JCCA
Journal of the Canadian Chiropractic Association

(Formerly the Canadian Chiropractic Association Journal)

Published by the Canadian Chiropractic Association and issued quarterly

EDITORIAL AND EXECUTIVE OFFICES,
186 SPADINA AVENUE, SUITE 6, TORONTO, CANADA M5T 3B2

General Information: The Journal of the Canadian Chiropractic Association is the official quarterly publication by the Canadian Chiropractic Association. The JCCA is published quarterly by the Canadian Chiropractic Association as a medium of communication between the Association and its members and is a forum for fair comment and discussion of all matters of general interest to the chiropractic profession and the Association. Readers are invited to comment and express their opinions on relevant subjects. Views and opinions in editorials and articles are not to be taken as official expression of the Association's policy unless so stated. Publication of contributed articles does not necessarily imply endorsement in any way of the opinions expressed therein and the Journal and its publisher does not accept any responsibility for them. Business correspondence should be addressed to: the Editor of JCCA, 186 Spadina Avenue, Suite 6, Toronto, Canada M5T 3B2.

INDEXING SERVICES

JCCA is indexed by PubMed Central, CINAHL (Cumulative Index to Nursing and Allied Health Literature), MANTIS (formerly CHIROLARS), AMED, PASCAL, British Library Complementary Medicine Index, Index to Chiropractic Literature, and selectively by SPORTDiscus.

Contents

JCCA Vol 57 No 3 ISSN 0008-3194 (Print) and ISSN 1715-6181 (Electronic)

Editorial Board

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/189–204/$2.00/©JCCA 2013

An evidence-based diagnostic classification system for low back pain

Robert Vining, DC*
Eric Potocki, DC, MS**
Michael Seidman, MSW, DC†
A. Paige Morgenthal, DC, MS††

Introduction: *While clinicians generally accept that musculoskeletal low back pain (LBP) can arise from specific tissues, it remains difficult to confirm specific sources.*

Methods: *Based on evidence supported by diagnostic utility studies, doctors of chiropractic functioning as members of a research clinic created a diagnostic classification system, corresponding exam and checklist based on strength of evidence, and in-office efficiency.*

Results: *The diagnostic classification system contains one screening category, two pain categories: Nociceptive, Neuropathic, one functional evaluation category, and one category for unknown or poorly defined diagnoses. Nociceptive and neuropathic pain categories are each divided into 4 subcategories.*

Conclusion: *This article describes and discusses the strength of evidence surrounding diagnostic categories*

Introduction : *Bien que les cliniciens conviennent généralement que les douleurs lombaires musculosquelettiques peuvent provenir de certains tissus, il reste néanmoins difficile d'en confirmer les sources précises.*

Méthodologie : *Partant de données probantes étayées par des études d'utilité diagnostique, des médecins en chiropratique exerçant en tant que membres d'une clinique de recherche ont créé un système de classification diagnostique, des examens correspondants et une liste de contrôle basés sur la solidité des données probantes et l'efficacité à la clinique.*

Résultats : *Le système de classification diagnostique comporte une catégorie de dépistage et deux catégories de douleurs : une catégorie d'évaluation fonctionnelle, une catégorie nociceptive et neuropathique et une catégorie englobant les diagnostics inconnus ou mal définis. Les catégories de douleurs nociceptives et neuropathiques sont chacune divisées en 4 sous-catégories.*

Conclusion : *Cet article décrit et examine la solidité des données probantes concernant les catégories*

* Corresponding Author, Associate Professor and Senior Research Clinician, Palmer College of Chiropractic, Palmer Center for Chiropractic Research, 741 Brady St, Davenport, IA 52803; Telephone: 563 884-5153 Fax: 1.563.884.5227 robert.vining@palmer.edu
** Palmer College of Chiropractic, Palmer Center for Chiropractic Research, 5433 Bryant Ave, South Minneapolis, MS 55419; dr.potocki@yahoo.com
† Research Clinician, Palmer College of Chiropractic, Palmer Center for Chiropractic Research, 741 Brady St, Davenport, IA 52803; michael.seidman@palmer.edu
†† Research Clinician, Palmer College of Chiropractic, Palmer Center for Chiropractic Research, 741 Brady St, Davenport, IA 52803; paige.morgenthal@palmer.edu

Disclaimers: No conflicts of interest and no disclaimers to declare

Funding support: This work was partially funded through a grant from the National Institute of Health's National Center for Complementary and Alternative Medicine (NCCAM) (1U19AT004137). This project was conducted in a facility constructed with support from Research Facilities Improvement Grant Number C06 RR15433 from the National Center for Research Resources, National Institutes of Health.

for an in-office, clinical exam and checklist tool for LBP diagnosis. The use of a standardized tool for diagnosing low back pain in clinical and research settings is encouraged.

KEY WORDS: low back pain, chiropractic, diagnosis, evidence-based

diagnostiques pour des examens cliniques et des outils de liste de contrôle pour le diagnostic de douleurs lombaires musculosquelettiques. L'utilisation d'un outil normalisé pour le diagnostic des douleurs lombaires en milieu clinique et de recherche est encouragée.

MOTS CLÉS : douleurs lombaires, chiropratique, diagnostic, données probantes

Introduction

Health professionals across such disciplines as orthopedics, physical therapy, and chiropractic have shared the goal of categorizing patients with musculoskeletal low back pain (LBP) according to evidence-based classification systems.[1,2] To this end, several investigators have generated classification systems for LBP diagnosis and treatment.[3-8] Identifying specific pathophysiology causing LBP has the potential to positively impact clinical research and practice by providing opportunities to test, validate or reject treatments targeted at specific diagnoses.[1,2] Clinical prediction rules[4,6] and symptom or treatment-based classification systems[7,8] lack the pathophysiological component(s) clinicians sometimes use to better understand a condition and make clinical decisions. Patho-anatomic diagnoses address pain arising from more specific anatomic structures or pathological processes. However, definitively confirming pain sources for LBP continues to be a challenge.

Clinical guidelines recommend evidence-based assessment and suggest classifying LBP patients with substantial neurological involvement, inflammatory arthritis, visceral or metastatic disease, and non-specific pain.[9,10] Rather than using the label of non-specific pain, an evidence-based diagnostic tool can potentially help identify conditions with similar characteristics, and aid communication with other clinicians, third-party payers, and patients by providing consistent terminology and assessment methods.

It is still largely unknown whether treatment according to various classification systems results in improved clinical outcomes. More research is needed to definitively answer this question.[1,2,11,12] The purpose of this methodological project was to create a diagnostic classification system with an evidence-based diagnostic checklist tool for use in a chiropractic research clinic conducting clinical trials of LBP [13-15] and for use in traditional clinical settings.

Eligibility and treatment decisions for clinical studies of LBP at our research center are in part based on diagnostic information. The authors recognized a need for both a standardized clinical evaluation and diagnostic criteria to facilitate more consistent use of evidence-based diagnostic rationale. Our goals for this project were to: (1) identify diagnostic LBP categories supported by the best available evidence, and (2) create an efficient in-office evidence-based LBP diagnostic checklist and accompanying exam for use in research and clinical practice. This article outlines the diagnostic categories, accompanying checklist, and discusses the supporting evidence.

Methods

Recognizing the need for more specific diagnostic information, the authors sought to create a LBP diagnostic classification system based on available evidence for use in both a research and clinical setting. One system was available for use as a model. Therefore, the process began with a diagnostic classification system published by Petersen.[3,16] This classification system was chosen because it encapsulated diagnosis from a patho-anatomic/pathophysiological perspective and it represented the potential to categorize LBP patients in a research setting.

Briefly, these diagnostic categories included (1) disc syndromes, (2) adherent nerve root, (3) nerve root entrapment, (4) nerve root compression, (5) spinal stenosis, (6) zygapophyseal joint, (7) postural, (8) sacroiliac joint, (9) dysfunction, (10) myofascial pain, (11) adverse neural tension, (12) abnormal pain, and (13) inconclusive.

Next, references from Petersen's classification system were reviewed and PubMed searches conducted to identify additional articles supporting each diagnostic category using key words describing the diagnostic category (e.g., facet, zygapophyseal joint, sacroiliac, SI joint, etc.), low back pain, utility, test, diagnosis, diagnostic, and manual therapy. Systematic reviews and clinical guidelines regarding low back pain diagnosis were also reviewed for conclusions, recommendations and as reference sources. Reference searches of diagnostic utility studies were also conducted.

Systematic reviews, clinical guidelines, and publications with higher diagnostic utility values, reference standards for higher quality research were sought and utilized to create the classification system. Criteria utilized for consideration were (1) commonly accepted diagnoses for which there is general agreement regarding pathophysiology (2) tests performed in an office setting, and (3) articles reporting consistent with evidence-based criteria, such as reporting sample population characteristics, appropriate statistical analysis, use of a gold standard comparison, validation studies performed, and sensitivity/specificity reporting.[17]

Nine doctors of chiropractic including the authors, functioning as members of the research clinic, utilized the initial diagnostic classification system and checklist for a period of one year while formally reviewing examinations of 166 participants with LBP who presented to the clinical research team during an IRB approved clinical trial. Formal meetings were held to discuss and inform clinicians about the classification system prior to its use. Clinicians using the checklist provided verbal and written feedback to the authors regarding clarity of terms, strength of evidence, efficiency, and usefulness as an in-office aid throughout the one-year trial period. The categories contained in the original classification system were (1) Screening, (2) Reducible disc, (3) Irreducible disc, (4) Discogenic pain, (5) Nerve root, (6) Neurogenic claudication, (7) SI joint, (8) Zygapophyseal joint, (9) Dysfunction/Postural instability, (10) Myofascial, (11) Non-organic, (12) Chronic pain syndrome, and (13) Other diagnoses.

Factors observed by clinicians leading to changes included (1) criteria for some categories were largely similar, (2) the large number of categories created a lengthy exam, (3) the neurogenic claudication category required a checklist item(s) to help rule-out similarly presenting conditions, such as vascular claudication, (4) a single category entitled central pain better represented the chronic pain syndrome and non-organic pain categories, and (5) separating nociceptive and neuropathic pain diagnoses into subcategories is more aligned with clinical assessment.

The revised classification system was reorganized into 4 main diagnostic categories. Criteria with positive likelihood ratios lower than 2.4 were removed except for the myofascial category. The classification system and checklist presented in this article is currently in use at our research center (Appendix A).

Results

Four diagnostic categories and 8 subcategories in the classification system include (1) a screening category, (2) two pain categories with subcategories for Nociceptive and Neuropathic Pain, (3) a functional evaluation category, Functional Instability, and (4) a category for unknown or poorly defined diagnoses. Table 1 presents key information for diagnostic categories and subcategories.

The clinical evaluation is characterized by a diagnostic category checklist comprised of yes/no questions and corresponding tests. Questions in each category of the checklist relate to symptoms, signs, and examination findings. Questions answered "Yes" indicate support for a diagnostic category. However, some questions indicate support for a category when answered "No". "No" answers indicating support for a diagnosis are highlighted to provide a visual cue to the clinician. Most information needed to answer checklist questions are derived from the condition history and patient interview. However, several categories such as Zygapophyseal joint and SI joint include questions requiring specific exam information. Examination procedures included within the diagnostic checklist are also separately provided in Appendix B.

Several items in the diagnostic checklist are supported by Likelihood ratios, which describe the probability that a test accurately detects a disease. A positive likelihood

ratio (+LR) of 1 lacks diagnostic value.[18] Higher values increase the diagnostic value. Positive LRs of 2-5 are considered small but sometimes important. Positive LRs of 5-10 are considered moderate but usually important while those over 10 are large and often conclusive.[19]

Diagnostic Categories

Screening

This category includes screening questions for acute injury, infection, potentially dangerous conditions such as cauda equina syndrome, or conditions requiring referral to an appropriate healthcare specialty. Criteria were drawn from evidence-based clinical guidelines and LBP screening recommendations.[9,10,20,21] The screening category was not designed as a comprehensive screen for any condition requiring additional evaluation. It is, therefore, imperative that providers utilizing this tool recognize it as a supplement rather than a replacement for careful interpretation of clinical information.

Nociceptive Pain

Nociceptive pain is perceived from noxious stimulation (e.g. inflammation, compression, injury) of peripheral tissues causing primary afferent neuron signaling.[22] One recent study found more than 50% of LBP patients could be classified with nociceptive pain based on clinical criteria developed by an expert panel of clinicians.[23] Nociceptive pain from the low back is divided into the following 4 subcategories: (1) lumbar discogenic pain, (2) sacroiliac joint pain, (3) zygapophyseal joint pain, and (4) myofascial pain.

Discogenic Pain

Lumbar discogenic pain is thought to be generated from nociceptive signaling of nerve fibers infiltrating the posterior annular fibers of an intervertebral disc and near its attachment at the endplate.[24] Infiltration appears to occur most in discs that exhibit some degree of annular disruption.[25,26] Discogenic pain, studied with the use of discography, has been shown to reproduce LBP symptoms in patients with annular disruption.[27] However, discography findings can be interpreted differently and procedural variations that can affect results.[28] A comprehensive review of diagnostic interventions for chronic spinal pain rated lumbar discography with evidence level II-2, or evidence obtained from at least one properly designed small diagnostic accuracy study.[29]

Studies utilizing discography for diagnostic confirmation show centralization of pain with repeated motion as a key diagnostic phenomenon.[30,31] Centralization is defined as progressive resolution, reduction or retreat of pain toward midline. Patients diagnosed with discogenic pain, particularly those whose symptoms centralize with repeated motion, tend to show a favorable response to conservative treatment.[32-34] A recent review of clinical tests rated centralization with repeated motion as diagnostic for discogenic pain[35] and a recent practice-based study found centralization signs in 41% of LBP cases.[36]

Sacroiliac (SI) Joint Pain

The SI joints are irregularly shaped, diarthrodial joints supported by strong ligaments.[37] Lumbar paraspinal and pelvic muscles are considered significant stabilizers and other muscles as remote as the latissimus dorsi may also contribute via attachments through the thoracolumbar fascia.[38] SI joint innervation arises from the sacral plexus, ventral rami from L4 and L5 and dorsal sacral rami.[37] Two studies using an anesthetic block procedure reported 18.5% and 30% of LBP patients experienced SI joint pain.[39,40] Another study using the same examination criteria found in the checklist diagnosed 27% of patients with SI joint pain.[36]

SI joint symptom presentation is similar to that from other low back sources and there is evidence to suggest that the SI joint may be responsible for some cases of sciatica in the absence of disc or nerve root pathology.[41] One study using controlled diagnostic SI joint blocks reports SI joint pain occurred in the area just inferior to the posterior superior iliac spine and rarely presented in the area over the ischial tuberosity.[42] However, further validation of these results is needed. One recent systematic review considered controlled SI joint injections, the current diagnostic standard, to be supported by a moderate level of evidence[43] and another rated it as level II-2 evidence derived from well-designed cohort or case-control analytic studies.[44]

The SI joint pain category includes one yes/no question assessing response to a combination of orthopedic maneuvers.[45] SI joint pain is suggested when 3 or more of 6 positive tests (Gaenslen's left and right, thigh thrust, sacral thrust, distraction and iliac compression) are present in

the absence of centralization.[45-47] When none of the tests are positive, SI joint pain is considered ruled-out.

Zygapophyseal Joint Pain

Lumbar zygapophyseal (Z) joints (or facet joints) are richly innervated with mechanosensitive neurons and free nerve endings.[48] Z-joints receive dual innervation from nerve roots exiting at the same and superior adjacent levels. Innervation extends into subchondral bone providing the potential for pain generation outside the joint.[49] Z-joints are diarthrodial synovial joints exhibiting variable orientation from upper to lower lumbar segments, usually becoming coronal in orientation at L5-S1, presumably as a response to local biomechanical stress.[48,50] Cohen's synthesis of existing data reported pain across the lumbosacral junction as the most common distribution. Other reported areas of Z-joint pain distribution include ischial, posterior thigh and groin, upper lumbar and flank, anterior medial thigh, and lateral leg.[49] Cohen also estimated the overall prevalence of primary LBP from Z-joints at between 10 and 15%.[49] One recent clinical study using the same criteria present in the checklist diagnosed 23% of 264 LBP patients with Z-joint pain.[36]

A controlled joint anesthetic block procedure is the standard test to confirm Z-joint pain. According to two recent reviews, controlled comparative anesthetic blocks are supported by level 1 (or ll-1) and by strong evidence.[29,51] However, anesthetic blocks are invasive, costly, require specialized settings and carry inherent risks.[29]

For zygapophyseal joint pain, a clinical prediction rule is included into the diagnostic checklist.[52] A positive prediction rule indicated by satisfaction of 3 or more of 5 criteria carries a positive likelihood ratio of 9.7. This clinical prediction rule is considered more effective at ruling out facetogenic pain when negative. The strength of evidence supporting the clinical prediction rule could be improved with subsequent validation studies.

