They cite Peterson as stating that *"somatic dysfunction and/or joint dysfunction induce persistent nociceptive input and altered proprioceptive input."* [4]

While a number of hypotheses exist, [7,8,724] to this writer's knowledge it has yet to be demonstrated conclusively whether the dysafferentation may affect the visceral tissue directly via modulated innervation influence upon:

Purely neural innervation

Microvascular disruption through the vasa nervorum or vasa vasorum

Vascular dilation as in an inflammatory response

Contraction of the tunica media (constriction –ischemia)

Other means yet to be discovered, or a combination of possibilities.

In an extensive text, Leach outlines various models associated with VSC theories, as well as associated signs and symptoms in the clinical presentation of such cases.[749]

In a review of the literature in 2000, Budgell stated that recent research confirmed *"…the clearest demonstration to date of a segmentally organised, spinally mediated, visceral response to noxious stimulation of spinal tissue."* This brief review discussed neurophysiologic research involving spine-related influence upon the following; cardiovascular function (including blood pressure), digestive function (including peristalsis, gastric muscle tone), endocrine, immune, adrenal and bladder function.[300] Since that time, more formal evidence relating to the somatovisceral phenomenon continues to emerge from the health professions (Table 1 & 2).

The integration of somatic and visceral noxious stimuli was demonstrated by Qin *et al* in 2002.[750] Their research supported a concept of a peripheral somatic influence on respiratory neural input. They concluded: *"Various somatovisceral and viscerovisceral patterns of input were observed in TRINs (Thoracic Respiratory Interneurons). The results suggested that TRINs participate in intraspinal processing and integration of nociceptive information from somatic fields and visceral organs."*

Although studying somatovisceral sensory convergence, as opposed to functional aspects, in 2004 Miranda *et al* investigated the common association of abdominal pain with fibromyalgia patients. Their observations indicated *"…that altered somatic afferent activity may influence visceral sensation. It (was) hypothesized that a noxious somatic stimulus increases input to the projection neurons in the dorsal horn. Resulting in visceral hyperalgesia."* They concluded that *"…noxious somatic afferent input from the hind limb facilitates visceral hyperalgesia, which is due to viscerosomatic convergence in the lower spinal cord."*[751]

In a further demonstration of integrative somatovisceral association, a 2006 study by Bielefeld Lamb and Gebhart concluded that their research into *"somatic inflammation* (sensitisation of) *visceral afferents converging onto the same spinal segments (somatovisceral convergence)"* - amongst other aspects, provided *"novel insights into peripheral mechanisms leading to the development of hypersensitivity affecting neighbouring organs or referral sites. The plasticity of these convergent sensory pathways may contribute to the coexistence of pain syndromes, Conversely, it (was) conceivable that interventions affecting such converging pathways could be employed therapeutically to modulate sensation in less accessible areas, such as the viscera."*[752]

In their text, Foreman and Croft cite an extensive variety of neurological sequelae which they associated with forces associated with the trauma of cervical whiplash (WAD). Such a range would seem to highlight the necessity of considering all the neurological and musculoskeletal possibilities, not just the obvious radiological findings associated with the more major degrees of whiplash-induced injuries. In referring to whiplash-associated disorders (WAD) they state that *"The nervous system may be injured by either direct or indirect trauma."* [753] Croft records the following associated neurological (and vascular) symptoms:[321]

Arm weakness

Auditory disturbances

Balance disorders

Cervical dystonia

Dysphagia

Headaches

Occipital neuralgia

Oculomotor disturbances

Otoneurological disorders

Paresthesias

Post-traumatic stress disorders

Psychological irritability

Raynaud's phenomenon

Swelling

Visual disturbances

A 2006 report by Johansson also summarised a number of neurological symptoms associated with whiplash injury.[754] He noted Radanov *et al's* study,[755] which differentiated neurological differences between upper cervical ("cervicocephalic syndrome") and lower cervical spine symptoms ("cervicobrachial"), and cited other studies which stated that a combination of the two could occur. The latter listed the following additional cervocephalic symptoms:

Balance problems

Disturbed visual accommodation

Poor concentration

Pronounced fatigue

Sensitivity to light

In a longitudinal study of 39 cases, Burke and Orton noted specific ocular conditions associated with disturbed neurophysiology attributed to whiplash of the cervical spine.[22] They noted that while the brain and brain stem may also be injured in such trauma, dysfunction of the cervical spine could be associated. They found that 25.6% of the patients had *"…reduced range of cervical spine movements in addition to symptoms of soft tissue injury."* Further, they found that the nature of the ocular disturbance was related to the *"different patterns of anatomical injury at the time of impact that presumably relate to the various types and distribution of forces…"* These resulted in a number of neurological disruptions through *"infranuclear to supranuclear oculomotor anomalies."* The range of neurological-related findings presented clinically as:

Decreased visual accommodation and/or convergence

Decreased prism vergence power

Oculomotor palsies or dysfunction

Horner's syndrome (Citing Duke-Elder)

Internuclear ophthalmoplegia

Inverted optokinetic nystagmus

Saccades and/or stereoacuity

Superior oblique paresis

Suspected maculopathy

This biological response to the trauma would naturally depend on a number of factors, including the degree of severity and direction of the forces, the duration since the accident, the degree of involvement of neurological disruption and other tissue injuries, as well as general underlying health, physical status, age, previous trauma history and other usual predisposing factors.

In relation to less extreme injury, it would seem reasonable to conclude that if the two foregoing lists of autonomic symptoms and signs were the result of cervical spine disturbance in whiplash, then rectification, modification or improvement of the functional cervical spine physiology through SMT, could potentially lead to improvement in those same signs and symptoms. In severe injury involving fracture, ligament rupture, disc prolapse and brain and cord damage, manual intervention would usually be contradicted, particularly in the early stages.