Myofascial Pain

Myofascial pain is defined as pain arising from muscles or related fascia.[53] Chronic myofacial pain can be regarded as a form of neuromuscular dysfunction[54,55] characterized by trigger points or focal areas of hypertonicity and tenderness.[53,56] The chronic myofascial pain hypothesis includes a sequelae of events leading to trigger point generation that includes excessive acetylcholine release from damaged motor nerve endplates, reduced local blood flow due to muscle contraction, and possible reduced calcium ion re-uptake by contracted muscle and ATP deficit.[56,57]

At present, there is no gold standard for evaluating myofascial pain and no specific diagnostic tests have been developed.[58] Therefore, the current standards of trigger points, and aggravation with use of the involved muscle(s) are included in the checklist.[58]

Neuropathic Pain

We defined neuropathic pain as generated or perceived from peripheral or central nervous system tissues designated further into 4 subcategories: (1) compressive radiculopathy, (2) non-compressive radiculopathy, (3) neurogenic claudication, and (4) central pain.

Compressive Radiculopathy

Compression of a nerve root can lead to peripheral symptoms and changes in motor and sensory function, often in a dermatome or narrow band-like distribution.[59,60] Symptomatic compressive radiculopathy may be the result of a combination of inflammation and compression of the dorsal root ganglion or nerve root.[61,62] Compression and inflammatory mediators arising from extruded nucleus pulposus material or from a degenerating disc have been shown to cause sciatica and hyperalgesia.[61-63] However, the compression model does not explain all neuropathic pain presentations.

Several checklist criteria for this category were derived from a single clinical study evaluating diagnostic information associated with compressive neuropathy confirmed by magnetic resonance imaging.[64] The diagnostic checklist includes symptoms of leg pain worse than back pain, dermatome distribution of pain when coughing, sneezing or straining, lower extremity paresis, and increased finger to floor distance during standing flexion. We also adapted questions from the Leeds Assessment for Neuropathic Symptoms and Signs (LANSS)[53,65] for use in the checklist. The LANSS is a tool comprised of 5 questions and two examination findings used to help discriminate between nociceptive and neuropathic pain.

Non-compressive Radiculopathy

Non-compressive neuropathic pain is thought to arise from neural tissue exhibiting normal axonal conduction sensitized by inflamed nerve roots, trunks, or other tis-

sue in close proximity. [66,67] The plexus surrounding peripheral nerve trunks contains free nerve endings capable of mechanoreception and nociception and can become mechanically sensitized (mechanical allodynia) in the presence of inflammation.[66-68] Post-surgical adhesions inhibiting nerve root mobility may also cause neuropathic pain[69] through mechanical sensitization, a process similar or identical to the adherent and entrapped nerve roots described by Petersen.[3]

Evidence suggests that inflamed nerve roots are sensitive to stretch. In an animal model, mechanically sensitized nerves generate nociceptive impulses when stretched.[70, 71] Clinical maneuvers designed to assess elastic tolerance of lower extremity peripheral nerves are the straight leg raise, slump, and femoral nerve stretch tests.[64,72,73]

Currently, there is no gold standard test to confirm the diagnosis of non-compressive radiculopathy. Therefore, the diagnostic criteria consist of neurological symptoms without signs of nerve compression and a LANSS score indicating neuropathic pain. Though they cannot be validated by a gold standard test, the straight leg raise, slump and femoral nerve stretch tests likely support this diagnosis in the presence of an appropriate clinical picture.

Neurogenic Claudication

Neurogenic claudication is thought to arise from compression of the cauda equina or nerve root(s) fostered by narrowing (stenosis) of the central spinal canal or neural foramina.[74] Stenosis occurs congenitally or arises from degenerative change to the disc, facets, ligamentum flavum (hypertrophy), or other factors such as degenerative spondylolisthesis and lumbar extension.[74,75] Physical activity increases neural oxygen demand, resulting in venous engorgement in stenotic areas, neural compression, and ischemia. Ischemia is the most likely pain generating mechanism demonstrated by reversible symptoms in patients with this condition.[74]

Neurogenic claudication typically presents with activity related unilateral or bilateral pain (sometimes weakness or heaviness) radiating into the buttock, thigh and/or leg that is relieved with sitting. Osteoarthritis and bursitis of the hip or knee, peripheral arterial disease (PAD), and several forms of peripheral neuropathy can present similarly and in combination with neurogenic claudication. What appears to be a simple diagnosis can require skillful differentiation.[74,76]

The criteria in this category were derived from a single study evaluating a clinical prediction rule with expert clinicians serving as the diagnostic standard.[77] A score of 7 or greater on the clinical prediction rule containing 8 questions carries a modest positive likelihood ratio of 3.9.

Differentiating neurogenic and vascular claudication can be particularly challenging. Therefore, a negative Ankle Brachial Index (ABI) was added to the checklist. The ABI test was chosen for its ability to reliably assist in detecting lower extremity vascular compromise and its utility as an in-office assessment.[78-80]

Central Pain

The central nervous system adapts to inflammation, nociceptive activity and/or injury by augmenting neural signaling leading to hypersensitivity (central sensitization).[81] Central sensitization is characterized by an amplified pain response, increased reaction to noxious sensory stimulation (hyperalgesia), convergence of low threshold mechanoreceptor pathways with nociceptive circuits, and pain perceived from otherwise non-painful stimuli (allodynia).[82] Patients with central sensitization perceive real pain. However, there is a departure from the stimulus response relationship of the nociceptive pain mechanism.[82] One recent study classified approximately 23% of 464 patients with low back pain with central sensitization.[83]

Patients with chronic LBP can exhibit signs of central sensitization.[84,85] Using a Delphi survey of expert clinicians, a consensus-derived list of clinical criteria was developed to identify patients suffering from nociceptive, neuropathic, and central pain.[86] Using these criteria in a clinical study, one sign and three symptoms were identified as consistent with the diagnosis of central pain.[23] These 4 criteria have not been validated in other settings and there is a possibility of bias because the standard to which these criteria were compared was expert opinion, possibly contributing to the high likelihood ratios for these criteria. Nevertheless, it is an important first step toward identifying and standardizing the assessment for clinical characteristics of central pain. This set of criteria represents evidence consistent with current patho-mechanistic understanding and has been shown to be useful and efficient in a clinical setting.

Functional Instability

Functional or lumbar segmental instability is described as

a disruption in the neuromuscular control of a spinal joint neutral zone during normal physiologic demand resulting in the potential for aberrant motion and loading of local tissue(s).[19,87] Functional instability is distinct from frank instability, which suggests structural injury or deterioration with the potential for neurological compromise.

It is thought that LBP may alter muscle activity around the lumbar spine, contributing to changes in neuromuscular control mechanisms that maintain position and protect it from injury.[88,89] The functional instability concept is supported by results from several clinical studies showing improvement in pain and function when introducing specific lumbar stabilization exercises for patients with LBP.[90-92] The prevalence of functional instability was calculated at 12% in a chronic LBP population[93] and 31.1% in patients with lumbar degeneration.[94] However, diagnosis by measuring intervertebral position from lateral lumbar radiographs has not been validated.

The three diagnostic checklist criteria in this category were derived from three clinical diagnostic utility studies and one systematic review.[19,93-95] They include the presence of any hypermobile segment (+LR 2.4), the absence of any hypomobile segment (+LR 9.0) and the passive lumbar extension test (+LR 8.8).[95] Hypo/hypermobility is assessed with the patient prone while the clinician gently presses anteriorly with the hypothenar eminence on the spinous processes of lumbar vertebrae.

Other diagnosis

This category was designed for LBP diagnoses not included in the checklist. Diagnoses such as thoracolumbar and piriformis syndrome[96-98] could be included here. These diagnoses are not yet supported by studies designed to validate diagnostic criteria and are not as common as others included in the checklist. Therefore, they are more suited for consideration when other more prevalent conditions are ruled-out or as co-presenting conditions.

Clinical Application

The goal of this project was to create a practical, in-office system to consistently diagnose LBP from an evidence-based perspective within the context of chiropractic clinical research and in private settings. We combined available scientific evidence into a user-friendly tool to provide an aid for more consistent diagnosis for practitioners, researchers, and students.

The checklist format enables the examiner to mark findings and visually observe how the evidence supports or fails to support a given diagnosis. Visually categorizing where the most evidence lies may help clinicians organize diagnostic information and aid them in clinical decision-making. Because of the limitations of current validated tests and diagnostic criteria, the checklist, in general, may be more effective at ruling out categories.

Examination procedures are minimal as much information comes from the clinical interview. The checklist identifies when a specific evaluation or test is required ensuring it as a stand-alone document. Appendix B is available as a single page reference to show the examination procedures included in the checklist. Some checklist categories do not state a minimum number of items necessary to conclude or rule out a diagnosis (i.e., compressive radiculopathy, discogenic pain). In all categories, checked items show where evidence is or is not clustering. Clustered evidence does not guarantee accuracy and sometimes indicates more than one diagnosis. In these instances, the checklist can help establish an evidence-based differential diagnosis or the possibility of pain arising from concurrent conditions. We submit that identifying diagnoses with clustered evidence is superior to the diagnosis of non-specific LBP because it provides a pathophysiological basis for targeted clinical decisions regarding management, progress evaluation, need for testing, and a consistent framework to facilitate communication with patients and other providers.

LBP diagnosis is challenging as evidenced by calls for additional research on classification.[1,2] The checklist presented in this article is best used by the astute and experienced clinician. It is not a diagnostic template, but rather an aid. Without incorporating all aspects of the clinical presentation, checklist items can be interpreted as indicating evidence for what could be an incorrect diagnosis. Consider a patient with a score of 7 on the neurogenic claudication clinical prediction rule and a negative ABI. Using only the checklist, this evidence suggests a diagnosis of neurogenic claudication. However, the true diagnosis could conceivably be pain originating from hip or knee joint osteoarthritis. Without differential examination, diagnostic accuracy could suffer. Therefore, checklist items indicating a diagnosis are most useful when balanced with a consistent clinical presentation and supported by differential examination whenever possible.

From a clinical perspective, this classification system represents an evidence-based approach to LBP diagnosis, which aids understanding of dysfunctional physiology, provides rationale for developing management strategies with patients and other providers, aids communication with patients and third-party payers, provides a common framework for interprofessional communication, and supports the education of student clinicians.

The classification system proposed in this article does not assess depression, post-traumatic stress disorder, or psychosocial factors important in the broader context of clinical diagnosis. These tools already exist, and at our center psychosocial components are screened with the clinical interview and established instruments such as the Patient Health Questionnaire-9 (PHQ-9) [99] and Generalized Anxiety Disorder-7 (GAD-7).[100]

Systematic reviews of each diagnostic category were not performed to develop this classification system. Clinicians are encouraged to examine the evidence supporting individual diagnostic categories. The effectiveness with which the checklist can aid clinicians in consistently diagnosing LBP has not yet been reported. The authors are engaged in ongoing studies designed to report reliability and LBP diagnoses generated with this system to further refine the evidence-based approach. Another logical next step is a hypothesis setting study to begin validation testing.[12]

Limitations

Until the development of new or improved comparative diagnostic methods, several checklist categories will be supported by construct validity and what is considered low-quality evidence, a common occurrence in many healthcare areas. It is important for clinicians to be aware of the strengths and limitations of the evidence on which diagnostic decisions are based. Second, diagnosis is inherently an art thus difficult to standardize. A diagnosis derived with the aid of the exam and checklist is at least somewhat dependent on the knowledge, skill, experience and perceptiveness of the diagnostician. Third, new evidence is constantly emerging and a systematic review of the literature was not performed. Therefore, articles reporting studies of diagnostic testing may have been missed.

Summary

Recognizing the need for a standardized, evidence-based method to evaluate and diagnose LBP, we created an evidence-based diagnostic classification system with accompanying clinical exam and checklist tool. The use of evidence-based diagnostic methods to differentiate and classify LBP in research and traditional clinical settings is encouraged.

Acknowledgments

This work was partially funded through a grant from the National Institute of Health's National Center for Complementary and Alternative Medicine (NCCAM) (1U19AT004137). This project was conducted in a facility constructed with support from Research Facilities Improvement Grant Number C06 RR15433 from the National Center for Research Resources, National Institutes of Health. The authors wish to thank Stacie Salsbury PhD, RN for her critical review of the manuscript.

References

1. Borkan JM, Cherkin DC. An agenda for primary care research on low back pain. Spine (Phila Pa 1976). 1996;21:2880-2884.
2. Waddell G. Subgroups within "nonspecific" low back pain. J Rheumatol. 2005;32:395-396.
3. Petersen T, Laslett M, Thorsen H, Manniche C, Ekdahl C, Jacobsen S. Diagnostic classification of non-specific low back pain. A new system integrating patho-anatomic and clinical categories. Physiotherapy Theory and Practice. 2003;19:213-237.
4. Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. Arch Phys Med Rehabil. 2005;86:1753-1762.
5. Brennan GP, Fritz JM, Hunter SJ, Thackeray A, Delitto A, Erhard RE. Identifying subgroups of patients with acute/subacute "nonspecific" low back pain: results of a randomized clinical trial. Spine. 2006;31:623-631.
6. Flynn T, Fritz J, Whitman J, Wainner R, Magel J, Rendeiro D, et al. A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with spinal manipulation. Spine. 2002;27:2835-2843.
7. Spitzer WO, LeBlanc FE, Dupuis M. Scientific approach to the assessment and management of activity-related spinal disorders. A monograph for clinicians. Report of the Quebec Task Force on Spinal Disorders. Spine. 1987;12:S1-S59.

8. Hill JC, Dunn KM, Lewis M, Mullis R, Main CJ, Foster NE, et al. A primary care back pain screening tool: identifying patient subgroups for initial treatment. Arthritis Rheum. 2008;59:632-641.
9. Dagenais S, Tricco AC, Haldeman S. Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. Spine J. 2010;10:514-529.
10. Chou R, Qaseem A, Snow V, Casey D, Cross JT, Jr., Shekelle P, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. Ann Intern Med. 2007;147:478-491.
11. Kent P, Keating JL. Classification in nonspecific low back pain: what methods do primary care clinicians currently use? Spine (Phila Pa 1976). 2005;30:1433-1440.
12. Kent P, Keating JL, Leboeuf-Yde C. Research methods for subgrouping low back pain. BMC Med Res Methodol. 2010;10:62.
13. Wilder DG, Vining RD, Pohlman KA, Meeker WC, Xia T, DeVocht JW, et al. Effect of spinal manipulation on sensorimotor functions in back pain patients: study protocol for a randomised controlled trial. Trials. 2011;12:161.
14. Hondras MA, Long CR, Cao Y, Rowell RM, Meeker WC. A randomized controlled trial comparing 2 types of spinal manipulation and minimal conservative medical care for adults 55 years and older with subacute or chronic low back pain. J Manipulative Physiol Ther. 2009;32:330-343.
15. Goertz C, Lyons SS, Andresen A, Hondras M, Jones M, Killinger LZ, et al. Collaborative Care for Older Adults (COCOA), Palmer College of Chiropractic. J Allied Health. 2010;39:e135-e136.
16. Petersen T, Olsen S, Laslett M, Thorsen H, Manniche C, Ekdahl C, et al. Inter-tester reliability of a new diagnostic classification system for patients with non-specific low back pain. Aust J Physiother. 2004;50:85-94.
17. Sackett D.L., Straus SE, Richardson W.S., Rosenberg W., Haynes R.B. Evidence-Based Medicine How to Practice and Teach EBM. 2nd ed. Churchill Livingstone, New York; 2000.
18. McGee S. Simplifying likelihood ratios. J Gen Intern Med. 2002;17:646-649.
19. Alqarni AM, Schneiders AG, Hendrick PA. Clinical tests to diagnose lumbar segmental instability: a systematic review. J Orthop Sports Phys Ther. 2011;41:130-140.
20. Hawk C, Schneider M, Dougherty P, Gleberzon BJ, Killinger LZ. Best practices recommendations for chiropractic care for older adults: results of a consensus process. J Manipulative Physiol Ther. 2010;33:464-473.
21. Murphy DR, Hurwitz EL. A theoretical model for the development of a diagnosis-based clinical decision rule for the management of patients with spinal pain. BMC Musculoskelet Disord. 2007;8:75.
22. Smart KM, Blake C, Staines A, Thacker M, Doody C. Mechanisms-based classifications of musculoskeletal pain: Part 3 of 3: Symptoms and signs of nociceptive pain in patients with low back (+/-leg) pain. Man Ther. 2012;17:352-357.
23. Smart KM, Blake C, Staines A, Thacker M, Doody C. Mechanisms-based classifications of musculoskeletal pain: Part 1 of 3: Symptoms and signs of central sensitisation in patients with low back (+/-leg) pain. Man Ther. 2012;17:336-344.
24. Adams MA, Roughley PJ. What is intervertebral disc degeneration, and what causes it? Spine (Phila Pa 1976). 2006;31:2151-2161.
25. Freemont AJ, Peacock TE, Goupille P, Hoyland JA, O'Brien J, Jayson MI. Nerve ingrowth into diseased intervertebral disc in chronic back pain. Lancet. 1997;350:178-181.
26. Fagan A, Moore R, Vernon RB, Blumbergs P, Fraser R. ISSLS prize winner: The innervation of the intervertebral disc: a quantitative analysis. Spine. 2003;28:2570-2576.
27. Moneta GB, Videman T, Kaivanto K, Aprill C, Spivey M, Vanharanta H, et al. Reported pain during lumbar discography as a function of anular ruptures and disc degeneration. A re-analysis of 833 discograms. Spine (Phila Pa 1976). 1994;19:1968-1974.
28. Manchikanti L, Glaser SE, Wolfer L, Derby R, Cohen SP. Systematic review of lumbar discography as a diagnostic test for chronic low back pain. Pain Physician. 2009;12:541-559.
29. Manchikanti L, Boswell MV, Singh V, Derby R, Fellows B, Falco FJ, et al. Comprehensive review of neurophysiologic basis and diagnostic interventions in managing chronic spinal pain. Pain Physician. 2009;12:E71-120.
30. Young S, Aprill C, Laslett M. Correlation of clinical examination characteristics with three sources of chronic low back pain. Spine J. 2003;3:460-465.
31. Laslett M, Oberg B, Aprill CN, McDonald B. Centralization as a predictor of provocation discography results in chronic low back pain, and the influence of disability and distress on diagnostic power. Spine J. 2005;5:370-380.
32. Donelson R, Silva G, Murphy K. Centralization phenomenon. Its usefulness in evaluating and treating referred pain. Spine (Phila Pa 1976). 1990;15:211-213.
33. Skytte L, May S, Petersen P. Centralization: its prognostic value in patients with referred symptoms and sciatica. Spine (Phila Pa 1976). 2005;30:E293-E299.
34. Lisi AJ. The centralization phenomenon in chiropractic

spinal manipulation of discogenic low back pain and sciatica. J Manipulative Physiol Ther. 2001;24:596-602.
35. Cook C, Hegedus E. Diagnostic utility of clinical tests for spinal dysfunction. Man Ther. 2011;16:21-25.
36. Murphy DR, Hurwitz EL. Application of a diagnosis-based clinical decision guide in patients with low back pain. Chiropr Man Therap. 2011;19:26.
37. Forst SL, Wheeler MT, Fortin JD, Vilensky JA. The sacroiliac joint: anatomy, physiology and clinical significance. Pain Physician. 2006;9:61-67.
38. Willard FH, Vleeming A, Schuenke MD, Danneels L, Schleip R. The thoracolumbar fascia: anatomy, function and clinical considerations. J Anat. 2012.
39. Schwarzer AC, Aprill CN, Bogduk N. The sacroiliac joint in chronic low back pain. Spine (Phila Pa 1976). 1995;20:31-37.
40. Maigne JY, Aivaliklis A, Pfefer F. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. Spine (Phila Pa 1976). 1996;21:1889-1892.
41. Fortin JD, Vilensky JA, Merkel GJ. Can the sacroiliac joint cause sciatica? Pain Physician. 2003;6:269-271.
42. van der Wurff P, Buijs EJ, Groen GJ. Intensity mapping of pain referral areas in sacroiliac joint pain patients. J Manipulative Physiol Ther. 2006;29:190-195.
43. Hansen HC, McKenzie-Brown AM, Cohen SP, Swicegood JR, Colson JD, Manchikanti L. Sacroiliac joint interventions: a systematic review. Pain Physician. 2007;10:165-184.
44. Rupert MP, Lee M, Manchikanti L, Datta S, Cohen SP. Evaluation of sacroiliac joint interventions: a systematic appraisal of the literature. Pain Physician. 2009;12:399-418.
45. Laslett M, Aprill CN, McDonald B, Young SB. Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. Man Ther. 2005;10:207-218.
46. Laslett M. Evidence-based diagnosis and treatment of the painful sacroiliac joint. J Man Manip Ther. 2008;16:142-152.
47. van der Wurff P, Buijs EJ, Groen GJ. A multitest regimen of pain provocation tests as an aid to reduce unnecessary minimally invasive sacroiliac joint procedures. Arch Phys Med Rehabil. 2006;87:10-14.
48. Cavanaugh JM, Ozaktay AC, Yamashita HT, King AI. Lumbar facet pain: biomechanics, neuroanatomy and neurophysiology. J Biomech. 1996;29:1117-1129.
49. Cohen SP, Raja SN. Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. Anesthesiology. 2007;106:591-614.
50. Masharawi Y, Rothschild B, Dar G, Peleg S, Robinson D, Been E, et al. Facet orientation in the thoracolumbar spine: three-dimensional anatomic and biomechanical analysis. Spine (Phila Pa 1976). 2004;29:1755-1763.
51. Rubinstein SM, van Tulder M. A best-evidence review of diagnostic procedures for neck and low-back pain. Best Pract Res Clin Rheumatol. 2008;22:471-482.
52. Laslett M, McDonald B, Aprill CN, Tropp H, Oberg B. Clinical predictors of screening lumbar zygapophyseal joint blocks: development of clinical prediction rules. Spine J. 2006;6:370-379.
53. Bennett M. The LANSS Pain Scale: the Leeds assessment of neuropathic symptoms and signs. Pain. 2001;92:147-157.
54. Shah JP, Phillips TM, Danoff JV, Gerber LH. An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. J Appl Physiol. 2005;99:1977-1984.
55. Shah JP, Gilliams EA. Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: an application of muscle pain concepts to myofascial pain syndrome. J Bodyw Mov Ther. 2008;12:371-384.
56. Simons DG, Travell JG, Simons L. Myofascial pain and Dysfunction: The Trigger Point Manual. 1st ed. Baltimore: Williams and Wilkins; 1999.
57. Simons DG. Clinical and etiological update of myofascial pain from trigger points. Journal of Musculoskeletal Pain. 1996;4:93-121.
58. Bennett R. Myofascial pain syndromes and their evaluation. Best Pract Res Clin Rheumatol. 2007;21:427-445.
59. Bogduk N. Low Back Pain. Clinical Anatomy of the Lumbar Spine and Sacrum. 3rd ed. New York: Churchill Livingstone; 1997. 187-213.
60. Henderson CM, Hennessy RG, Shuey HM, Jr., Shackelford EG. Posterior-lateral foraminotomy as an exclusive operative technique for cervical radiculopathy: a review of 846 consecutively operated cases. Neurosurgery. 1983;13:504-512.
61. Omarker K, Myers RR. Pathogenesis of sciatic pain: role of herniated nucleus pulposus and deformation of spinal nerve root and dorsal root ganglion. Pain. 1998;78:99-105.
62. Hou SX, Tang JG, Chen HS, Chen J. Chronic inflammation and compression of the dorsal root contribute to sciatica induced by the intervertebral disc herniation in rats. Pain. 2003;105:255-264.
63. Harrington JF, Messier AA, Bereiter D, Barnes B, Epstein MH. Herniated lumbar disc material as a source of free glutamate available to affect pain signals through the dorsal root ganglion. Spine (Phila Pa 1976). 2000;25:929-936.
64. Vroomen PC, de Krom MC, Wilmink JT, Kester AD, Knottnerus JA. Diagnostic value of history and physical examination in patients suspected of lumbosacral nerve root compression. J Neurol Neurosurg Psychiatry. 2002;72:630-634.

65. Bennett MI, Smith BH, Torrance N, Lee AJ. Can pain can be more or less neuropathic? Comparison of symptom assessment tools with ratings of certainty by clinicians. Pain. 2006;122:289-294.
66. Hall TM, Elvey RL. Management of mechanosensitivity of the nervous system in spinal pain syndromes. In: Boyling JD, Jull GA, editors. Grieve's Mondern Manual Therapy The Vertebral Column. 3rd ed. New York: Churchill Livingston; 2004. 413-431.
67. Hall TM, Elvey RL. Nerve trunk pain: physical diagnosis and treatment. Man Ther. 1999;4:63-73.
68. Bove GM, Light AR. Calcitonin gene-related peptide and peripherin immunoreactivity in nerve sheaths. Somatosens Mot Res. 1995;12:49-57.
69. Ido K, Urushidani H. Fibrous adhesive entrapment of lumbosacral nerve roots as a cause of sciatica. Spinal Cord. 2001;39:269-273.
70. Bove GM, Light AR. Unmyelinated nociceptors of rat paraspinal tissues. J Neurophysiol. 1995;73:1752-1762.
71. Kuslich SD, Ulstrom CL, Michael CJ. The tissue origin of low back pain and sciatica: a report of pain response to tissue stimulation during operations on the lumbar spine using local anesthesia. Orthop Clin North Am. 1991;22:181-187.
72. Porchet F, Fankhauser H, de TN. Extreme lateral lumbar disc herniation: clinical presentation in 178 patients. Acta Neurochir (Wien). 1994;127:203-209.
73. Majlesi J, Togay H, Unalan H, Toprak S. The sensitivity and specificity of the Slump and the Straight Leg Raising tests in patients with lumbar disc herniation. J Clin Rheumatol. 2008;14:87-91.
74. Katz JN, Harris MB. Clinical practice. Lumbar spinal stenosis. N Engl J Med. 2008;358:818-825.
75. Modic MT, Ross JS. Lumbar degenerative disk disease. Radiology. 2007;245:43-61.
76. Fritz JM, Delitto A, Welch WC, Erhard RE. Lumbar spinal stenosis: a review of current concepts in evaluation, management, and outcome measurements. Arch Phys Med Rehabil. 1998;79:700-708.
77. Sugioka T, Hayashino Y, Konno S, Kikuchi S, Fukuhara S. Predictive value of self-reported patient information for the identification of lumbar spinal stenosis. Fam Pract. 2008;25:237-244.
78. Carmo GA, Mandil A, Nascimento BR, Arantes BD, Bittencourt JC, Falqueto EB, et al. Can we measure the ankle-brachial index using only a stethoscope? A pilot study. Fam Pract. 2009;26:22-26.
79. Bonham PA, Cappuccio M, Hulsey T, Michel Y, Kelechi T, Jenkins C, et al. Are ankle and toe brachial indices (ABI-TBI) obtained by a pocket Doppler interchangeable with those obtained by standard laboratory equipment? J Wound Ostomy Continence Nurs. 2007;34:35-44.
80. Suri P, Rainville J, Kalichman L, Katz JN. Does this older adult with lower extremity pain have the clinical syndrome of lumbar spinal stenosis? JAMA. 2010;304:2628-2636.
81. Latremoliere A, Woolf CJ. Central sensitization: a generator of pain hypersensitivity by central neural plasticity. J Pain. 2009;10:895-926.
82. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. Pain. 2011;152:S2-15.
83. Smart KM, Blake C, Staines A, Doody C. Self-reported pain severity, quality of life, disability, anxiety and depression in patients classified with 'nociceptive', 'peripheral neuropathic' and 'central sensitisation' pain. The discriminant validity of mechanisms-based classifications of low back (+/-leg) pain. Man Ther. 2012;17:119-125.
84. O'Neill S, Manniche C, Graven-Nielsen T, Arendt-Nielsen L. Generalized deep-tissue hyperalgesia in patients with chronic low-back pain. Eur J Pain. 2007;11:415-420.
85. Giesecke T, Gracely RH, Grant MA, Nachemson A, Petzke F, Williams DA, et al. Evidence of augmented central pain processing in idiopathic chronic low back pain. Arthritis Rheum. 2004;50:613-623.
86. Smart KM, Blake C, Staines A, Doody C. Clinical indicators of 'nociceptive', 'peripheral neuropathic' and 'central' mechanisms of musculoskeletal pain. A Delphi survey of expert clinicians. Man Ther. 2010;15:80-87.
87. Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis. J Spinal Disord. 1992;5:390-396.
88. Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. Spine (Phila Pa 1976). 1994;19:165-172.
89. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine (Phila Pa 1976). 1996;21:2763-2769.
90. Suni J, Rinne M, Natri A, Statistisian MP, Parkkari J, Alaranta H. Control of the lumbar neutral zone decreases low back pain and improves self-evaluated work ability: a 12-month randomized controlled study. Spine (Phila Pa 1976). 2006;31:E611-E620.
91. Barr KP, Griggs M, Cadby T. Lumbar stabilization: core concepts and current literature, Part 1. Am J Phys Med Rehabil. 2005;84:473-480.
92. Barr KP, Griggs M, Cadby T. Lumbar stabilization: a review of core concepts and current literature, part 2. Am J Phys Med Rehabil. 2007;86:72-80.
93. Abbott JH, McCane B, Herbison P, Moginie G, Chapple C, Hogarty T. Lumbar segmental instability: a criterion-related validity study of manual therapy assessment. BMC Musculoskelet Disord. 2005;6:56.
94. Kasai Y, Morishita K, Kawakita E, Kondo T, Uchida A.

A new evaluation method for lumbar spinal instability: passive lumbar extension test. Phys Ther. 2006;86:1661-1667.
95. Fritz JM, Piva SR, Childs JD. Accuracy of the clinical examination to predict radiographic instability of the lumbar spine. Eur Spine J. 2005;14:743-750.
96. Fortin JD. Thoracolumbar syndrome in athletes. Pain Physician. 2003;6:373-375.
97. Kirschner JS, Foye PM, Cole JL. Piriformis syndrome, diagnosis and treatment. Muscle Nerve. 2009;40:10-18.
98. Halpin RJ, Ganju A. Piriformis syndrome: a real pain in the buttock? Neurosurgery. 2009;65:A197-A202.
99. Lowe B, Unutzer J, Callahan CM, Perkins AJ, Kroenke K. Monitoring depression treatment outcomes with the patient health questionnaire-9. Med Care. 2004;42:1194-1201.
100. Ruiz MA, Zamorano E, Garcia-Campayo J, Pardo A, Freire O, Rejas J. Validity of the GAD-7 scale as an outcome measure of disability in patients with generalized anxiety disorders in primary care. J Affect Disord. 2011;128:277-286.

Table 1:
Low Back Pain Diagnostic Categories and Key Information.