It is acknowledged that musculoskeletal (somatic) alterations of the cervical spine with inherent sensory changes can produce pathophysiological changes in

relatively common clinical presentations such as cervicogenic headaches. It would also seem possible that such alterations could have the potential to produce other pathophysiological changes elsewhere, including cranial nerve innervation. (See *Cranial Nervous System* in Table 1 & Appendix B.) In addition, comparable altered musculoskeletal mechanisms at other levels of the spine could similarly have the potential to pathoneurophysiologically influence visceral structures within their spinal level of innervation.[756]

In relation to cranial nerves, Bolton *et al* found a direct association with the neck and visceral innervation. They stated that *"This reflex-sympathetico-excitation component has been suggested to arise from the dorsal neck musculature, with stimulation of nerves arising from these muscles* ***causing a reflex increase in splanchnic, hypoglossal, and abdominal nerve activity."*** [17]

A somatic component in the immune response was identified by Gordienko in 1958, the concept is now attracting increasing attention.[285] Research into an immune response to trauma has been noted by Kivioja in 2001 and Rutkowski in 2002.[286,289]

More recently, interest is developing in relation to the phenomena of the autonomic-immune and somato-autonomic-immune associations.[290] For instance, Cevikbas *et al* conclude *"Peripheral sensory and autonomic nerves are critically involved in many pathways of the innate and adoptive immune system during allergic and atopic skin diseases. Further dissection of receptor-mediated and intracellular signal pathways will help to develop more effective therapeutic approaches for allergic and inflammatory skin diseases."*[283]

Chiropractic researchers, particularly Brennan and others, have published a number of observations on this phenomena and its association with spinal manipulation.[2]

Sato cites a 1994 study by Kimura *et al*, who found a somatic afferent association with the spleen in *"using anaesthetized animals to eliminate emotional factors, (they) succeeded in proving that somatic afferent stimulation produces a reflex effect on immune function, with autonomic nerves acting as the efferent pathway."*[757]

In manual therapy research in 2004, Johnson noted that *"… the neuropeptide levels in the cell bodies located within the dorsal root ganglion of sensory nerves fluctuate according to the physiological state of the zygapophysial joint."*[758] This observation would tend to support the concept of a connection between the state of the somatic component – importantly a vertebral articulation, and at least the sympathetic nervous system – a somatosympathetic neurological circuit. Earlier, Slosberg in 1988, reviewed the effects of altered joint physiology on the sympathetic nervous system.[759] Sterling *et al* demonstrated further, the effect on the sympathetic nervous system through cervical articulation mobilisation.[362]

It would be difficult to imagine that after this clear evidence of autonomic disturbance following trauma such as whiplash, that mechanical disturbance of spinal regions other than the cervical spine, would not also influence associated neurophysiology.[2] It is noted that the absence of evidence is not the evidence of absence, and as Budgell stated, *"there is little evidence of any sort to argue against…"* the concept of chiropractic management of a range of visceral disorders.[760]

The research by Sato et al, examines the rather extensive influence of somato-autonomic-visceral function. They studied how stimulation of the thoracic spine in rats produced simultaneous response of adrenal and renal nerve activity, heart rate and blood pressure, and that *"Lateral stress stimulation of the spine produced consistent decreases in blood pressure and renal nerve activity."*[761]

"Spinal manipulative therapy can affect the resting status of somatic structures via mechanical and neurological (somato-somatic reflex) mechanisms, and this can cause a change to the afferent arm of the somato-visceral reflex. It is likely that supraspinal influences play a major role in this effect. … Such changes can occur by the direct action of a somatovisceral effect at the segmental level."[762]

RELATIONSHIP TO SPECIFIC VISCERA OR SYSTEMS

"In this study of body homeostasis and environmental adaptation it would seem very important to further analyse the contribution of somatic afferent input to the autonomic nervous and hormonal regulation of visceral organ activity… (and)... that visceral functions can be moderated by somatic afferent input via various degrees of integration of autonomic nerves, hormones, and immunological processes."[309]

Both medicine and the manipulative sciences have shown varying degrees of interest in a wide variety of spine-related somatovisceral disorders. The numerous papers include literature reviews, single and multiple case reports, as well as more formal studies on such conditions as asthma, enuresis, headaches and some gynaecological conditions (Tables 1 & 2).

A classic example of the physiological base regarding the SAV Triad in the published literature is in relation to some cardiovascular disorders. In 1973 Barron and Coote demonstrated that movements of the knee, especially noxious movements, are known to induce increases in the heart rate, arterial blood pressure and ventilation of non-anaesthetised decerebrated cats. Further, they noted that *"… electrical stimulation of articular nerves led to similar cardiovascular responses."*[763] In 1975, Coote reviewed the decade of published literature surrounding the somatovisceral connection between somatic structures and heart circulation.[764]

In other studies, spine-related influence of blood pressure has been investigated. Neurophysiologic research by Sato *et al* stated that *"… the decreases in blood pressure and renal nerve activity during manipulation of the spine are thought to be supraspinal reflexes*.[765] This significant 1997 study clearly demonstrated a neurospinal influence on blood pressure and renal nerve activity. They noted that changes took place even after resection of the upper cervical cord and involved an *Articulo-Cardiac Sympathetic Reflex*. They stated that *"Following acute spinalization at the C1-C2 level, mechanical stimulation of the spinal column produced small increases in blood pressure and increases in adrenal nerve activity and renal nerve activity. Thus the decreases in blood pressure and renal nerve activity during manipulation of the spine are thought to be supraspinal reflexes."*[765]

In May 2007, in a significant neurophysiologic study using mice and rats, Edwards and colleagues identified the central neural pathways through which they felt lay an explanation as to why neck manipulation in cases reducing hypertension may be explained. They drew the connection between sympathetic nerve activity and the *"projection from the Intermedius nucleus (InM) of the medulla to the nucleus tractus solitarius (as) a major area for autonomic control circuits."*[687] Further, in citing two other studies by Kuwagata *et al* and Shortt and Ray,[766,767] Edwards *et al* also state that, *"... Activation of neck muscle spindle afferents via neck flexion can initiate an increase in heart rate, muscle sympathetic nerve activity, and arterial blood pressure."* – a finding attributed to Bolton *et al*.[768] Significantly, they recognised papers of chiropractic research concerning spinal adjustments and a relationship to blood pressure to by stating *"Additional evidence for the involvement of the suboccipital muscle group in the cervico-sympathetic reflex comes from changes to blood pressure associated with chiropractic manipulations of the C1 vertebrae, which would result in altering the length of fibers in the suboccipital group."* This statement was supported by citing the two chiropractic papers by McKnight & DeBoer, 1988[97] and Knutson, 2001.[95] Edwards also cited two papers by Bolton *et al*,[768,769] their research was conducted through a medical research facility. Bolton's papers are significant in that as a neurophysiologist and chiropractor, his formal research is leading to a clearer understanding of some of the foundation principles behind chiropractic neurophysiology models. In this writer's (PLR) observation, it is becoming more frequent for chiropractor-authored papers to be cited in medical research. However at other times, even on chiropractic topics, this profession's papers seem to be pointedly avoided.