Category	Definition	Key Findings	Diagnostic Standard Used	Performance Statistics[9]	References
Screening	Findings indicating recent injury, special testing, referral or need for emergent evaluation	Evidence of possible fracture, progressive neurologic deficit, infection, tumor…	N/A[1]	N/A[1]	Chou 2007 Dagenais, 2010 Hawk, 2010 Murphy, 2007
Nociceptive	Pain from noxious stimulation (inflammation, compression, injury) of peripheral tissues				
Discogenic	Pain from the posterior annulus and near the endplate	1. Centralization with repeated end-range loading 2. Any two: Centralization with repeated motion, vulnerable/apprehensive when stooped, lumbar extension loss	Lumbar discography	1. +LR 6.9 2. +LR 6.7	1. Laslett, 2005 2. Laslett, 2006
Sacroiliac Joint (SI-joint)	Pain from the sacroiliac joint and/or supporting ligaments	SI-joint area pain with 3 or more of: L & R Gaenslen's[2], Thigh Thrust[3], Sacral Thrust[4], Iliac Comp[5], Distraction[6]	Flouroscopically-guided, controlled anesthetic block	+LR 4.3 for 3 or more positive tests	Laslett, 2005
Zygapophyseal Joint (Z-joint)	Pain from Z-joint structures including the joint capsule and subchondral bone	3 or more: > Age 50, relief by walking, relief by sitting, paraspinal onset, positive extension-rotation test	Flouroscopically-guided, controlled anesthetic block	+LR 9.7	Laslett, 2006
Myofascial	Pain from muscles, tendons, and/or fascial tissue in the low back	Pain with use of involved muscle and trigger points	None	N/A[1]	Bennett, 2007
Neuropathic	Pain from peripheral or central nervous system tissues				
Compressive Radiculopathy	Pain from compression and inflammation of a nerve root	1. Absent ankle/knee reflex 2. Pain worse in lower extremity than in back 3. Dermatome distribution (cough, sneeze, straining) 4. Paresis (extremity motor strength loss) 5. Finger to floor distance > 25 cm 6. LANSS[7] score > 12	1.- 5. Clinical findings in individuals with nerve root compression confirmed by Magnetic Resonance Imaging 6. Expert opinion	1. OR 2.4 2. OR 5.5 3. OR 3.8 4. OR 5.2 5. OR 2.4 6. PPV = 86-100	1-5. Vroomen, 2002 6. Bennett, 2001
Non-compressive Radiculopathy	Pain from compression, stretch and/or inflammation of peripheral nerve structures	1. LANSS[7] score > 12 2. Compressive Radiculopathy criteria are not met	1. Expert opinion 2. N/A[1]	1. PPV = 86-100 2. N/A	1. Bennett, 2001
Neurogenic Claudication	Pain from ischemia/compression of individual nerve roots, the cauda equina or spinal cord	1. Age > 60 2. Activity induced lower extremity pain with relief upon forward bending, or rest 3. Symptoms worsened by standing or extension 4. Urinary incontinence 5. Negative ABI	1.- 4. Expert opinion 5. Doppler Ultrasound	1.-4. +LR 3.9 for a score of ≥ 7 on clinical prediction rule (see appendix for scoring) 5. Sensitivity 71 Specificity 91	1.-4. Sugioka, 2008 5. Carmo, 2008
Central	Pain from a lesion or dysfunction within the central nervous system	1. Disproportionate pain, 2. Unpredictable symptom aggravation and relief, 3. Maladaptive psychosocial factors 4. Non-anatomic distribution	Expert opinion	1. +LR 15.19 2. +LR 30.69 3. +LR 7.65 4. +LR 27.57	Smart, 2012
Functional Instability	Disruption of neuromuscular control of a spinal joint neutral zone during normal physiologic demand	1. Positive prone passive lumbar extension[8] 2. Hypermobile lumbar segment(s) 3. Absence of hypomobile lumbar segment	Radiographic measurements of intervertebral motion	1. +LR 8.8 2. +LR 2.4 3. +LR 9.0	1. Kasai, 2006 2. Fritz, 2005 3. Fritz, 2005
Other Diagnoses	Diagnoses not categorized above	Dependent on suspected condition	N/A[1]	N/A[1]	N/A[1]

1. N/A: Not applicable or not available;
2. Patient lies supine at the edge of a table with one leg hanging off. The examiner applies downward pressure to the knee of the hanging leg while pressing the opposite knee (flexed) toward the patient's chest.
3. Patient lies supine with hip flexed to 90 degrees. With one hand, the examiner cups the sacrum and holds the comfortably flexed knee with the other. Pressure is applied along the femur shaft.
4. Patient lies prone while examiner manually applies an anterior pressure on the sacrum.
5. Patient is side-lying with hips and knees flexed to 90 degrees. The examiner applies medially oriented pressure on the upper iliac crest.
6. Patient lies supine while examiner manually presses posteriorly on the anterior superior iliac spines.
7. Leeds Assessment for Neuropathic Symptoms and Signs
8. With patient in prone position, both lower extremities are passively elevated 30 cm with knees extended. Positive test causes LBP.
9. +LR = (Positive Likelihood Ratio) Probability of the finding in patients with condition divided by the probability of the finding in patients without condition. Greater than 1 indicates test is associated with condition. Higher numbers indicate greater probability of association. PPV = (Positive Predictive Value) The number of true positives divided by the sum of true and false positives, indicating the probability that a positive test is truly positive for a condition. Higher numbers indicate greater diagnostic strength or accuracy. OR = (Odds Ratio or Diagnostic Odds Ratio [DOR]) A ratio measuring effectiveness of a diagnostic test. OR greater than 1 indicates ability to predict diagnosis. Higher numbers indicate greater diagnostic strength or accuracy. Sensitivity = percentage of individuals with a condition who test positive for that condition. Specificity = percentage of individuals who do not have a condition are identified as negative by the test

Appendix A
Diagnostic Classification Checklist.

Screening		
Is there evidence of progressive neurological deficit?	❑ No	❑ Yes
Is there evidence of pathologic fracture, infection or malignancy?	❑ No	❑ Yes
Are there gait difficulties, spasticity or other signs of myelopathy?	❑ No	❑ Yes
Recent history of unplanned or unexplained weight loss?	❑ No	❑ Yes
Is there evidence of acute injury?	❑ No	❑ Yes
Is there evidence of seronegative spondyloarthropathy?	❑ No	❑ Yes
Nociceptive Pain		
Discogenic Pain		
Centralization with repeated motion	❑ No	❑ Yes
Any two: (Centralization w/ repeated motion, vulnerable/apprehensive when stooped, & exten. loss)	❑ No	❑ Yes
SI Joint Pain (3 or more of 6 tests)		
Three or more of 6 + SI Joint tests without centralization with repeated motion	❑ No	❑ Yes
(Gaenslen's L & R, Thigh Thrust [symptomatic side], Distraction, Iliac Compression, Sacral Thrust)		
Zygapophyseal (Facet) Joint Pain (3 or more)		
Age > 50	❑ No	❑ Yes
Pain relieved when walking	❑ No	❑ Yes
Pain relieved when sitting	❑ No	❑ Yes
Onset of pain was paraspinal	❑ No	❑ Yes
Positive Extension-Rotation test	❑ No	❑ Yes
Myofascial Pain		
Ache-type pain with aggravation by use of involved muscle	❑ No	❑ Yes
Trigger point in muscle with possible radiation	❑ No	❑ Yes
Neuropathic Pain		
Compressive Radiculopathy		
Absent ankle/knee reflex	❑ No	❑ Yes
Leg pain worse than back pain?	❑ No	❑ Yes
Dermatome distribution (cough, sneeze, strain)	❑ No	❑ Yes
Paresis (extremity motor strength loss)	❑ No	❑ Yes
Finger floor distance during flexion >25cm	❑ No	❑ Yes
LANSS score >12	❑ No	❑ Yes
Non-compressive Radiculopathy		
LANSS score >12	❑ No	❑ Yes
Compressive Radiculopathy criteria are satisfied	❑ **No**	❑ Yes
Neurogenic Claudication		
Score of 7 or more on clinical prediction rule	❑ No	❑ Yes
ABI greater than 0.9 (if indicated)	❑ No	❑ Yes
Central Pain		
Pain disproportionate to injury/pathology	❑ No	❑ Yes
Disproportionate, non-mechanical, unpredictable pattern of aggravating/relieving factors	❑ No	❑ Yes
Strong association with maladaptive psychosocial factors	❑ No	❑ Yes
(neg. emotions, poor self efficacy, maladaptive beliefs & pain behaviors, conflicts [family, work…])		
Diffuse or non-anatomic distribution of tenderness to palpation	❑ No	❑ Yes

Appendix A
Diagnostic Classification Checklist (continued).

Functional Instability (Lumbar Segmental Instability)		
Prone passive lumbar extension positive	❑ No	❑ Yes
One or more lumbar hypermobile segment(s)	❑ No	❑ Yes
One or more lumbar hypomobile segment(s)	❑ **No**	❑ Yes
Other diagnoses		
Evidence for other diagnoses (Thoracolumbar syndrome, Piriformis syndrome, Hip pain)...	❑ No	❑ Yes

---

Leeds Assessment of Neuropathic Symptoms and Signs (LANSS Pain Scale)

Does the pain feel like strange unpleasant sensations on the skin (e.g. pricking, tingling, pins/needles)?	5
Does skin in the painful area(s) look different (mottled, more red or pink than usual)?	5
Is the skin in the painful area abnormally sensitive to touch? (e.g. lightly stroked, tight clothes)	3
Does the pain come on suddenly? (e.g. electric shocks, jumping, or bursting)	2
Does the pain feel as if the skin temperature in the painful area has changed abnormally (e.g. hot, burning) ?	1
Exam: Does stroking the painful area of skin with cotton produce pain?	5
Exam: Does a pinprick at the painful area feel different than a pinprick in an area of normal skin?	3

0 – 12 = likely nociceptive, Score > 12 likely neuropathic **Total**: _____

Adapted from: Bennett, M.I. (2001). The LANSS Pain Scale: The Leeds assessment of neuropathic symptoms and signs. *Pain, 92*(1-2), 147–157.

Neurogenic Claudication Clinical Prediction Rule (Score of ≥ 7)

Age 60-70	2
Age >70	3
Onset over 6 months	1
Symptoms improve when bending forward	2
Symptoms improve when bending backward	–2
Symptoms exacerbated while standing	2
Intermittent claudication symptoms (symptoms while walking and relieved by rest)	1
Urinary incontinence	1
Total	_____

Adapted from: Sugioka T, Hayashino Y, Konno S, Kikuchi S, Fukuhara S. Predictive value of self-reported patient information for the identification of lumbar spinal stenosis. Fam Pract 2008;25:237-244.

Appendix B
Clinical evaluation procedures included in the diagnostic classification checklist.

Discogenic

Repeated end range loading

1. Left lateral shift (standing)
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
   Right lateral shift (standing)
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
2. Flexion (standing)
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
   Extension (standing)
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
3. Supine flexion
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
   Prone extension
   ❑ Centralize ❑ Peripheralize ❑ Status Quo
4. Finger to floor distance
   ❑ <25 cm ❑ ≥ 25 cm

SI Joint

1. Gaenslen's L	❑ Neg	❑ Pos
2. Gaenslen's R	❑ Neg	❑ Pos
3. Thigh Thrust	❑ Neg	❑ Pos
4. Distraction	❑ Neg	❑ Pos
5. Iliac Compression	❑ Neg	❑ Pos
6. Sacral Thrust	❑ Neg	❑ Pos

Neuropathic Pain

Reflexes	**Left**	**Right**
(L2-4) Patellar	_____ (0-5)	_____ (0-5)
(S1,2) Achiles	_____ (0-5)	_____ (0-5)
Other	_____ (0-5)	_____ (0-5)

Muscle strength	**Left**	**Right**
(**L4**-S1) Tibialis Anterior	____	____
(L4, **L5**, S1) Extensor Hallicus Longus	____	____
(L4-**S1**) Peroneus Longus	____	____
Other	____	____

Nerve tension

1. Straight Leg Raise	❑ Neg	❑ Pos
2. Slump test	❑ Neg	❑ Pos
3. Femoral Nerve Stretch	❑ Neg	❑ Pos

LANSS Examination

4. Does stroking the painful area of skin with cotton produce pain	❑ No	❑ Yes
5. Does pinprick at the painful area of skin feel different than at a normal area	❑ No	❑ Yes

Zygapophyseal (Facet)

1. Extension-rotation test	❑ Neg	❑ Pos

Myofascial

1. Evidence of trigger points	❑ No	❑ Yes

Functional Instability ❑ Not indicated

1. Prone passive lumbar extension	❑ Neg	❑ Pos
2. Hypomobility detected L1-L5	❑ No	❑ Yes
3. Hypermobility detected L1-L5	❑ No	❑ Yes

Ankle Brachial Index

	Left	Right
A. Post. tibial systolic pressure	____	____
B. Highest brachia systolic pressure (L or R)		____

Calculate
Left (A. / B.) ____
Right (A./ B.) ____

Results
❑ Normal (1.0 – 1.1)
❑ Borderline (.91 - .99)
❑ Abnormal (less than .9)

Other

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/205–213/$2.00/©JCCA 2013

On Vaccination & Chiropractic: when ideology, history, perception, politics and jurisprudence collide

Brian Gleberzon, DC, MHSc*
Marlee Lameris, BSc, DC
Catherine Schmidt, BSc, DC
Jillian Ogrady, BSc, DC

The Palmers espoused anti-vaccination opinions in the early part of the 20th century, rejecting the germ theory of disease in favor of a worldview that a subluxation-free spine, achieved by spinal adjustments, would result in an unfettered innate intelligence; this, along with other healthful lifestyle choices, would allow a person to thwart disease by marshaling the body's natural recuperative abilities. Some chiropractors continue to staunchly champion the Palmer postulates, while others do not. At the national level, advocacy organizations publish conflicting position statements. We explore how this divisiveness has impacted chiropractic ideology, perceptions among students and practitioners, politics and issues of jurisprudence as reflected by the evolution of a standard of chiropractic practice in at least one Canadian province (Ontario). We opine that the chiropractic profession should champion a health promotion and disease prevention approach to vaccination, which would allow it to align itself with the broader healthcare community while not abandoning its traditional tenets.

KEY WORDS: vaccination, chiropractic

Au début du 20e siècle, les Palmer ont soutenu des opinions anti-vaccination, rejetant la théorie microbienne des maladies en faveur d'une idée répandue mondialement suivant laquelle une colonne vertébrale sans subluxation, résultat d'ajustements vertébraux, se traduirait par une intelligence innée et sans contrainte. Ceci, accompagné d'autres choix sains de mode de vie, permettrait à une personne d'écarter les maladies en faisant appel aux capacités de récupération naturelles de son corps. Certains chiropraticiens continuent de défendre farouchement la thèse de Palmer, alors que d'autres s'y opposent. À l'échelle nationale, divers groupes de défense publient des opinions contradictoires. Nous examinons l'impact de cette divergence d'opinion sur l'idéologie de la chiropratique, les perceptions des étudiants et des praticiens, les politiques et les enjeux de jurisprudence, comme le reflète l'évolution de normes de pratique de la chiropratique dans au moins une province canadienne (Ontario). Nous sommes d'avis que la profession de la chiropratique devrait favoriser une approche de promotion de la santé et de prévention des maladies concernant la vaccination, ce qui lui permettra de s'harmoniser avec le reste de la communauté médicale sans pour autant abandonner ses principes traditionnels.

MOTS CLÉS : vaccination, *chiropratique*

*Corresponding author: Professor, Chair of Department of Chiropractic Therapeutics, CMCC, 6100 Leslie St. Toronto, Ontario, M2H 3J1.
E-mail: bgleberzon@cmcc.ca

Introduction

> *"It is the very height of absurdity to strive to 'protect' any person from smallpox and other malady by inoculating them with a filthy animal poison... No one will ever pollute the blood of any member of my family unless he cares to walk over my dead body... "*
>
> D.D. Palmer, c1910[1]

With the possible exceptions of the term 'subluxation'[2,3] and chiropractic's role in the health care delivery system[4-7], no other issue has polarized the chiropractic profession as much as vaccination. From the time of its inception in the early part of the 20th century, both Daniel David (commonly referred to as "D.D.") Palmer along with his son Bartlett Joshua (commonly referred to as "B.J.") promulgated anti-vaccination stances, stances that animated much of the profession's opposition to organized medicine.[1,7,8] It was D.D. Palmer, a magnetic healer, who performed the first chiropractic adjustment in what has become the epochal event of the profession. According to chiropractic lore, D.D. restored the hearing of a deaf janitor named Harvey Lillard by adjusting a vertebrae of his mid thoracic spine that he determined to be 'racked' out of place.[1,3,9,10] By doing so, by resolving a neurological problem (deafness) with a refined manual method of cure first employed by European bone-setters (spinal manipulation)[10], D.D. and later B.J. came to believe that chiropractic care had far-reaching and more powerful effects on the human body than simply resolving back pain.[1,3,5,8] Among these far reaching effects was the ability to provide defence against communicable diseases.[1,3,5]

But do chiropractors espouse these anti-vaccine worldviews today? As the third largest primary health profession in North America this question may have serious implications to public health initiatives.[11] With roughly 60,000 chiropractors in the United States[11,12] and close to 8,000 in Canada[13], chiropractic's cultural authority tends to lie in the area of 'spinal care' with roughly 80% of a chiropractor's patient portfolio consisting of headache, low back and neck pain conditions[6,14,15], and a number of well-designed systematic reviews are investigating the effectiveness of the types of manual therapies chiropractors most often use for patient care[16-19]. Many chiropractors emphasize a 'wellness' or a health promotion and disease prevention paradigm, advising patients to exercise, not to smoke, to maintain good nutritional practices, employ proper ergonomics and to practice safe sex and safe sun[20-23] – all healthful strategies around which no controversies exist. However, since chiropractors interact with a significant number of patients throughout their professional careers, it stands to reason that if a segment of chiropractors also advise their patients to eschew vaccinations, this could imperil the success of large-scale immunization programs championed by the World Health Organization (WHO)[24], the Centre of Disease Control and Prevention (CDCP)[25] and the Public Health Agency of Canada[26].

This paper explores the issue of chiropractic and vaccination in terms of: (i) historical perspective; (ii) attitudes among chiropractic students; (iii) attitudes among chiropractors; (iv) political perspectives and; (v) issues of jurisprudence. We discuss how these issues impact the relationship between chiropractic and medicine and we recommend a path forward, one that will more firmly entrench chiropractic into the larger healthcare community, while not necessarily abandoning its core ideological tenets.

(i) Historical perspective

At the beginning of the previous century, the Palmers rejected the germ theory of disease, despite the fact it was gaining wide acceptance at the time.[3,8] B.J, who assumed the mantle of the profession's leadership in 1906 after purchasing the Palmer School of Cure (PSC) from his father (who was jailed for a time for practicing medicine without a license), asserted that: *"chiropractors have found in every disease that is supposed to be contagious, a cause in the spine. In the spinal column we will find a subluxation that corresponds to every type of disease... If we had one hundred cases of small-pox, I can prove to you, in one, you will find a subluxation and you will find the same condition in the other ninety-nine. I adjust one and return his function to normal... There is no contagious disease... There is no infection. There is a cause internal to man that makes of his body in a certain spot, more or less a breeding ground [for microbes]"*[8]. It was B.J.'s opinion that *"the idea of poisoning healthy people with vaccine virus... is irrational. People make a great ado if exposed to a contagious disease, but they submit to being inoculated with rotten pus, which if it takes, is warranted to give them a disease"*[24]. The curriculum at the PSC was

based on the central tenet that adjusting spinal segments assessed as being subluxated [i.e. operating in an aberrant manner in terms of their structure, function or neurology, depending on the prominent model at the time[10,28]] would marshal the natural recuperative abilities of the body, relying on what the Palmers labelled *innate intelligence*[29]. It was reasoned that removing the nerve interference caused by subluxated spinal segments would, in the parlance of B.J., *"emancipate the rivulets of entrapped life force"*[27]. By removing subluxation and marshalling the innate intelligence of the person (removing them from a state of *dis-ease*) the patient's neurological system could function unfettered, ultimately thwarting disease. This ideology, often described as a core tenet of chiropractic philosophy, continues to be embraced by a significant portion of the profession, a portion who label themselves as 'straight' or 'principled'.[30] Although estimates vary, one epidemiological study conducted in Canada reported roughly 30% of chiropractors identify themselves as having this traditional or orthodox worldview.[30]

(ii) Attitudes Among Chiropractic Students

Busse and his colleagues[31] surveyed a cohort of Canadian chiropractic students during the 1999/2000 academic year in order to ascertain their attitudes toward vaccination. Busse writes that, as a chiropractic student at the time, as the program progressed, an increasingly anti-vaccination sentiment was noted among the students[32] and, since over 80% of all chiropractors practicing in Canada were educated at the Canadian Memorial Chiropractic College (CMCC), the only English-speaking chiropractic college in Canada, it was reasonable to posit that attitudes toward vaccinations identified among CMCC students may predict their attitudes upon graduation. Upon surveying his classmates, Busse *et al*[32] found that, although 72.3% of first year students were in favour of vaccination, this number fell to 58.2% of students in their final year of study. The investigators also found that students who had a negative attitude toward vaccination were more likely to have relied on informal sources of information, such as non-peer reviewed chiropractic literature and informal social club talks.[32] This study did not go unnoticed by the medical community, especially paediatricians, and a commentary appearing contemporaneously with the published Busse *et al* study described these results as 'disturbing', although it did suggest there be more inter-professional collaboration and that this may be an ideal opportunity for medical and chiropractic students to work together and learn from each other.[33] Notwithstanding how it may appear, since theirs was one-time cross-sectional 'snap-shot' study of a cohort and not a longitudinal one, it cannot be said with certainly whether students' attitudes became more negative as they progressed throughout the 4-year academic program or if the attitudes identified in each year were a reflection of some other unidentified factor unique to each specific class.

When Busse *et al*[31] published their article in the Canadian Medical Assocation Journal in 2002, the lead author of this manuscript (BJG) posited that the anti-vaccine attitudes held by senior students may be a reflection of the influence of some charismatic students enrolled in the college c1999. Their advocacy of traditional chiropractic ideologies, which included a rejection of the benefits of vaccination, was spread by the student groups they organized. If correct, it would be reasonable to expect that 12 years later these results would vary greatly due to changes in the academic program, current student population, accrued scientific knowledge between the two time intervals, advances in scientific research and the adoption of the doctrines of evidence-based medicine that have been inculcated into the college milieu.

In order to learn if attitudes toward vaccination has indeed changed, we surveyed the class of 2011/12 at CMCC using the same survey instrument used in 1999/2000. In addition to using the identical 11 survey questions used by Busse *et al* [31] (with the exception of substituting H1NI for Pertussis in one of the questions) students were also asked whether or not they had been vaccinated, if they believed they had been adequately educated on the topic of vaccination, if they believed they could discuss the topic of vaccination with their patients and if they believed they should have the legal right to be allowed to do so. Unlike the Busse et al[31] study, however, we did not seek to learn what sources of information students relied upon in order to develop their attitudes toward vaccination.

As predicted, our results[34] were fundamentally different than the results reported by Busse *et al*[31]. Specifically, a minimum of 83% of chiropractic students in all years in the 2011/12 acacdemic year held a favorable attitude towards vaccination. The highest favorable rate was reported by second year students (89.9%), followed by students in their final year of study (87.75). When asked

'are you in favor of vaccination and immunization in general?' between 80.7% and 91.9% of students in our study responded 'yes'. We used a Welsh t-test for two samples having possible unequal variances and found a statistical difference between the two surveys, with current academic year having a more positive attitude towards vaccination. It must be noted, however, that our study did suffer from a non-response bias disproportionately affecting later years of study.[see 34]

(iii) Doctor Perspectives

There exists one large survey of the attitudes of chiropractors towards vaccination. Colley and Haas[35] conducted a mail survey of randomly selected American chiropractors. Despite the fact the validity of the study suffered from a very low response rate (36%), and the sample size represented less than 1% of all chiropractors in the United States, the researchers reported roughly one-third of the 171 respondents believed there was no scientific proof that immunization prevents disease, that immunization has substantially changed the incidence of infectious diseases that immunization causes more disease than it prevents and that contacting a disease is in fact safer than being immunized against it.[35]

A study by Evans et al[36] surveyed a random sample of chiropractors' website that purportedly discussed 'wellness'. Sixteen of these websites (34%) contained anti-vaccination information, and these same websites were the ones to most often mention 'innate', 'subluxation' and 'spinal pain' as well. This led the authors to conclude that many of these websites contained 'useless' information that would not help a person maintain good health.

Page and colleagues[37] explored how chiropractors in Alberta brought up the topic of immunization with their patients using a set of interview questions. They reported the discussion typically was initiated after a media report of some kind, as the result of reading material left in the chiropractor's waiting room or after a patient's perceived adverse reaction to a vaccine. The discussion could also be initiated by chiropractors if they were seeing the children of patients. The researchers reported some chiropractors used this as an opportunity to provide anti-vaccination information and material, and that much of the waiting room material had an anti-immunization slant. The same group of researchers then asked whether these Albertan chiropractors felt prepared to discuss immunization with their patients.[38] Of the 503 Albertan chiropractors surveyed, only 45% felt their chiropractic education adequately prepared them to counsel patients on the topic of immunization. Despite this, 72% of respondents indicated they felt adequately prepared to counsel their patients on immunization.

Medd and Russell[39] conducted a secondary analysis of the study by Injeyan *et al* [38] cited above. Medd and Russell[39] reported that, while over 90% of the chiropractors interviewed were themselves immunized, only 35.7% of them would accept to be immunized in the future. Furthermore, only 66% of respondents had immunized their children and only 21% would refer patients for possible immunization. Russell *et al*[40] reported that 41% of chiropractors felt immunizations were safe, that 60% felt immunization should never be given to children under the age of 1, that 30% felt they should never be provided to the elderly and 27% of them advised their patients "against having themselves/ their children immunized". Finally, a recent study by Downey et al[41] reported that children were significantly less likely to receive all four recommended vaccinations if they saw a naturopathic doctor and significantly less likely to receive three of the four recommended vaccinations if they saw a chiropractor.

That all having been said, Russell *et al*[42] subsequently reported 60% of Albertan chiropractors would be interested in participating in community immunization awareness programs. Lastly, in contrast to aforementioned studies, studies by Davis and Smith [43] and Smith and David[44] reported that chiropractic patients were *no less likely* to be vaccinated for the seasonal influenza flu than were non-chiropractic patients, although they also reported that chiropractic users were significantly less likely than non-users to use the pneumococcal vaccine. A study by Stokley et al[45] described vaccination coverage among patients according to their use of Complementary and Alternative Medicine (CAM) and found vaccination coverage levels were actually higher among recent CAM users compared to non-CAM users.

(iv) Political Perspective

It requires minimal effort to gather position statements from prominent chiropractic organizations, newsletters and non-peer reviewed articles that assert an attitude towards vaccination that ranges from cautionary to scep-

tical to alarmist. Many of these documents and concerns have been catalogued by Campbell et al[46], essentially advancing on an article by Nelson[47] a decade earlier and expanded on by Ferrance[48] a few years after that. For example, the position statement from the International Chiropractic Association (ICA) states:

> The International Chiropractors Association recognizes that the use of vaccines is not without risk. The ICA supports each individual's right to select his or her own health care and to be made aware of the possible adverse effects of vaccines upon a human body. In accordance with such principles and based upon the individual's right to freedom of choice, the ICA is opposed to compulsory programs which infringe upon such rights. The International Chiropractors Association is supportive of a conscience clause or waiver in compulsory vaccination laws, providing an elective course of action for all regarding immunization, thereby allowing patients freedom of choice in matters affecting their bodies and health.[49]

Rather than debate the effectiveness of vaccines per se, the ICA position statement focuses on issue of safety and civil liberties. The policy statement on vaccination from the American Chiropractic Association[50], an organization that could be characterized as the more progressive of the American chiropractic organizations (see 11), is essentially identical.

At the other end of the ideological spectrum is the position statement from the largest national chiropractic advocacy organization in Canada, the Canadian Chiropractic Associations (CCA).[51] The CCA which represents upwards of 80% of all Canadian chiropractors, issued the following position statement:

> Vaccination is a well-established and widely mandated public health policy and the CCA supports public health promotion and prevention strategies that encourage physical and mental health and well-being. The CCA accepts vaccination as a cost-effective and clinically efficient public health preventative procedure for certain viral and microbial diseases, as demonstrated by the scientific community. The public responsibility for vaccination and immunization is neither within the chiropractic scope of practice, nor a chiropractic specific issue. Public health programming and literature provide appropriate sources of information for patient education regarding vaccination and immunization. [51]

Another topic that provides a great deal of animation to the opposition to vaccination among some chiropractors is the purported relationship between immunizations and autism.[52,53] Autism is the most commonly diagnosed neurological pediatric condition among many countries (including Canada, the United States, and the United Kingdom), with current estimates that 1 in 88 children, and as many as 1 in 54 boys, are autistic.[54] Although there is evidence that some of these increased diagnoses can be attributed to *diagnostic substitution*[55], whereby children previously labeled as 'mentally retarded' are now classifiable as autistic, that cannot account for the exponential rise in the number of diagnosed cases. Since a definitive cause of autism has eluded modern-day science and, given the fact that autistic symptoms often appeared concurrently with vaccination schedules, a causal relationship suspected from a temporal one was understandable.

The main research evidence for this relationship was derived by a study by Wakefield *et al*[56] published in the Lancet in 1998. In that article, Wakefield and his colleagues reported that 8 of 12 children with a disease of the digestive tract who had received the MMR vaccination subsequently developed autism.[56] However, not only have no scientific studies been able to replicate Wakefield's findings or confirm his assertion[57,58], but an investigative report by journalist Brian Deer[59] raises suspicions that the Wakefield study was fraudulently conducted altogether.

This led the licensing board (the Medical Council)[60] in the United Kingdom to refer the matter to the Fitness to Practice Committee (FPC). The FPC found Wakefield guilty of a number of acts of professional misconduct including unethical conduct, breach of scholarship ethics, performing diagnostic procedures he was not trained to perform, not divulging conflicts of interest and abusing his power as a physician.[60] At the same time, the Lancet retracted the Wakefield study from the journal.[61]

Concerns shifted away from the vaccines themselves and instead focused on the ethyl mercury preservative thimerosol.[62] However, studies have equally failed to demonstrate any causal relationship between thimerosol

and the development of autism.[63,64] Despite these studies, some chiropractors continue to believe that Wakefield was the victim of a 'witch-hunt' and that the entire thing is a cover up by "Big Pharm".[46-48,53]

The anti-vaccine opinions espoused by a small but vocal segment of the chiropractic profession has not gone unnoticed by allopathic medicine. The Canadian Paediatric Society (CPS)[65] published a position statement on chiropractic in general and on the subject of chiropractic and vaccination in particular. The statement, published in 2002 and reaffirmed in 2012, referenced a survey of American chiropractors that reported one-third of respondents believed there was no scientific proof that immunization prevents disease, that immunization has not substantially changed the incidence of any major disease and that immunization causes more disease than it prevents. The CPS statement concluded:

> Chiropractic treatment for children and adolescents is not uncommon. Open and honest discussions with families using or planning to use chiropractic for their children will, hopefully, bring about a rational use of this treatment in selected musculoskeletal conditions for which there is proof of efficacy, and enable parents to make informed choices about this form of therapy.[65]

(v) Jurisprudence

The year 2004 was something of a watershed moment for chiropractic in Ontario, and it represented a perfect storm of challenges to the profession. In that year, the provincial government of Ontario announced that chiropractic services would be delisted from the Ontario Health Insurance Plan (OHIP), the socialized healthcare payment plan that paid for most medical services in that province.[66] This followed a failed university affiliation between York University and CMCC[67], as well as a decision from the Lewis Inquest that concluded the death of a patient under chiropractic care was 'accidental'[68], a decision that baffled many chiropractors based on the testimony of content experts provided at the time[69]. Lastly, as previously mentioned, the CPS issued its' position statement on chiropractic[65] around that time and a few years earlier the Busse et al study[31] was published.

It was within this political backdrop that the licensing body of chiropractors in Ontario, the College of Chiropractors of Ontario (CCO) enacted *Standard of Practice S-015: Vaccination/Immunization* that essentially made it an act of professional misconduct to discuss vaccinations/immunizations with chiropractic patients. It was thought by some members of the CCO at the time (c2004) that this action would avert impending deregulation of chiropractic in Ontario. (This was no idle concern. Self-regulation is a *privilege* and not a *right* and in Ontario a Minster of Health can intervene and remove a regulatory body's privilege of self-regulation if s/he believes it is not acting within its mandate to protect the public interest, something that recently happened to the College of Denturists).

SP-015 spawned considerable backlash from many rank and file chiropractors. Even more moderate chiropractors found the 'gag order' distasteful; given their education including courses on microbiology, immunology and public health and, as primary contact portal of entry healthcare providers, it was thought that a chiropractor ought to be able to render his or her own informed opinion on the issue of vaccination.