In 2007, another medical manipulative study by Bakris et al concluded that *"restoration of an Atlas alignment (through its adjustment) is associated with a marked and sustained reduction in BP similar to the use of two-drug combination therapy."* [119]

Earlier, in osteopathic research, Burns studied the effects of *"... somatovisceral reflexes in animals, (when) electrical and mechanical stimulation was applied to spinal muscles and the reaction of the viscera noted. … In human subjects electrical stimulation of the thoracic spinal muscles increased blood pressure and heart rate while steady mechanical pressure upon a vertebra decreased blood pressure and heart rate."* She concluded that *"...somatovisceral reflexes are less limited and direct than viscerosomatic reflexes"* and suggested further *"that normal visceral activity depends on somatosensory stimulation."*[239]

Other osteopathic researchers have also noted the somatovisceral connection in relation to the cardiovascular system. They have particularly looked at an association between somatic (spinal) palpatory findings and an association of them with a variety of cardiac conditions. These have shown a reasonable degree of correlation.[130-132,140-142] Cardiac conditions researched by osteopaths, include coronary artery,[130,132,134] myocardial infarct,[136,251,770,771] cardiopathy,[250] hypertension [135,140-143] and cardiopulmonary disease.[133]

The more widespread ramifications of the SAV Triad would seem to be assessed by Budgell and Sato who concluded that *"… it is apparent that somatic stimulation is capable of causing widespread and, at times, profound visceral responses, both in the short and long term. The most consistent and potent reflexes are induced by noxious stimulation or the activation of unmyelinated afferent fibers."*[299]

SIMULATED CONDITIONS

It is possible that a percentage of so-called somatovisceral symptoms which present clinically, or respond to SMT or virtually any other regimen, are symptoms simulating a condition.[702]

There are numerous papers in the literature on simulated disease. Such conditions were recognised in a series of papers by Davis and Ritso between 1948 and 1953,[772-774] and Carnett in the 1920's,[775,776] while Cyriax published on the topic as early as 1919.[45]

Some presenting conditions may have been previously diagnosed by other health professionals, without the consideration of a spine-related element. Such cases may involve the presentation of a *simulated* symptomatic form of a condition, which may have subsequently responded to manipulative intervention. If it had been treated by the previous health practitioner as an actual condition instead of a simulated one, the patient may not have been correctly managed. Consequently, the accuracy of the diagnosis as well as the efficacy of the treatment must then be questionable. A positive patient response would then be thought favourable regardless of the intervention. That is, in the absence of a specific pathology, it is purely the symptom itself being recognised and addressed by the treatment. In the case of simulated conditions generally, it could hardly be regarded as satisfactory for treatment response to be used to confirm the diagnosis after ministrations – *the treatment worked so therefore the diagnosis must have been correct (or did the symptoms resolve themselves?)*.

If a patient's symptoms are deemed to be simulated based on a prior diagnosis, and previous health professionals have treated the patient based on that diagnosis, then the other professionals would also have been treating a simulated condition.

As simulated conditions have been recognised in medical papers and the accuracy of the diagnosis may therefore be uncertain, it would be understandable that findings, even particular Cochrane Collaboration studies, may be inconclusive. In cases of deferred recognition of simulated conditions, such findings would depend on the accuracy of the diagnosed condition originally.

If it was claimed that chiropractors treating visceral conditions only attain results if the condition is a *simulated* one, then it would be appropriate to consider patients with the same diagnosed simulated spine-related conditions presenting to all health professions, not just those in the manipulative sciences.

Following an accurate diagnosis, and to achieve optimal patient results, it would be expedient to determine which patients are best suited to respond to manipulative therapy, which patients are best suited to other forms of therapy, which cases would be best suited to a combination of regimens,

why patients find they may need less medication – if any, and ultimately, how can results be further improved?

A recent osteopathic study by Noll *et al* explored the benefits of combined manipulative care and reduced medication in elderly patients with pneumonia.[296] Chiropractic[777-781] and osteopathic [240,242,245,247,250,252,782-784] evidence has suggested that vertebral manipulative influence may have the potential to enhance in-patient response in co-operative inter-professional therapeutic approaches in surgical and other hospitalised patients.

"The health fields have largely overlooked the importance of the VSC, particularly the autonomic implications." [785]

EVIDENCED-BASED MEDICINE (EBM) / EVIDENCED-BASED HEALTH CARE (EBHC)

"Prevailing theories and accepted explanations for empirical phenomena appear to have strong influence on the acceptance of new ideas. Prevailing theories may delay the acceptance of ultimately proven innovation."[786]

One could suppose that if EBM was truly enforced as promoted, there would be no recall of drugs, surgical procedures or therapies. Forms of manual therapies have persisted for hundreds of years and the more modern versions for over 100 years without recall or major change.

Even recently, empiricism has been quite an acceptable foundation for medical treatment and research,[787] and centuries of acupuncture apparently provided a base for medical acceptance. Now however, evidence-based medicine (EBM), particularly in the form of double-blinded, placebo controlled randomised studies appears to have become the yardstick.[788] However, some doubt has been expressed as to its strength, weaknesses, appropriateness, and conclusiveness for aspects of the clinical health sciences.[789-792]

Chapman-Smith noted Hawk *et al's* review concerning evidence. In casting *"… a wider net for evidence than just randomized controlled trials…"* they included observational studies and case reports, and cited recent *"… protest within the scientific community against near-total reliance on RCTs as a source of evidence."* Amongst other conclusions, they opined that *"body-based practices like chiropractic do not lend themselves to blinding of patients as to what treatment they are receiving."* They note however that RCT's are "*not necessarily incompatible with WSR*" (Whole System Research) but that this profession should adopt more *"observational design"* research – retrospective cohort studies being an example of this. Chapman-Smith reports *"… that there is now sufficient evidence to support the conclusion that chiropractic care – meaning the entire clinical encounter rather than for example spinal manipulation only – 'provides benefits to patients with asthma, cervicogenic vertigo and infantile colic.'"*[793]

In relation to the clinical application of research, Chapman-Smith also cites Triano by stating *"Randomized controlled trials should not be the sole basis of practice benchmarks… problems with them are that they focus on easily measurable items only, ignore context and the skill of the provider, minimally acknowledge the confounding effects of placebo healing properties, and ignore patient actions and preferences. Additionally poorly performed RCTs are more misleading than well-performed cohort studies."*[794]

As an example of this, and its practicality in research for the clinical sciences, Brox stated that in relation to RCT's of spinal surgery *"No study comparing surgery with sham surgery was identified."* He concluded that *"RCT's provide evidence to support clinical opinions before implementation of new techniques, but the individual clinical experience is still important for the doctor who has to face the patient."*[795]

Simon also questions the infallibility of RCTs when he stated that *"all research has flaws… so it would be a mistake to label the RCT as a gold standard for all research. A silver standard may be a more appropriate label."*[788] While Grossman stated that the RCT *"… is not a gold standard: it is a good experimental design in some circumstances, but that's all."*[796] That is not to say that there is not a need for RCTs in chiropractic, there is a definite need for it as one part of the profession's evolution. Supportive (or negating) evidence should be derived from a variety of sources. Patient results and satisfaction would have to be two of those forms of evidence. In relation to medicine, Pring notes Zwi as stating *"… that the definition of evidence remains contested, and there has not been enough attention to values, perceptions and the consumer perspective."*[797] In other words, the last phrase suggests that the treatment was administered perfectly, but the patient may not have been satisfied! Case reports still appear regularly in medical journals; these record revelations, efficacy, and observations of drug findings and surgical outcomes. Other such papers may be single case reports of positive findings or adverse events. It is submitted that in the clinical sciences, not all situations are suitable to undergo double-blinded, placebo-controlled studies. Based on medical precedents, case reports published in chiropractic journals would seem to be a legitimate indicator of clinical efficacy or otherwise, albeit at a basic evidential level. It would seem that the weight of numbers would help provide a foundation to justify further research, clinical utilisation, development, and advisability.