Council members of CCO change every year, and are subject to elections held throughout various districts in the province, in accordance to CCO by-laws and the *Regulated Health Professions Act* (*RHPA*)[70], the omnibus regulations that governs all regulated healthcare professionals in Ontario. With a new Council constituency, the passage of time, a turnover of provincial governments (including the appointment of Ministers of Health who were seemingly much more favorably inclined towards chiropractic since 2004), and an overall change in the political milieu in the province, the CCO approved a new Standard of Practice, S-001: *Scope of Practice* in February 2011[71]. This new Standard subsumed Standards of Practice S-010 (techniques, technologies, devices and procedures) and S-015, both of which were rescinded. Among other changes, the new Scope of Practice Standard permits chiropractors to discuss vaccination/immunization with their patients. Essentially, the Standard calls for a three-step process: (i) the patient must be informed that immunizations and vaccinations are outside the scope of chiropractic practice; (ii) if providing an opinion, the response provided must be 'accurate, professional and balanced' and; (iii) the chiropractor must then advise the patient to consult a healthcare practitioner who has vaccination/immunization within their scope of practice.

Summary

The interface between vaccination and chiropractic history, ideology, attitudes among chiropractic students, attitudes among practitioners, politics and jurisprudence has been a complex and mercurial boundary. Internecine fighting has not gone unnoticed by external stakeholders and observers.[33] If the issue were one that was only of primary interest to chiropractors themselves (such as the 'subluxation' question) it is doubtful that outside observers would take notice. But because a significant portion of the chiropractic profession has aligned itself against one of the most successful health care initiatives of the past 100 years, the issue of chiropractic and vaccination will continue to be a source of contention, scrutiny and perhaps even animosity between chiropractic and medicine.

Perhaps recent commentaries by Lawrence[11], Page [see 22], and a series of 'Best Practice' documents by Hawk et al[72-74] provide a conceptual platform that will allow the profession to move forward on this issue. Rather than focus on the issue of an individual's rights of autonomy to opt out of immunization programs, thus framing the issue as an ethical privilege, the profession should harken to its core emphasis of health promotion and disease prevention achieved by healthful lifestyle choices. While certainly not risk-free, there does exist an over-abundance of evidence proving that vaccines are both safe and effective. By recommending their use as clinically indicated the chiropractic profession would promote the public good and, by doing so, would be in a better position to be embraced by the broader healthcare community while not abandoning its traditional tenets.

References

1. Palmer DD. In: The Chiropractor's Adjustor. Portland (OR): Portland Printing House Company; 1910
2. Keating JC Jr, Chalton KH, Grod JP et al. Subluxation: dogma or science? Chiropractic & Osteopathy. 2005;13(17):1-23. (Accessed Feb 10/06)
3. Owens EF. Chiropractic subluxation assessment: What the research tells us. J Can Chiro Assoc. 2002;46(4):215-220.
4. Meeker WC, Haldeman S. Chiropractic: A profession at the crossroads of mainstream and alternative medicine. Ann Intern Med. 2002;136:216-227.
5. Nelson CF, Lawrence DJ, Triano JJ et al. Chiropractic as spine care: a model for the profession. Chiropractic and Osteopathy. 2005;13:9.
6. Villanueva-Russell Y. Caught in the crosshairs: Identity and cultural authority within chiropractic. Soc Sci & Med. 2011;1-12.
7. Brown R. A health care system in transformation: making the case for chiropractic (commentary). Chiropractic and Manual Therapies. 2012;20:37. doi 10.1186/2045-709X-20-37.
8. Palmer BJ. The Philosophy of Chiropractic. V. Davenport. IA: Palmer School of Chiropractic; 1909.
9. Harvey Lillard c1897. As quoted by Keating JC Jr et al. Chiropractic History: A Primer. 2004.
10. Keating JC Jr. Several pathways in the evolution of chiropractic manipulation. J Manipulative Physio Ther. 2003;26(5):300-321.
11. Lawrence D. Anti-vaccination attitudes within the chiropractic profession: Implications for public health ethics (commentary). Topics in Integrative Health Care. 2012;3(4):1-8.
12. http://www.chiropractic.org/?p=chiroinfo/main (Accessed July 25, 2012)
13. http://www.chiropracticcanada.ca/en-us/FactsFAQs.aspx (Accessed July 25, 2012)
14. Cherkin DC, Deyo RA, Sherman KJ et al. Characteristics of visits to licensed acupuncturists, chiropractors, massage therapists and naturopathic physicians. J Am Board Fam Pract. 2002;15:463-72.
15. National Board of Chiropractic Examiners. Job Analysis of Chiropractic: a project report, survey analysis and summary of the practice of chiropractic within the United States. Greeley, Colorado, USA. National Board of Chiropractic Examiners; 2005
16. Bronfort G, Haas M, Evans R et al. Effectiveness of manual therapies: The UK evidence report. Chiropractic & Osteopathy. 2010;18:3.
17. Rubinstein SM, Terwee CB, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for acute low-back pain. Cochrane Database Syst Rev. 2012 Sep 12;9:CD008880.
18. Rubinstein SM, van Middelkoop M, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for chronic low-back pain. Cochrane Database Syst Rev. 2011 Feb 16;(2):CD008112.
19. Gross A, Miller J, D'Sylva J, Burnie SJ, Goldsmith CH, Graham N, Haines T, Brønfort G, Hoving JL Manipulation or mobilisation for neck pain. Cochrane Database Syst Rev. 2010 Jan 20;(1):CD004249.
20. Stainsby BE, Poor JTC, Kim P et al. A survey of wellness management strategies used by Canadian doctors of chiropractic. J Manip Physiol Ther. 2011;34:388-393.
21. Gleberzon BJ. Geriatric chiropractic care as a health promotion and disease prevention initiative: Focus on fall prevention. Topics in Integrative Health Care. 2010;1(2):1-15.
22. Johnson C, Rubinstein SM, Cote P et al. Chiropractic care and public health: Answering difficult questions about safety, care through the lifespan, and community action (editorial). J Manip Physiol Ther. 2012; 35:493-513.

23. Hawk C, Schneider M, Evans MW, Redwood D. Consensus process to develop a best practices document on the role of chiropractic care in health promotion, disease prevention and wellness. J Manip Physiol Ther. 2012;35:556-567.
24. Immunization safety. http://www.who.int/immunization_safety/en/
25. Immunization and vaccines http://www.phac-aspc.gc.ca/im/index-eng.php
26. Vacccines and immunization http://www.cdc.gov/vaccines/
27. Palmer BJ. The Science of Chiropractic. Its Principles & Adjustments. Davenport IA: The Palmer School of Chiropractic, 1906:17.
28. Cooperstein R, Gleberzon BJ. Towards a taxonomy of subluxation-equivalents. TICC. 2000;8(1):49-60.
29. Keating JC Jr. The meaning of innate (commentary). J Can Chiro Assoc. 2002;46(1):4-10.
30. Biggs L. Mierau D, Hay D. Measuring philosophy- a philosophy index. J Can Chiro Assoc. 2002;46(3):173-184.
31. Busse JW, Kulkarni AV, Campbell JB et al. Attitudes towards vaccination: a survey of Canadian chiropractic students. CMAJ. 2002; 166(12):1531-1534.
32. Busse JW, Wilson K, Campbell JB. Attitudes towards vaccination among chiropractic and naturopathic students. Vaccine. 2008;26:6237-43.
33. Pless R, Hibbs B. Chiropractic student's attitudes towards vaccination: A cause for concern? JAMC. 2002;166(12):1544-1545.
34. Larmeris M, Schmidt C, Gleberzon BJ, Ogrady J. Attitudes towards vaccination: a follow up survey of Students at the Canadian Memorial Chiropractic College. J Can Chiro Assoc. 2013;57(3):214-220.
35. Colley F, Haas M. Attitudes on immunization: a survey of American chiropractors. J Manip Physiol Ther. 1994;41:145-154.
36. Evans MW, Perle SM, Ndetan H. Chiropractic wellness on the web: The content and quality of information related to wellness and primary prevention on the Internet. Chiro & Manual Therapies. 2011;19:4.
37. Page SA, Russel ML, Verhoef MJ, Injeyan HS. Immunization and the chiropractor-patient interaction: a Western Canadian injury. J Manip Physiol Ther. 2006;29:156-161.
38. Injeyan HS, Russell ML, Verhoef MJ et al. Canadian chiropractor's perception of educational preparation to counsel patient on immunization. J Manip Physiol Ther. 2006;29:643-650.
39. Medd A, Russell ML. Personal and professional immunization behavior among Alberta chiropractors: a secondary analysis of cross-sectional survey data. J Manip Physiol Ther. 2009;32:448-452.
40. Russell ML, Injeyan HS, Verhoef MJ, Eliasziw M. Beliefs and behaviours: understanding chiropractors and immunizations. Vaccine. 2004;23(3):372-9.
41. Downey L, Tyree PT, Huebner CE, Lafferty WE. Pediatric vaccination and vaccine-preventable disease acquisition: association with care by complementary and alternative medicine providers. Matern Child Health J. 2010;6:922-930.
42. Russel MS, Vehoef MJ, Injeyan HS. Are chiropractors interested in participating in immunization awareness and promotion activities. Can J Public Health. 2005;96:194-6.
43. Davis MA, Smith M, Weeks WB. Influenza vaccination among chiropractic patients and other users of complementary and alternative medicine: are chiropractic patients really different? Prev Med. 2012;54:5-8.
44. Smith M, Davis MA. Immunization status of adult chiropractic patients in analyses of national health interview study. J Manip Physiol Ther. 2011;34:602-8.
45. Stokley S, Cullen KA, Kennedy A et al. Adult vaccination coverage levels among users of complementary/alternative medicine- results from the 2002 National Health Interview Survey (NHIS). BMC Complementary and Alternative Medicine. 2008;8(6).
46. Campbell JB, Busse JW, Injeyan HS. Chiropractors and vaccination: a historical perspective. Pediatrics. 2000;105(4):e43.
47. Nelson CF. Why chiropractors should embrace immunization. J Chiropractic. 1993;30:85-88.
48. Ferrance RJ. Vaccinations: how about some facts for a change? Commentary. JCCA. 2002;46(3):167-172.
49. ICA Policy statement. http://www.chiropractic.org/?p=ica/policies#immunization
50. ACA Policy statement on vaccination. http://www.acatoday.org/level2_css.cfm?T1ID=10&T2ID=117 Accessed Jan 24, 2013
51. Vaccination and immunization. http://www.chiropracticcanada.ca/en-us/AboutUs/TheCCA/PositionStatements/VaccinationandImmunization.aspx
52. Gleberzon BJ. Chiropractic and the management of children with autism. Clin Chiropr. 2006;
53. Ferrance RJ. Autism-another topic often lacking facts when discussed within the chiropractic profession. Commentary. JCCA. 2003;47(1):4-6.
54. CDC – Data and Statistics, **Autism** Spectrum Disorders – NCBDDD www.cdc.gov/ncbddd/**autism**/data.html. March 29, 2012 (Accessed Nov 15, 2012
55. Shattuck PT. The contribution of diagnostic substitution to the growing administrative prevalence of autism in US special Education. Pediatrics. 2006;117(4):1028-37.
56. Wakefield AJ et al. Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorders in children. The Lancet. 1998;351:637-641.
57. Taylor B et al. Autism and measles, mumps and rubella vaccine: no epidemiological evidence of causal association. Lancet. 1999;353:2026-28.

58. Madsen KRM, Hviid A, Vestergaard M et al. A population-based study of measles, mumps and rubella vaccination and autism. N Engl J Med. 2002;347(19):1477-1482.
59. Deer B. How the case against the MMR vaccine was fixed. BMJ. 2011;342:77-82
60. http://www.gmc-uk.org/static/documents/content/Wakefield__Smith_Murch.pdf
61. Lancet retracts Wakefield MMR paper. http://www.bmj.com/content/340/bmj.c696.full
62. Geier MR, Geier DA. Thimerosol in childhood vaccines, neurodevelopmental disorders and heart disease in the United States. J Am Physicians Surg. 2003;8:6-11.
63. Hviid A et al. Association between thimerosal-containing vaccine and autism. JAMA. 2003;290:1763-6.
64. Buescher JJ. Vaccinations containing thimerosal do not increase rates of autism. J Fam Pract. 2004;53(2):94-96.
65. Canadian Paediatric Society. Position Statement. Chiropractic care for children: Controversies and issues. Paediatr Child Health. 2002;7(2):85-88. http://www.cps.ca/en/documents/position/chiropractic-care-children
66. Longo M, Grabowski M, Gleberzon BJ et al. The perceived effects of the delisting of chiropractic services from the Ontario Health Insurance Plan on practice activities. J Can Chiro Assoc. 2011;53(3):193-202.
67. Grayson JP. The academic legitimization of chiropractic: the case of CMCC and York University. J Can Chiro Assoc. 2002;46(40):265-279.
68. http://www.mcscs.jus.gov.on.ca/english/DeathInvestigations/office_coroner/VerdictsRecommendations/AlphabeticalList/OCC_verdicts_alpha.html
69. Dunn G. Jury Decision Stuns Profession- Leadership determined to rise to the occasion. Canadian Chiropractic. 2004;9(1):5, 18-19.
70. Regulated Health Professions Act. http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_91r18_e.htm
71. Standard of Practice- Scope of Practice (S-001) http://www.cco.on.ca/site_documents/S-001.pdf
72. Hawk C, Schneider M, Evans MW, Redwood D. Consensus process to develop a best practices document on the role of chiropractic care for older adults: results of a consensus process. J Manip Physiol Ther. 2012;35:556-567.
73. Hawk C, Schneider M, Dougherty P, Gleberzon BJ, Killinger LZ. Best practices recommendations for chiropractic care for older adults: results of a consensus process. J Manip Phyisol Ther. 2010;33(6):464-473.
74. Hawk C, Schneider M, Ferrance R, Hewitt E et al. Best practices recommendations for chiropractic care for children: results of a consensus process. J Manip Physiol Ther. 2009;32:649-647.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/214–220/$2.00/©JCCA 2013

Attitudes toward vaccination: A cross-sectional survey of students at the Canadian Memorial Chiropractic College

Marlee Lameris, BSc, DC
Catherine Schmidt, BSc, DC
Brian Gleberzon, DC, MHSc*
Jillian Ogrady, BSc, DC

Introduction: *The purpose of this study was to conduct an online survey of chiropractic students in the 2011/12 academic year at CMCC in order to determine their attitudes toward vaccination, their history of vaccination and their opinions towards their level of preparedness and confidence to discuss vaccination with patients.*

Method: *All students enrolled in the program at CMCC were eligible to participate in this anonymous survey modeled after a similar survey administered in 1999/2000.*

Results: *The response rate was 43%. Over 90% of all students reported they had been vaccinated. Roughly half of students felt they were well prepared to discuss vaccination with their patients and two-thirds felt they were confident to do so. Between 83.9% and 90% of students in various years of the program expressed a positive attitude toward vaccination.*

Discussion: *Separate Welsh t-test for each year of study indicated statistically significant differences between our survey and the survey published in 1999/2000, with students in our study expressing a more positive attitude toward vaccination.*

Conclusion: *Students enrolled in the chiropractic program at CMCC in the 2011/12 expressed a positive attitude toward vaccination.*

KEY WORDS: vaccination, chiropractic, survey, attitudes

Introduction : *L'objet de cette étude était de mener une enquête en ligne auprès des étudiants en chiropratique de l'année scolaire 2011-2012 à CMCC afin de connaître leurs attitudes envers la vaccination, leurs propres antécédents de vaccination, et leurs opinions sur leur niveau de préparation et de confiance pour discuter de la vaccination avec leurs patients.*

Méthodologie : *Tous les étudiants inscrits au programme à CMCC étaient admissibles à participer de façon anonyme à cette enquête modelée sur une enquête similaire menée en 1999-2000.*

Résultats : *Le taux de participation a été de 43 %. Plus de 90 % des étudiants ont indiqué qu'ils ont été vaccinés. Environ la moitié des étudiants s'estimaient être bien préparés pour discuter de la vaccination avec leurs patients, et les deux tiers pensaient le pouvoir faire en toute confiance. Entre 83,8 % et 90 % des étudiants de différentes années du programme ont exprimé une attitude positive envers la vaccination.*

Discussion : *Un test t de Welch distinct pour chaque année d'étude a indiqué la présence de différences statistiquement significatives entre notre enquête et celle publiée en 1999-2000, révélant une attitude plus positive des étudiants de notre enquête envers la vaccination.*

Conclusion : *Les étudiants en chiropratique à CMCC de l'année 2011-2012 ont représenté une disposition positive envers la vaccination.*

MOTS CLÉS : vaccination, chiropratique, enquête, attitudes

*Corresponding author: Professor, Chair of Department of Chiropractic Therapeutics, CMCC, 6100 Leslie St. Toronto, Ontario, M2H 3J1.
E-mail: bgleberzon@cmcc.ca

Introduction

Dating back to the time of the Palmers[1,2], chiropractors have held very divisive attitudes toward the use of vaccination. These attitudes may be a reflection of a person's upbringing, their undergraduate education, their graduate education or perhaps this may be a reflection of their chiropractic education.[3,4] Busse and his colleagues[3] sought to identify the attitudes of chiropractic students in the 1999/2000 academic year enrolled at the Canadian Memorial Chiropractic College (CMCC). Using an 11-item cross-sectional survey, the researchers found that the proportion of students who had negative attitudes toward vaccination increased along with the year of study, increasing from 4.5% among first year students to 29.4% of students in the fourth (and final year) of study. More over, 36% of students reported their attitudes had become more negative during their studies, whereas only 5% of students indicated their attitude had become more positive during that time. It was found that students who relied on informal sources of information (chiropractic trade magazines, student club speakers) were more likely to have anti-vaccination attitudes.[3,4] Since this was a cross-sectional, 'snap-shot' survey of students c1999, it is unknown if the attitudes of students declined during their progression through their undergraduate education and internship. Even so, this study did not go unnoticed by outside observers in the medical community, with one paediatrician characterizing these attitudes among chiropractic students as 'disturbing'.[5]

When the results of the Busse *et al*[3] study was published, one of the authors of this study (BJG) opined that it may have been influenced by a subgroup of some charismatic students who were enrolled at CMCC at the time, students who championed the Palmer postulates that advocated against the use of vaccination. In order to ascertain if the attitudes of CMCC students toward vaccination had changed over the intervening decade, a decision was made to re-administer the Busse *et al*[3] survey (with some modification as described below) to a new cohort of chiropractic students.