In relation to anecdotal case reports, it could be reasoned that professions cannot indulge in level 1 double-blinded research studies unless there is a basis upon which indications have emanated that substantiate those deeper studies. Serious research demands can arise from fundamental clinical observations and case reports. These must be positive to warrant initiating continued interest and justify research for possible adoption of particular findings.

Practitioners of the manipulative health sciences cannot ignore the clinical observations that many patients both appear to respond, and claim to respond to SMT for non-musculoskeletal conditions and symptoms. The evidence presented may provide some insight into the underlying reasons for such a response. One anticipates further elucidating research to explain, justify and develop those successful results into the future.

Studies have been made to assess the general well-being of patients under manipulative health care, while other studies have examined their overall health status, activity tolerance and spinal integrity under such care.[34,60,205,206,210,221,234,243,484] One study compared the general health status

of paediatric patients under manual health care with those under medical care.[215] This study compared the health of 200 paediatric patients of chiropractors with 200 patients of medical paediatricians with a response rate of 35.5% - the patients were the practitioners own children. Amongst other conditions, the chiropractic patients *"showed 69% otitis media free response"* compared to 20% of the children under paediatric care. They also had less allergies, less tonsillitis, and five-times less antibiotic use.

The question must arise as to whether a patient presenting clinically should be managed with drugs or other means. Indeed, it is submitted that if vertebral influence can be a negative factor in a particular condition, and if that spinal influence has not been considered in that condition, other therapeutic methods may well be limited in their efficacy. Alternatively, therapeutic benefit may be enhanced if manual vertebral attention is employed in certain cases where spine-related aspects may be involved. The possibility of assessing patient results through combined inter-professional co-operation in the management of patients with dysfunctional spine-related factors would seem warranted, but yet to be fully explored.

As stated by Plaugher "*If the chiropractic approach to low back pain had been abandoned early on due to the lack of research data, we would have never known its superiority to other conservative treatments*."[798] It is submitted that the material presented here would indicate that a neurovertebral-manual-pathophysiological model may have the potential for making a significant contribution to health care. Eventual corroboration would justify continued research, development, and ultimately its clinical adoption as one of the worthy natural models in the provision of general health care. Evidence Based Health Care[798] (EBHC) would have to be a part of that validation and acceptance. A Pubmed search would suggest that the term EBHC[800] has only existed since 1994.

To be able to influence at least some internal biological physiology by manual means, would have to potentially be one of the most significant, least invasive, optimal, and preferable forms of health care management for a particular range of conditions. In the absence of contraindications or evidence to the contrary, the material proffered here suggests a case for positive rationalisation in this direction rather than rejection.

As Goodman noted, *"While RCT's are the 'gold standard' of internal validity for causal relationships, they are not necessarily the best method for answering all questions of relevance to an HTA*" (Health Technology Assessment).[801]

In assessing the opinions reviewed here, it would seem EBHC is essential for optimal levels of care. However, it needs to be based on a range of evidential methods that include clinic-based care and patient satisfaction outcomes. Strictly formal high-level research and laboratory studies are central, but their relevance to clinical application also demands patient-based studies. It is appreciated that the research criteria for medical sciences such as chemotherapeutic regimes may differ from those in the physical and manual clinical sciences – as in the application of a placebo for instance.[802]

ANECDOTAL EVIDENCE

One could argue that empiricism is a form of anecdotal evidence. Many of the services provided by health professionals on a day-to-day basis are based on experience, observations, verbal communication and clinical expertise. These are not necessarily bound by rigid rules of the pure scientific experiments. To treat all patients with the same condition in exactly the same way would no doubt compromise efficacy. Certainly, definite scientific principles apply, as well as a scientific foundation as a basis for knowledge and application of interventions.

Enkin and Jadad have crystallised the underlying contribution of anecdotal evidence when they conclude that, *"Anecdotes are powerful tools that humans use to make decisions. Despite their power and influence, they are sometimes misused, and sometimes undervalued. Ignoring or under-estimating the role of anecdotal information in health care decisions is likely to hinder communication among decision makers, and to retard their uptake of research evidence. Anecdotal evidence should not be considered a replacement for, but as a complement to formal research evidence. If evidenced-based health care is to meet its potential, the important role of anecdotes must be acknowledged, studied and utilized."* [803]

The writer (PLR) has collected a number of examples of papers from the literature concerning spine-related respiratory conditions, particularly asthma. These are in the form of anecdotal observations, single case reports, and literature reviews, through to the double-blinded studies. There are at least 21 chiropractic and 8 osteopathic papers concerning respiratory conditions. In addition, there are at least a further 35 medical references published in relation to spine-related respiratory conditions – dating from 1925 to 1995.

Although many of the papers to date constitute low-level evidence, they nevertheless provide a base as well as a record of clinical observations upon which deeper research can be justified. Without these, both the interest in, and the demand for an explanatory understanding would arguably wane. Significantly stronger formal evidence is steadily accumulating, and cannot be ignored.

Previously, when anecdotal observations and case reports were noted in the medical literature, many seem to have provided the basis for serious consideration, and justify subsequent formal research into the particular topics raised. An example of this is in the Medical Journal of Australia, where letters to the editor often seek to raise clinical observations for discussion. The same principle could reasonably be applied to the case reports and observations recording chiropractic clinical experiences.

It could be said that it would be irresponsible *not* to record such observations in anecdotal reports and that clinical observations and anecdotal findings should have a role in the literature of the health care sciences. As John Faine, a Melbourne radio commentator noted, *"Anecdotes are just anecdotes. But plenty of them add up to evidence."*[804]

Without hypotheses and case reports, there is no first stage of interest to provide, nor basis to justify the impetus for further research. It has to begin somewhere - in the same way it has for other professions over the decades.