The purpose of this study, therefore, was to conduct a cross-sectional survey of chiropractic students enrolled in the 2011/2012 academic year at CMCC in order to assess their attitudes toward vaccination, and to determine if these attitudes were statistically different from a similar study that surveyed CMCC students enrolled in the 1999/2000 academic year. Unlike the Busse et al[3] study, however, we did not seek to learn what sources of information students relied upon in order to develop their attitudes toward vaccination.

Methods

The Research Ethics Board (REB) at CMCC granted approval for this study.

Inclusion criteria

This was a descriptive, cross-sectional study that analyzed survey results of CMCC students at a specific point in time. To be eligible to participate in this study, respondents had to be currently enrolled at CMCC in the 2011-2012 academic year. Students from all four years of the program were eligible to participate in the survey. There was no control group as all participants in the study completed the same survey. Respondents were not offered any compensation to participate in the study. This study consisted of an online survey using Survey Monkey and was distributed electronically to all students in all four academic years. The survey was open between October 2011 and March 2012. Several reminders (approximately one per month) were sent out over the college-wide email and announcements were made during various classes.

Confidentiality

Respondents were assured their responses were anonymous. Participation was voluntary. The survey contained a consent form that a prospective respondent had to complete in order to participate in the survey. Survey Monkey would only accept one complete survey from each student email address.

Survey instrument

The survey consisted of demographic information (year of study, gender, age range and country of origin) as well as the original 11 questions from the Busse *et al*[3] study. In addition, we asked non-attitudinal questions (inquiring whether or not the respondent had received various vaccines for example), as well as questions about their attitudes toward their preparedness and interest in discussing vaccination with their future patients (see Table 1).

Identical to the Busse *et al*[3] study, respondents were given three answer options: "Yes", "No" or "Undecided". Each answer was scored as '0', '1' or '2' based on whether

Table 1:
Responses to questionnaires about attitudes towards vaccinations among chiropractic students in the 2011-2012 academic year.

Question		Year 1 (n=114) RR^ = 32.8%		Year 2 (n=74) RR = 43%		Year 3 (n=80) RR = 38.5%		Year 4 (n=60) RR = 72.2%	
		n	%	N	%	n	%	n	%
1*	The risk of a few adverse reactions to vaccines is acceptable if the majority of the population is protected against infectious disease	95	83.3	63	85.1	65	81.3	52	86.7
2*	There is little scientific proof that immunization prevents infectious disease	7	6.1	0	0.0	6	7.5	2	3.3
3*	Vaccines have not substantially changed the incidence of any major infectious disease	10	8.8	3	4.1	5	6.3	5	8.3
4*	Vaccines actually cause more disease than they prevent	2	1.8	0	0.0	4	5.0	1	1.7
5*+	The risk of HINI Influenza vaccine outweighs its usefulness in preventing the disease	20	17.5	13	17.6	23	28.8	15	25.0
6*	Vaccines should never be given to elderly persons	11	9.6	1	1.4	6	7.5	0	0.0
7*	Vaccines should never be given to infants under 1 year of age	18	15.8	14	18.9	17	21.2	8	13.3
8*	In general, contracting an infectious disease naturally is safer than being vaccinated against it	9	7.9	3	4.1	7	8.8	5	8.3
9	Did you receive all of your childhood vaccinations? (DPT, Hep B, MMR)?	112	98.2	72	97.3	76	95.0	54	90.0
10	Do you feel as though everyone should be receiving these vaccinations?	90	78.9	62	83.8	55	68.8	43	71.7
11*	Would you want your children to be vaccinated against infectious disease with any currently recommended vaccine?	95	83.3	62	83.8	64	80.0	48	80.0
12	Did you receive the H1N1 vaccine?	32	28.1	27	36.5	7	8.75	10	16.7
13	Do you receive the annual flu shot?	18	15.8	11	14.9	4	5.0	9	15.0
14	Do you think the elderly should be vaccinated annually with the flu shot?	64	56.1	53	71.6	47	58.8	41	68.3
15	Do you think that all kids should receive the MMR vaccine?	74	64.9	66	89.2	60	75.0	48	80.0
16	Do you support the use of vaccines to prevent HPV?	74	64.9	47	63.5	46	57.5	27	45.0
17	Do you believe there is a direct link between vaccination and autism?	2	1.8	1	1.4	5	6.3	0	0.0
18*	If you were required to travel to a country in which certain infectious diseases were endemic and prevalent, would you undergo prior vaccination?	111	97.4	66	89.2	69	86.3	55	91.7
19	Do you think we should have the right to discuss vaccinations with patients?	69	60.5	57	77.0	46	57.5	44	73.3
20	Do you feel that your education at CMCC has prepared you to talk about vaccinations?	2	1.8	33	44.6	31	38.8	34	56.7
21	Do you feel confident talking to patients about vaccines?	17	14.9	32	43.2	38	47.5	37	61.7
22*	Are you in favour of vaccination and immunization in general?	92	80.7	68	91.9	61	76.3	50	83.3

(^) RR = Response Rates
(*) denotes questions were derived from the survey by Busse *et al*[3] with the exception of Question 5 (+).
In that question, we changed 'pertussis/whopping cough' to 'H1N1 influenza' since it is a more contemporary concern.

Table 2:
Average scores of responses for positive attitudes toward vaccinations among CMCC students in the 2011-2012 Academic Year

Class of	Mean Score	%	N	St. Dev	Max	Min
Year 4	19.3	87.7%	60	3.9	22	5
Year 3	18.5	84.2%	80	5.0	22	2
Year 2	19.8	90.0%	74	3.3	22	4
Year 1	18.4	83.9%	114	3.3	22	8

Table 3:
Two-sample t-test with unequal variances of all 4 years between the Academic Year of 2011-2012 and Busse's study of the Academic Year of 1999-2000

Class of	t-value	P-value	Degrees of freedom
Year 4	–5.3728	0.0000	158.690
Year 3	–3.6256	0.0004	176.047
Year 2	–3.9500	0.0001	162.398
Year 1	–3.2701	0.0013	152.879

the statement supported vaccination or not. A score of '2' indicated the most positive attitude toward vaccination, a score of '1' indicated "undecided" and a score of '0' indicated the most negative attitude toward the statement. For some questions, a '2' may be associated with a "yes" (for example, the question *"are you in favor of vaccines in general?"*) and for other questions a '2' would be associated with a "no" response (for example, the question *"there is little scientific proof that immunization prevents infectious disease*"). When we compared our responses with those from the Busse *et al*[3] study, we excluded questions that did not assess a respondent's attitudes toward vaccination (for example, *"did you receive all of your childhood vaccinations?"* and *"do you feel confident talking to patients about vaccines?"*). In other words, we were able to analyze responses in our study to the same 11 questions that were used in the Busse *et al*[3] study. Although a few questions could be interpreted as inquiring about a student's attitudes toward vaccination [*'do you think the elderly should be vaccinated annually with a flu* shot'] we decided to discuss the questions not asked in the Busse *et al* study separately. This allowed for a statistical comparison of our results to those from Busse *et al*.[3] Using those 11 questions, therefore, the highest possible attainable score was '22' (indicating the strongest favorable attitude toward vaccination) and '0' being the lowest possible attainable score (indicating the strongest negative attitude toward vaccinations).

Based on the score out of 22, percentages of each response were calculated from the total number of responses. We performed a Welch's t-test for two samples having possibly unequal variances to calculate if there were any statistically significant differences in the opinions between all students from our study to the Busse *et al*[3] study, as well as comparing students by year of study from our study to the students in each year of study to the previous study by Busse *et al*[3].

Results

The total response rate for the survey was 43% (328 of 760). Specifically, 114 of 199 first year students (57.2%), 74 of 192 second year students (38.5%), 80 of 186 third year students (43%) and 60 of 183 fourth year students (32.8%) responded to our survey. A list of the survey questions and the number of 'yes' responses per class are recorded in Table 1. Welch t-test scores are recorded in Table 2 and 3.

Non-Attitudinal Questions

A number of questions in our survey sought to obtain general information from our respondents but did not ascertain any information with respect to the respondent's attitudes toward vaccination. Less than 15.8% of all respondents received an annual flu shot (highest among first year students, lowest among third year students) and the number of students by academic year who had received

the vaccine against H1N1 showed a wide discrepancy, varying between 36.5% among second year students but only 8.75% among third year students. Roughly half to two-thirds of students thought the elderly should receive an annual flu shot.

Over 90% of respondents reported they had received their childhood vaccines (DPT, MMR), with the highest number (98.2%) among first year students and the lowest (90%) among fourth year students. Third year students, when asked if *'everyone should receive these vaccines?'* were least in favor (68.8%) whereas first year students were most in favor (78.9%). Numbers were similar when respondents specifically were asked if they thought children should be vaccinated against MMR, ranging from 89.2% among second year students to as low as 64.9% among first year students. Of particular note, when specifically asked if they thought there was a link between the MMR vaccine and autism, the highest number of respondents who thought there was were in third year (6.3%) but that percentage dropped to 0% by fourth year.

When asked *'would you want your children to be vaccinated against infectious disease with any currently recommended vaccine?'* responses were very consistent, varying between 80% and 83.8%. However, when asked if they supported vaccination to prevent against human papilloma virus (HPV), roughly two-thirds of first year students agreed but this number dropped for all successive years, to a low of 45% among fourth year students.

Three questions inquired about the respondent's opinion with respect to their perception of how well they have been educated on the topic of vaccination, how confident they would be to discuss this topic with patients and if they should be legally entitled to do so. Not surprisingly, only 1.8% of first year students thought the academic program at CMCC prepared them to discuss vaccination, but this number jumped to 44.6% by second year and 56.7% in third year (this is most likely due to the fact courses on immunology, pathology and public health are all positioned later in the academic program). Students were asked about their level of confidence in discussing vaccination with their patients. Specifically, only 14.9% of first year students stating they were confident to have that discussion; this number rose to 61.7% by fourth year. As far as legal entitlements, 60.5% of first year but 73.3% of fourth year students responded that they thought they should have the right to speak to their patients about vaccination.

Attitudes toward vaccination

We examined the responses from our survey to the same 11 questions asked by Busse *et al* [3]. Out of a possible high score of '22' (indicating most favorable attitude towards vaccination), the mean score for the first year class was 18.4 (standard deviation 3.3), the mean score for the second year class was 19.8 (standard deviation 3.3), the third year class had a mean score of 18.5 (standard deviation 5.0) and the fourth year class had a mean score of 19.3 (standard deviation 3.9); these results are listed in Table 2. When asked if *'the risk of adverse reaction to vaccines is acceptable if the majority of the population is protected against infectious disease?'* over 80% of current students throughout the program agreed with this statement, with the highest number among fourth year students (86.7%). Similarly, when asked *'there is little scientific proof that immunization prevents infectious disease'* 6.1% of current first year students but only 3.3% of current fourth year students agreed.

Students were asked their attitudes toward two similar statements. These were: *' vaccines have not substantially changed the incidence of any major infectious disease'* and *'vaccines actually cause more disease than they prevent'*. In general, very few students in any year of study agreed with either of these statements.

One interesting finding in our study was with respect to students' attitudes towards the H1N1 vaccine. Between 17% and 28.8% of students across the college felt that the risk of the H1N1 vaccine outweighs its usefulness in preventing the disease (Question 5), and no more than 15% of students in any one year stated they received an annual flu shot (Question 13).

When asked: *'are you in favor of vaccination in general'*, 80.7% of first years, 91.9% of second years, 76.3% of third years and 83.3% of fourth year agreed with this statement.

A comparison between CMCC students in the 2011-2012 academic year and students in the Busse *et al*'s study was then performed. Since we had independent samples in all cases, we did separate Welch t-tests for all four years independently. We used the Welch's t-test for two samples having possible unequal variances. Since our standard errors were in fact half the standard errors for the Busse *et*

Table 4:
Arguments Against Vaccination[9-11]

i.	Immunizations are not effective
ii.	Vaccines are harmful
iii.	Vaccinations are unnecessary
iv.	Medical experts argue over the Effectiveness of Vaccinations
v.	Immunizations are a product of the Medical-Pharmaceutical Complex
vi.	Since vaccinations are compulsory, they infringe on a person's civil liberties
vii.	Accepting vaccination as a part of wellness is to repudiate chiropractic philosophy

al[3] study, we recognize that the data sets represent different populations. However, although we recognize this, we considered the robustness of the t-test as a validation of analysis. All four t-tests found a statistically significant difference between the two samples, with the current academic year having a more positive attitude towards vaccination (Table 3).

We reviewed aggregate scores from our survey to all attitudinal questions; this included the 11 common questions from the Busse *et al*[3] study as well as 5 other questions we developed. Out of a possible score out of '32' (indicating the most favorable attitude toward vaccination), first year students scored 26.3, second years scored 28.2, third year students 26 and fourth year students scored 27.1.

Discussion

The chiropractic profession has had a long history of divergent opinions with respect to vaccination, and these attitudes have impacted perceptions among chiropractors, the political landscape as well as issues of jurisprudence and ethics.[6-8] There are many reasons why students and chiropractors may have negative attitudes toward vaccination (see Table 4), and although these reasons have been deconstructed in recent commentaries[9-11] and despite the accrual of scientific evidence demonstrating the effectiveness of vaccination in general, it is likely anti-vaccination attitudes will persist within the profession. It should be mentioned that similar negative attitudes toward vaccines have been observed among naturopathic students.[4]

The results from our study were fundamentally different than the results of a virtually identical study conducted a decade earlier. Students in our study overall had a more positive attitude toward vaccination than they did in the Busse *et al*[3] study. The highest favorable score (by percentage) among students from the Busse study were second year students (73.2%); all students in our study had more favorable attitudes toward vaccination in each class (between 83.9% and 90%). Not only were more students in each year more favorably disposed toward vaccination in our study, but the second highest number of anti-vaccination attitudes were reported by fourth year students, a finding in stark contrast to the Busse's study where the lowest number of pro-vaccination attitudes were reported by fourth year students. Although the results of our study are statistically different than those from the Busse *et al*[3] study, since both studies were cross-sectional studies it can not be said with any certainly if this represents a trend toward a more favorable attitude with respect to vaccination among chiropractic students at CMCC.