In the health professions, scepticism persists in relation to anecdotal evidence.[805] It also persists in relation to higher levels of evidenced-based medicine. Borgerson discussed the appropriateness of EBM and noted *"The validity of evidence-based medicine (is) the subject of ongoing controversy"* [806] Further, Muffulli stated in an editorial that *"These days, evidenced-based medicine (EBM) is considered a major step forward. It is not a new concept, it is not always applicable to the whole of one's practice, it is not necessarily "good" medicine, and it is not always the standard to which we should all aspire. Nevertheless, EBM is an attempt at making our practice more scientific and successful."* She states further that *"Case reports, one of the quintessential examples of Level V evidence, are the bricks on which modern biomedical research has been built. … Even those of us who believe in EBM recognize that not every aspect of our practice can or should be randomised."*[807]

Regarding reservations in relation to this somatovisceral model, it can be noted that similar scepticism was expressed towards chiropractic manipulation in relation to back and neck pain. This attitude was the antithesis of the medical model on those conditions at the time. In due course, SMT has become not only recognised but adopted as a medical procedure, presumably based on anecdotal evidence – a different standard of evidenced-based health care.

When a patient reports that despite previous allopathic care, treatment from a chiropractor did relieve their symptoms of asthma, headaches or hay fever, and that they would like further care should the symptoms recur, what is a practitioner supposed to do? Reject the patient by denying them care because "there is no 'scientific' evidence to justify their expectation and their observed response?" (Despite the fact that medication had not helped them!) In view of repeated positive response, the patient would be justified in seeking the care of their preference. Where there is a rising incidence of asthma despite rising prescription rates, surely it is a patient's prerogative to seek the choice of care available when they experience positive results!

In chiropractic care, it may not be the practitioner who initiates anecdotal evidence, but the demands for health management of a particular non-musculoskeletal condition by patients themselves. The patient's own observation may report symptomatic relief, or resolution of the condition itself. This evidence may well be based on their previous positive response, or results noted by relatives and acquaintances. It is hardly justifiable to deny a patient's request for care in the absence of 'hard' scientific data, when their own clinical observations have been repeated time and again. The absence of hard evidence does not necessarily mean that treatment is ineffective, it may however mean that hard research or clinical trials have not explained it - *yet*. Enkin and Jadad state that *"Ignoring or under-estimating the role of anecdotal information in health care decisions is likely to hinder communication among decision makers, and to retard their uptake of research evidence. Anecdotal information should not be considered as a replacement for, but a complement to formal research evidence."*[803]

While anecdotal evidence is not generally regarded as high level evidence and therefore not conclusive, gathering anecdotal evidence would seem to be a legitimate and justified part of establishing a realistic clinical base, without which further, deeper research would be limited. Much of all the health professions' clinical developments appears to have evolved from clinical observations over a long period of time.

"The randomised trial is unlikely to be replaced, but it should be complemented by other designs that address questions about technology from different perspectives." [808]

SUMMARY

"There is increasing evidence that manual therapies may trigger a cascade of cellular, biomechanical, neural, and/or extracellular events as the body adapts to the external stress …including those that function proprioceptively…and, in turn, can lead to responses by the central and autonomic nervous systems. These responses or alterations may, in turn, lead to observed changes in circulating levels of various neuropeptides and regulatory proteins." [809]

This paper and its forerunner [2] have sought to depict some of the published literature supporting the underlying profundity of chiropractic theory. It has striven to demonstrate the existence of a respectable degree of material in relation to chiropractic concepts up to this time.

It is submitted that this paper establishes a valid basis for a legitimate concept of a somatosensory-autonomic-visceral role in health care, and:

- That published formal research by chiropractic and other professions, as well as clinical observations, have contributed towards substantiating this foundation.
- That there are reasonable grounds for a manipulative model supporting aspects of health care, much of which is based on the medical literature.
- That elements other professions have adopted and published material on this model.
- That there is far more evidence in support of this chiropractic hypothesis, with virtually none refuting it.

An integral connection between the autonomic nervous system and the somatic structures has been recognised by chiropractors for some time. Almost 100 years ago, the founder of this profession acknowledged it as the *"nervous system known as the autonomic functions."*[810] It is the basis for the chiropractic premise of influencing the body through the ANS, namely through the neurospinal axis. This connection also implicates the adverse effects of noxious neural input particularly through spinal articulations. As shown, these connections are the subject of ongoing research based on considerable supportive studies within the various health professions.

It is again submitted that spinal manipulative health care relates to one aspect of chiropractic health care management. Other natural regimens may also be employed when thought appropriate. Evidence from the literature on other aspects has not been presented at this time.

Surprisingly, despite an apparent reluctance in accepting this model, there seems to be a dearth of evidence which might reveal that a vertebral adjustment or spinal manipulation may

not have an influence on the autonomic nervous system and internal physiology. Given that in orthodox circles there is some scepticism as to the role of manual influence of neural physiology, one would have expected serious research to justify those doubts. On the contrary, there appears to be more papers from within medicine as well as the manual therapies that tend to support, or at least acknowledge, a potential role of autonomic influence through manual input.

This paper has sought to present a number of significant points in relation to neurospinal hypotheses:

- Formal clinical studies comprising high level evidence does exist (Table 2).
- Formal neurological studies comprising high level evidence do exist.[2] (Also see Table 2).
- Clinical observations to varying degrees, have been extensively reported in the literature by all professions (Table 1).
- That animal studies in relation to neurovertebral physiology have been undertaken.[2]
- That studies of both human and animal models have been undertaken.
- That supportive neurophysiologic evidence underlies the hypothesis.[2]
- There is evidence of medical adoption (mostly European) of vertebrogenic visceral principles. Over 90 papers and 50 primary authors are cited in this listing (Appendix A).
- That an historical basis for a somatovisceral-ANS model has existed in the medical literature, with there being no apparent physiological research studies to demonstrate why this evidence has not been adopted or developed by allopathic medicine (Appendix C).
- That one could reasonably conclude there is a rational basis upon which to build a model of this facet of health care, or at least further explore its potential.

In addition, the citations in this paper would indicate that clinically, chiropractic, osteopathy, medicine, and physiotherapy all recognise a mechanical neurovertebral connection with organic or visceral influence. However, it would appear chiropractors and osteopaths have focussed more strongly on the hypotheses concerning the phenomenon. Not only is the vertebral lesion, known by chiropractors as a 'vertebral subluxation complex' (subluxation or VSC) the central focus, but the term is now identified by a variety of other appellations by all these professions.[720] Significantly, manual correction of this form of spinal neuro-mechanical dysfunction is recognised as a therapeutic regime for a number of conditions by all these professions or sections therein. Ironically, these two points suggests subtle recognition and acceptance as to their significance.

The evidence presented varies from recent to long-standing. That is, the manual health sciences have based their hypotheses on both the neurophysiologic and clinical or anecdotal findings. It can be noted that the available evidence is:-

- Not limited to chiropractic journals,
- Published in chiropractic, medical, osteopathic, and neurophysiology sources,
- Derived from medico-scientific neurophysiologic research,
- Often inter-professional in authorship,
- Often inter-professional by the journals in which it is published,
- More strongly adopted by European medicine than in the US, Australia or the UK,
- Supportive of continued utilisation and efficacy, and that research should continue.

In 1974, Johnson and Spalding remark that, *"All human actions, voluntary and involuntary, are accompanied by activity of the autonomic nervous system. Nevertheless, clinical textbooks give little space to its dysfunction, and its disorders are often reported as medical curiosities."*[811]

In 2006, Jänig made clearer recognition by stating *"…the results reported so far suggest that the autonomic circuits in the spinal cord are important for integrating information from the periphery and from supraspinal brain structures for the spinal autonomic outflows. They clearly demonstrate that the spinal cord contains neural circuits, which consist of preganglionic neurons, putative interneurons (which includes segmental and propriospinal interneurons) and the synaptic connections of these neurons with the afferent inflow from the periphery and with autonomic premotor neurons projecting to the spinal cord."*

"Spinal circuits may be important in the coordination of somatomotor functions and spinal autonomic function." [812]

Judging by the number of journals and textbooks currently emerging, there would seem to be a growing recognition of the everyday clinical importance of the ANS.

CONCLUSION

Considering the weight of evidence submitted, there would, in selected cases, appear to be the potential to positively optimise human physiology with minimal physical intervention through manual methods. The evidence has been produced from within all the health professions where manipulation has been utilised including medicine. It has been there for all of them, but some of the professions employ that information more than others.

In essence, this dissertation has been an attempt to highlight the published literature surrounding the hypotheses appropriate to the manual manipulative therapies in general, and the science of chiropractic health care in particular. Following on from a previous paper,[2] it draws connections between the effect upon the autonomic nervous system of pain, postural disturbance, and the mechanical articular disruption of trauma with whiplash being the most readily demonstrated. The emphasis in this paper has been to look at the reflexogenic effects of factors associated with aberrant vertebral segmental function the VSC. It then follows the next association that of an effect of subsequent spine-related irritation of the ANS upon the physiology and

pathophysiology of structures innervated by this modified ANS. In this paper, this particular model has been designated the SAV Triad.

On balance, there would seem to be sufficient published evidence to warrant the adoption of, rather than the rejection of, continued exploration into the potential of this model. This would call for deeper research into the clinically observed phenomena of organic responses or processes as well as patient health status, by manual influence upon the nervous system.

The major foundation of demonstrable rationalisation of the vital connection between overt intervertebral mechanisms influencing neural function in a controlled manner, would seem to be emerging through modern research. This has followed years of positive indications of influence through clinically observable patient response.

Much of the evidence base for spine-related somatovisceral papers is sound, orthodox neurophysiologic rationale, underpinning a plethora of case studies and anecdotal reports. A substantial amount of this evidence is from medical sources.

There are numerous level I evidence papers on various lumbar spine and cervical spine conditions, as well as cervicogenic headaches. There is however, a need for more and continued development to exploit any potential for manually-influenced somatovisceral physiology.

It is the emphasis on a localised ANS connection with the spine which would differentiate the chiropractic health care profession from others in the manipulative and manual therapies field. It must be appreciated that this association implies more than a musculoskeletal connection, and thereby may have the potential to influence neurophysiology and consequently homeostasis, which could contribute to overall patient well-being.

Research continues to emerge which clarifies why this chiropractic model endures. This model appears to provide some rationale as to its efficacy in certain neuromusculoskeletal cases. It would also seem that relegating chiropractic into a corner of solely musculoskeletal conditions would potentially deny benefits to those patients who are experiencing what may be termed spine-related or vertebrogenic autonomic conditions. Research may also demonstrate which patients, which conditions, and which combinations of therapeutic approaches are best suited in a particular case. On the other hand, it should also eventually demonstrate why it may not produce a positive response in certain cases, and therefore render a particular patient as a non-candidate for this type of care.

If the vertebral neuraxis is indeed a significant factor in some internal conditions, then professions would be remiss in ignoring or overlooking such a central element. The somatovisceral hypothesis cannot be rejected before sound, fundamental scientific answers are defined to negate it.

There is however, also much research still to be carried out in order to obtain the many answers required to meet today's standards of evidence-based and patient-centred needs. After more than a century of clinical observations, the complex scientific research by Sato et al, Bolton, Budgell and others mentioned, is establishing some fundamental answers for the somatovisceral phenomenon (Table 2).

It is this author's view that in many cases, the weight of scientific evidence so far, strengthens and supports, rather than opposes a role for the chiropractic vertebral adjustment in influencing the autonomic nervous system and associated pathophysiology in effector structures. At the very least, the evidence would suggest that there is indeed potential for this hypothesis, and it would be unscientific and irresponsible to dismiss or disregard it.

Given the volume and variety of papers listed, it is surprising that there is a dearth of research studies from any profession, which contradicts or challenges either the case reports or the findings of the levels IV and V research studies. Medical science seems to have researched much more obscure hypotheses in the past, but apart from verbal opinion, it has never, to this author's knowledge, ever seriously undertaken even fundamental research into the manipulative sciences per se. This is despite the use of strong medical physiological research which goes some considerable way in underpinning the neurovertebrospinal principles.

The weight of available scientific and anecdotal evidence would tend to support the concept of a neurological link between the clinically identifiable lesion known as a VSC, related signs and symptoms, and vertebral manipulation. In addition, there is evidence to suggest that addressing those lesions through vertebral adjustments, does tend to alleviate many of these signs and symptoms. While there may not be categorical evidence to date, as is also the case in many current medical diagnostic and clinical procedures, manipulation has survived and indeed thrived on its positive patient response and continuing patient referrals.

On the basis that there is demonstrable independent supportive evidence of somatosensory-autonomic influence and associated autonomic-visceral links, as well as numerous clinical observations there would have to be some justification for serious research into the potential of the SAV Triad. This may provide one of the possible models of spine-related somatovisceral managed conditions. Notably, most of the evidence supporting the SAV Triad hypothesis is based on both previously published medical neurophysiology research as well as contemporary studies.

Given this evidence, to deny that there is influence upon the ANS from articular disturbance (VSC) and manipulation – especially from spinal articulations, would be sharply contrary to existing evidence. Ensuing impact from an irritated ANS upon an innervated organ function must also be acknowledged as a pathophysiological phenomenon. However in recognising a VSC factor, the type of segmental disruption, the severity of initial trauma and duration since onset of that trauma, are aspects that may also govern the efficacy of a manipulative treatment. The neurological mechanisms have been and are currently, being more fully examined through promising neurophysiologic research and clinical observations.

Chapman-Smith, in citing the neurophysiology research reviews by Sato et al,[12] states that the book: *"… presents numerous basic scientific studies from which it is now*

perfectly reasonable to propose that noxious stimulation of the spine may disturb visceral behaviour of internal organs."[813]

While there may be limited definitive research at this stage,[203] there would appear to be strong grounds to warrant further research and possibly develop the knowledge further, rather than dismiss the concepts altogether.

The rather extensive list of references and appendices are available from the author via e-mail on cadaps@bigpond.net.au

Appendix A – European Medical Papers

Appendix B – More Detailed Version of Table 1

Appendix C – Early Medical Papers of Historical Interest

Table 1*

NEUROSPINAL RELATED VISCERAL CONDITIONS
NOMINATED ORGANIC CONDITIONS

CHIROPRACTIC	MEDICAL
CARDIOVASCULAR SYSTEM	
Angina [79,80]	Angina [111-116]
Congestive Heart failure [81]	Circulatory [117,118]
Circulatory [82-86]	Hypertension [119-121]
Heart Physiology [87-103]	Heart physiology/pathophysiology [122-128]
Hypertension [104-110]	Heart – catheteristion [129]
	Vasomotor 7[2]
OSTEOPATHIC	PHYSIOTHERAPY
Cardiovascular disease [130-135]	Cardiovascular [144-145]
Circulatory [136,137]	
Heart physiology [64,138]	
Hypertension [139-143]	
ENDOCRINE SYSTEM	
Pancreas - Chiropractic [146,147]	Pancreas - Osteopathic [148,149]
Endocrine - Medical [150]	Thyroid – Chiropractic [151,152]
EAR, NOSE & THROAT	
ENT – Chiropractic [153-168]	ENT – Medical [169-172]
ENT – Osteopathic [173-177]	
GASTROINTESTINAL	
Bowel – Chiropractic [178-182]	Bowel – Medical [183,184]
Colic – Chiropractic [185,186]	Colic – Medical (nursing) [187]
Gastrointestinal – Chiropractic [188-19]	Gastrointestinal – Medical [196-201]
Gastrointestinal – Osteopathic [202]	
GENERAL CATEGORY	
General – Chiropractic [6,8,31,203-219]	General – Medical [34,56,71,72,222--233]
Psoriatic Arthritis [220]	Sudomotor – Medical [234-236]
Sudomotor [221]	
General Osteopathic [14,63,65-67,237-252]	General – Physiotherapy [257]
Sudomotor – Osteopathic [253-255]	
Caffeine Withdrawal – Osteopathic [256]	
GENITOURINARY SYSTEM	
G/U Chiropractic [181,258-261]	Renal – Osteopathic [268,269]
Enuresis – Chiropractic [262-267]	Urinary – Medical [270,271]
IMMUNE SYSTEM	
Chiropractic [272-281]	Medical [282-290]
Osteopathic [291-298]	
NERVOUS SYSTEM	
Autonomic Nervous System –Chiropractic [2,299-304]	Autonomic Nervous System – Medical [305-309,358]
Autonomic Nervous System – Osteopathic [310-315,525]	

NERVOUS SYSTEM - BRAIN	
Chiropractic [4,6,19,25,316-338]	Medical [306,339-355]
Osteopathic [356]	Physiotherapy [357-365]
NERVOUS SYSTEM - CRANIAL	
Cranials - Chiropractic [366-373]	Cranials – Medical [374-379]
Cranials - Osteopathic [380-381]	Vertigo – Chiropractic [68,382-386]
Vertigo – Medical [387-39]	Vertigo – Physiotherapy [395]
Headache – Chiropractic [396-415]	Headache – Medical.[53,54,69,70,339,376,416-444]
Headache – Osteopathic [445-449]	Headache – Physiotherapy [450-458]
Multiple Sclerosis – Chiropractic [459-461]	Multiple Sclerosis – Osteopathic [462]
Myasthenia Gravis – Chiropractic [463,464]	Pain – Chiropractic [465,466]
Pain – Medical [2,467]	Parkinson's Disease – Osteopathy [468]
PEDIATRICS	
Chiropractic [215,327,329,330,333,383,469-506]	Medicine [74,187,507-513]
Osteopathy [170,514-523]	Physiotherapy [458]
POSTURE[2]	
Chiropractic [151,214]	Osteopathy [524-526]
Medical [20,34,199,226-229,364,439,443,527-535,612,613]	
PSYCHOLOGY/PSYCHIATRY	
Chiropractic [110,469,471-473,483,502,503,536-549]	Medical [550-553]
Osteopathic [554-558]	Physiotherapy [361,559]
REPRODUCTIVE SYSTEM	
Gynecological Chiropractic [560-582]	Gynecological – Osteopathic [583-587]
Gynecological – Physiotherapy [588]	Obstetrical – Chiropractic [589-591]
Obstetrical – Medical [592-595]	Obstetrical – Osteopathic [519, 596]
RESPIRATORY SYSTEM	
Chiropractic [597-610]	Medical [226,611-615]
Osteopathic [174,176,177,291,294,297,616-626] Incl. Influenza vaccination [292,296]	Physiotherapy [144,145,627]
VISION	
Chiropractic [628-646]	Medical [20,22,340,376,647]
Osteopathic [648-652]	

(* ABRIDGED VERSION. For complete table listing nominated conditions and references, please contact the author by email.)
This table represents papers of interest to the manipulative sciences, they may involve the management of particular cases and do not necessarily involve spinal manipulation. Such management may include dietary advice, exercise recommendations, life style changes and weight loss recommendations.
Table 1 is a representation of published literature demonstrating aspects of the spine-related SAV Triad (SAVT).
The format of Table 1 has been designed to depict the topics or condition which could be classified under this SAV Triad. By citing a number of papers under a particular area, it also reflects the weight of interest in the various conditions or systems. It can be noted that there is an overlap of categories, professions, authors, and journals as these can be interchangeable due to the inter-professional nature of journal selection and authorship of papers submitted. The year of publication has been included here to depict the degree of interest in the subject matter and its evolution over the decades.
*Includes a chiropractic author.
(Note Nominated categories tend to overlap due to an integration of authors, professions and journals associated with multiple professions,) See reference list for legend of journal abbreviations.

TABLE 2

EXAMPLES OF RANDOMISED CONTROLLED TRIALS
- AND OTHER MORE FORMAL RESEARCH STUDIES OF SPECIFIC CONDITIONS

PRIMARY AUTHOR	ALPHABETICAL FOCUS OF STUDY	MODE	TYPE OF STUDY	YEAR
CHIROPRACTIC				
Christensen HW	Angina	Man Therapy	Non-randomised prospective trial	2005 [78]
Brontfort G	Asthma	SMT	Prospective clinical series	2001 [598]
Hayek R	Asthma	SMT	Single Blind Cross- Over Study	1998 [599]
Nielsen NH	Asthma	SMT	RCT	1995 [607]
Balon J	Asthma	SMT	RCT	1998 [611]
Sanders GE	β-endorphin levels	Single LB Adjustment	Randomised Controlled Trial/Clin Trial	1990 [465]
Vernon H	β-endorphin levels	CervIcal Adjustment	Placebo/Controlled/RCT/CT	1986 [466]
Christian GF	β-endorphin levels & cortisol	SMT	Controlled Clin Trial	1988 [275]
Knutson GA	Blood Pressure	Upper Cerv Adjustment	Controlled Clinical Trial	2001 [95]
Plaugher G	Blood Pressure	SMT	Practice-based RCT/Pilot Study	2002 [107]
Yates RG	Blood Pressure/Anxiety	SMT	Randomised Controlled Trial	1988 [110]
Olafsdottir S	Colic	SMT	Randomised blinded placebo controlled trial	2001 [653]
Wiberg JM	Colic	SMT	RCT/Blinded observer	1999 [186]
Klougart N	Colic	SMT	Prospective Study	1989 [185]
Kokjohn K	Dysmenorrhea	SMT	RCT	1992 [570]
Holtzman DA	Dysmenorrhea	L5/S1 SMT	Prospective case series	2008 [567]
Hondras M	Dysmenorrhea Primary	SMT	Randomised Observer Blinded Clinical Trial	1999 [568]
Peterson KB	Emotional Arousal - Psychology	SMT	Double Blinded Clinical RCT	1997 [541]
Gemmell HA	Enuresis	SMT	Time series descriptive design	1989 [262]
Henriksen HH	Enuresis	SMT	Literature review/prospective study	1986 [263]
LeBoeuf C	Enuresis	SMT	Prospective outcome study	1991 [265]
Reed WR	Enuresis	Mechanical instrument	Controlled clinical trial/RCT	1994 [266]
Williams S	Headaches incl.	SMT	Double-Blinded Time Series	1989 [415]
Cochran JA	Headache (Migraine)	SMT	Case study	1994 [383]
Tuchin P	Headache (Migraine)	SMT	Randomised Controlled Trial	2000 [408]
Killinger L	Headache	SMT	Case series	1995 [602]
Mootz R	Headache (Tension)	SMT	Case series analysis	1994 [405]
Tuchin P	Headache (Chronic)	SMT	Case Series study	1996 [409]
Vernon H	Headaches	SMT	Retrospective and prospective study	1982 [410]
Whittingham W	Headaches	SMT	Continuous time series pilot study	1994 [414]
Budgell B	Heart rate	SMT/upper cervical	Cross-over	2001 [89]
Budgell B	Heart Rate Variability	SMT/Thoracic	Controlled Crossover Trial	2006 [88]
Bryner P	Indigestion/Heartburn	Prevalence	Descriptive Study	1996 [188]
Straub WF	Jet Lag	SMT	RCT	2001 [654]
Weber M	Menopause	SMT	Time series case report	1996 [583]
Sawyer CE	Otitis Media	SMT	Feasibility study	1999 [164]
Fallon J	Otitis Media	SMT	Case studies	1997 [156]
Fysh P	Otitis Media	SMT management	Case series	1998 [159]

Phillips N	Otitis Media	VSC	Case study	1992 [163]
Walsh MJ	PMT	SMT	Randomised placebo-controlled CT	1999 [581]
Rogers RG	Proprioception kinesthesia	SMT	Matched non-randomised controlled /Clinical setting	1997 [334]
Kokjohn K	Prostaglandin	SMT	Randomised clinical - pilot study	1992 [570]
Masarsky CS	Respiratory (Lung Volumes)	SMT	Retrospective Study	1986 [605]
Masarsky CS	Respiratory/COPD	General management	Case Report	1988 [655]
Stephens D	Vision	SMT	Prospective Case Report	1996 [644]
OSTEOPATHIC				
Guiney PA	Asthma	OMT	RCT	2005 [518]
Bockenhauer SE	Asthma	OMT	Blinded cross-over pilot study	2002 [619]
Mesina J	Basophilia – Transient -	Lymphatic Pump	Cohort controlled pilot study	1998 [295]
Belcastro MR	Bronchiolitis/infants	OMT	RCT pilot study	1984 [618]
Beal MC	Cardiovascular Disease	VCS/Predictive	Single-blind Study	1985 [130]
Beal MC	Cardiovascular Disease	Spinal Palpation	Prospective Clinical Study	1983 [131]
Cox JM	Cardiovascular Disease	Spinal Palpation	Double-blind Study	1983 [132]
Howell RK	Cardiovascular Disease	OMT	Anecdotal Case Report	1973 [133]
Plotkins BJ	Depression	OMT	Placebo randomised controlled pilot study	2001 [557]
Blood SP	EEG/ADD/ADHD	OMT	Pilot study	2000 [554]
Kelso AF	General Visceral Correlation	Palpatory & Visual	Double-blind Controlled Study	1980 [247]
Henley CE	Heart rate variability/ANS	OMT	Placebo controlled	2008 [64]
Kelso AF	Health Status	Palpation study	Double-blind Clinical Controlled Study	1971 [247]
Johnston WL	Hypertension	Spinal Palpation	Short-term longitudinal study	1995 [140]
Johnston WJ	Hypertension	Spinal Palpation	Long-term longitudinal study	1995 [141]
Morgan JP	Hypertension	SMT	Controlled trial	1985 [143]
Hundscheid HW	Irritable bowel syndrome	OMT	Randomised controlled pilot study	2007 [656]
Radjienski JM	Pancreatitis	OMT	Blinded RCT pilot study	1998 [149]
Beal MC	Pulmonary Disease	Spinal Examn	Literature Review/Clinical Study	1984 [617]
Miller WD	Pulmonary Disease (COAD)	OMT	Double-blinded Randomised Clinical Study	1975 [65]
Larson NJ	Pathology Correlation	Spinal Examinationn	Limited Controlled Study	1975 [250]
MEDICAL				
Bakris G, *et al*.	Hypertension	C1 (Atlas) adjustment	Double-blind placebo controlled	2007 [119]
Eddicks S	Angina	Dorsal Spine Stimulation	Placebo controlled randomised	2007 [113]
Heikkila M	Dizziness/Proprioception	Cervical Manipulation	Single subjects x14 - Pilot Study	2000 [342]
Goertz CH	Hypertension	SMT	RCT	2002 [121]
Margolius FR	Infantile colic	SMT	RC with blinded observer	2000 [187]