Limitations

The most significant limitation of our study is the response rate. In the Busse *et al*[3] study the overall response rate was 75.2%, and a relatively consistent number of students responded across all four years of study, ranging

from 112 to 121 (there were approximately 150 students in each year of study at that time). In our study, however, the response rate was 43% overall, and the number of respondents declined from a high of 114 respondents in first year (response rate of (57.2%) to a low of 60 respondents in fourth year (response rate 32.8%). This represents a significant non-response bias that disproportionately affected students in the later years of study. It is possible that students with anti-vaccination views chose not to respond to our survey. If that was indeed the case, and had those students responded, it would have significantly altered our results.

Conclusion

When surveyed, students enrolled in the 2011-12 academic year at CMCC reported an overall consistently favourable attitude toward vaccination, with percentages ranging between 76.3% and 91.9%. The majority of respondents were in favour of having children and the elderly vaccinated, and few respondents believed there was a link between vaccination and autism. The majority of respondents thought they should have the to legal right to discuss this topic with their patients (highest percentage among interns) and, not counting first year students, over half of respondents reported they were prepared to discuss this topic with their patients and felt confident enough to do so. In all categories and across all years of study, students in this survey reported favourable attitudes toward vaccination.

References

1. Palmer DD. In: The Chiropractor's Adjustor. Portland (OR): Portland Printing House Company; 1910
2. Palmer BJ. The Philosophy of Chiropractic. V. Davenport. IA: Palmer School of Chiropractic; 1909.
3. Busse JW, Kulkarni AV, Campbell JB, Injeyan HS. Attitudes toward vaccination: a survey of Canadian chiropractic students.
4. Busse JW, Wilson K, Campbell JB. Attitudes towards vaccination among chiropractic and naturopathic students. Vaccine. 2008;26:6237-43.
5. Pless R, Hibbs B. Chiropractic student's attitudes towards vaccination: A cause for concern? JAMC. 2002;166(12):1544-1545.
6. Gleberzon BJ, Lameris M, Schmidt C, Ogrady J. On Vaccination & Chiropractic: When ideologies, history, perceptions and jurisprudence collide. J Can Chiro Assoc. 2013;57(3):205-213.
7. Lawrence D. Anti-vaccination attitudes within the chiropractic profession: Implications for public health ethics (commentary). Topics in Integrative Health Care. 2012;3(4):1-8.
8. Johnson C, Rubinstein SM, Cote P et al. Chiropractic care and public health: Answering difficult questions about safety, care through the lifespan, and community action (editorial). J Manip Physiol Ther. 2012; 35:493-513.
9. Campbell JB, Busse JW, Injeyan HS. Chiropractors and vaccination: a historical perspective. Pediatrics. 2000;105(4):e43.
10. Nelson CF. Why chiropractors should embrace immunization. J Chiropractic. 1993;30:85-88.
11. Ferrance RJ. Vaccinations: how about some facts for a change? Commentary. JCCA. 2002;46(3):167-172.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/221–232/$2.00/©JCCA 2013

Did American social and economic events from 1865 to 1898 influence D.D. Palmer the chiropractor and entrepreneur?

Josip Batinić, DC*
Mirek Skowron, DC*
Karin Hammerich, DC, MHS†

This paper explores how the social landscape of the latter half of the nineteenth century influenced D. D. Palmer and the many occupations he pursued. It focuses on the geographical area where D. D. lived from 1865 to 1898. This paper will show how the American social and economic events of the time provided favourable circumstances for D.D.'s entrepreneurial successes.

KEY WORDS: chiropractic, DD Palmer, entrepreneur

Cet article examine les facteurs du paysage social de la seconde moitié du dix-neuvième siècle qui ont influencé D. D. Palmer et les nombreuses professions qu'il a exercées en mettant l'accent sur la région géographique où D. D. Palmer a vécu entre 1865 et 1898. L'article montre comment les événements socio-économiques américains de l'époque ont créé les circonstances favorables aux réussites entrepreneuriales de D. D. Palmer.

MOTS CLÉS : chiropratique, DD Palmer, entrepreneur

Introduction

Most historians concur September 18, 1895 to be the date Daniel David (D.D.) Palmer adjusted Harvey Lillard's spine and restored his hearing.[1] However, D.D.'s life, as it relates to his career journey, has not been fully researched in the chiropractic historical literature. What we do know about D.D. in reasonable detail is his life and philosophy after that famous initial adjustment. Less is known about D.D.'s life and work before he began to practice chiropractic.

The objective of this paper is to explore the question of whether the social landscape of the latter half of the nineteenth century influenced D.D. and the many occupations he pursued. The paper will focus on the areas of Iowa and Illinois where D.D. lived from 1865-1898. By gathering information about D.D. Palmer and the events surrounding his life from multiple sources, we hypothesize that the evidence will show that the events and circumstances of the latter 1800s contributed to making D.D. a successful chiropractor and entrepreneur. The importance of this

*Private practice
†Faculty, Chiropractic Principles and Practice and Clinical Education,
Canadian Memorial Chiropractic College, 6100 Leslie Street Toronto, ON M2H 3J1
Corresponding Author: Josip Batinić, DC
132 Braniff Place SW, Calgary, AB T2W 1R9
Telephone: 403-926-9432
E-mail: batinicj@hotmail.com

knowledge is significant to chiropractic in order to better understand its origins in the context of time. The influence D.D. had on the establishment of the profession still resonates today.

The end of the American Civil War ushered in many social changes throughout the country. The Civil War led to circumstances in which women occupied previously male-dominated professions,[2] resulting in male employees being highly sought after. As such, D.D. took advantage of the many opportunities available and became a schoolteacher. After six years of teaching in various schools in different counties, D.D. decided it was time to change to a more profitable occupation.[3] During the 1870s, Iowa had become an agricultural hub in the Midwestern United States with farmers' fields and crops covering the majority of the state.[4] During this time, D.D. married, purchased farm acreage, and started to farm bees, raspberries and other fruit to sell across the nation.[2] D.D. eventually sold and left the farm, records showing that this was due to his bees perishing in unusual weather conditions. Other reasons for his move are not known, although they might include his divorce from his first wife Abba, the loss of a child, and the fact that his nuclear family resided in What Cheer, Iowa.

D.D.'s next profession, at the age of 35, was that of a grocer in What Cheer in the early 1880s. Based on the population growth of the area at the time, entering the grocery business was a very shrewd business idea. Between the years 1880 and 1890, there was a 350% increase in What Cheer's community,[5] undoubtedly due to the influx of European immigrants.[6] During this time D.D. also became interested in spiritualism and alternative healing. Historical records are unclear about the reasons D.D. quit the grocery business and commenced magnetic healing. According to D.D.'s journal, he began his career as a magnetic healer on September 3, 1886, in Burlington, Iowa.[2] In the years leading up to the beginning of chiropractic, D.D.'s magnetic healing practice proved an ideal stepping stone to his next, and ultimately most successful vocation of chiropractic.[2]

In order to facilitate the reader's understanding of time and place, a geographical map of significant locations is found in Appendix A, a brief time line in Appendix B, and the pattern matching logic chart in Appendix C.

Literature review

The literature search for this paper began at the Canadian Memorial Chiropractic College (CMCC) library. The only primary sources found were D.D. Palmer's *The Science, Art and Philosophy of Chiropractic: The Chiropractor's Adjuster*[7] and a digital copy of the *American Bee Journal* published in 1878.[8] To continue the search for primary sources, the Palmer College of Chiropractic library archivist was contacted for assistance in retrieval of any suitable documents held within their archives. According to the archivist, their special collections documents are not digitized and hence not available electronically. Due to lack of funding and resources for this paper, the authors were not able to visit Palmer College to access their records.

The search for secondary sources generated many credible literary works within the chiropractic literature. These included Vern Gielow's *Old Dad Chiro: a Biography of D. D. Palmer, Founder of Chiropractic*[4]*;* Scott Haldeman's *The Principles and Practice of Chiropractic*[9]*;* Walter Wardwell's *Chiropractic: History and Evolution of a New Profession*[10]*;* Joseph Keating's *B. J. of Davenport: The Early Years of Chiropractic*[11]*;* Stuart Moore's *Chiropractic in America: the History of Medical Alternative*[12]*;* and Cyrus Lerner's *The Lerner Report: A History of the Early Years of Chiropractic*[13]. The information relating to the American Civil War was retrieved from Robert Krick's *The American Civil War: The War in the East 1863-1865*.[14]

Other secondary sources came from peer-reviewed journal articles such as Joseph Keating's "Several Pathways in the Evolution of Chiropractic Manipulation"[15]; "The Meanings of Innate"[16]; "A Brief History of Historical Scholarship in Chiropractic"[17]; Rolf Peter's "The Subluxation – Historical Perspectives"[1]; Joseph Donahue's "D. D. Palmer and the Metaphysical Movement in the 19th Century"[18]; Glenda Wiese's "New questions: Why did D. D. not Use "Chiropractic" in His 1896 Charter"[19]; Vern Gielow's "Daniel David Palmer: Rediscovering the Frontier Years, 1845-1887"[20]; and Michael Monalto & Gene Cartwright's "From the Incandescent Light Bulb to Digital Pathology."[21]

A hand search of CMCC archives was undertaken by the college archivist. The archival records searched included Herbert K. Lee (F52) fonds; Herbert J. Vear (F50) fonds; Canadian Chiropractic History Association (F92)

fonds; Douglas M. Brown (F51) fonds; Association for the History of Chiropractic; Canadian Chiropractic Historical Association files contained in Canadian Chiropractic Association (F69 fonds; Joseph C. Keating (F64) fonds; Office of the President (F2) fonds; Donald C. Sutherland (F63) fonds; and Roger K. Partlow (F59) fonds. The hand search was inconclusive for the subject of this paper.

Gray literature, used to supplement credible sources, came from several web sites. These electronic sources were used for information on the Iowa and United States timelines, the history of Iowa, statistics on Iowa and the United States, historical currency conversions, and a geographical map of Iowa and the Midwest.

Goodbye Canada: April 3, 1865

It was the spring of 1865, just eleven days before President Abraham Lincoln was assassinated by John Wilkes Booth,[14] that D.D. and his brother Thomas Jr. (T.J.), ages twenty and eighteen respectively, made their way south from rural Ontario to the still divided American states.[2] As jobs were scarce due to the influx of American workers coming to Canada to avoid the Civil War and the draft, the Palmer brothers were forced to look for work further from home. The rest of the Palmer family had already uprooted and moved to the United States some years earlier. This provided D.D. and T.J. with a final destination.

It was not long after the brothers had embarked on their journey that Robert E. Lee of the Confederate States army surrendered to Ulysses S. Grant of the Union army at the Appomattox courthouse thus ending the Civil War.[14] Iowa did not play as large a role in the Civil War as some of the eastern states. However, the state of Iowa had many educators that were very important in bringing about political action with respect to public education. In the two years prior to the Civil War, approximately 1,100 schoolhouses were built in the state of Iowa, with another thousand being founded at the end of the war.[2] Eight months after the Palmer brothers arrived when the war was declared over, D.D. became a schoolmaster in Muscatine County, Iowa, the first of many places where he would serve as an educator. He was in fact no stranger to formal teaching. D.D. was schooled from the age of four until eleven, when his father's business collapsed and he was forced to move to the United States leaving D.D. and his brother behind.[2,10] As an eleven-year-old, D.D. had achieved an eighth grade level of education. He studied Greek, Latin, and higher mathematics during those early years.[20] When his family was separated, his education time became sparse and was limited by his need to sustain himself with work. With the abrupt end to his formal education in 1856, D.D. and his brother T.J. were left behind to work in a stave and match factory.[22] It is unclear if they continued employment there for the next decade before their move to the United States.

Teaching and farming: February 1866 to December 1881

D.D.'s first serious job in the new country was that of a schoolmaster. He probably never continued his formal education, but it is highly likely, given his new occupation, that he continued to read and write on his own in his free time. Over the years following his arrival in the Midwest with his brother, he held several teaching positions in various Iowa counties.[20] D.D., who was now 25 years old, taught for approximately five years before putting his entrepreneurial skills to use by working his own land, trying to turn a profit.

Farmland was a hot commodity in that part of the Mississippi River valley in the 1870s with acreage being purchased along the length of the Mississippi River. Nearly the entire state consisted of crops worked by American farmers.[4,22] In 1871, at the age of 25, D.D. decided to try his hand at farming when he and his first wife Abba, purchased ten acres of land just north of New Boston in Eliza Township.[2] He planted many seedlings including an extensive array of fruit trees, as well as other trees such as balsam fir, white spruce, red cedar and hemlock.[2] These unfortunately were not to yield any substantial profit.

In the spring of 1874, at the age of 29, D.D. married his second wife, Louvenia Landers, and purchased a raspberry plant that he referred to as Lumm's Everbearer.[2] This plant would prove to be his livelihood for the next few years due to his adeptness at producing fruit from it. A plot of land located on a steep hill, which was less than ideal for farming, turned out to be idyllic for D.D.'s needs because of the rich, untouched soil.[4] This in combination with a mutation in the plant from "cultivation and crossing"[4] resulted in a well-bearing plant that would come to be known as the "Sweet Home" raspberry. The popularity of the "Sweet Home" raspberry had soared, so much so that it was shipped across the entire nation via a newly laid railroad. Railways were expanding rapidly and were

connecting the large nation of America. It was only 8 years earlier in 1867 that the region had welcomed its first railroad.[4] Two years later, in 1869, the first transcontinental railway was completed. This proved to be the perfect medium to distribute his much sought after raspberry plant to eager buyers across the country. It also gave D.D. a chance to prove his competency in another beneficial business skill: marketing.

Putting to use his education and aptitude with words, D.D. constructed several advertisements for his "Sweet Home" raspberry plants that displayed his creative marketing ability. He often incorporated full page-long advertisements that discussed not only the superiority of his product, but also mentioned new ways of preserving the fruit to last during the winter months.[2] Many years before in 1857, a glass blower named John L. Mason had patented his newest invention of a preserving jar with a screw-on cap[2], now known as the mason jar. D.D.'s integration of Mason's new, cutting-edge advancement and his innovative writing skills resulted in a clever marketing strategy for his "Sweet Home" raspberry plants. At the same time that he was concentrating on his raspberry plants, he also acquired an interest in bee keeping.[2]

It is not known exactly how D.D. first became interested in farming bees, but it is evident that he was quite serious about it and was deeply involved in the beekeeping community. An interesting excerpt (Figure 1) from volume 14 of the *American Bee Journal*, published in 1878, shows that D.D. was the president of the Western Illinois Bee-Keepers' Society[8] and a successful bee farmer. In 1877 he took an astonishing 18,600 lbs. of honey to New York City to be sold.[2] In his own words, D.D. stated that the trip cost him $232 and that he had "done fair".[2]

Unfortunately, D.D.'s apiary success came to an end. Unusual fluctuations in weather had a lethal impact on his bees, and in the spring of 1880, D.D. abandoned his farm life and moved to What Cheer, Iowa.

No more farm life: 1882

The exact reason that D.D. moved to What Cheer and opened his own grocery store is unclear, but it is known that the majority of his family lived there.[2] His move to What Cheer was possibly attributable not only to his family's proximity, but also to the swiftly developing prosperous community. Years earlier in 1869, the Iowa Board of Immigration published and distributed booklets

Figure 1.

Western Ill. & Eastern Iowa Society.

The third semi-annual meeting of the Western Illinois Bee-keepers' Society was held at Burlington, Iowa, May 7 and 8, 1878.

The meeting was called to order at 10, a. m., by the President, D. D. Palmer, of Eliza, Ill. The attendance of members was quite large, and exceeded that of any previous meeting. During the day, 49 new members were added to the roll, as follows:

which encouraged European immigration to the state. These booklets were published in languages such as German, Dutch, Swedish and English. In the early 1880s, there were nearly one hundred coalmines in and around the growing town which employed the massive influx of European immigrants. The establishment of manufacturing plants, saloons, gambling houses, an opera house, and a brewery[2] naturally attracted people from various walks of life. What Cheer was a prosperous town well serviced by the railroad. In fact, by 1880 there was not a town in Iowa more than 25 miles from a railroad depot.[22] In addition, 1880 was the watershed year when the number of urban residents outnumbered rural residents and the population of the United States surpassed fifty million.[22] People were moving, whether for job opportunities or otherwise, from farms to the cities, and D.D. was no exception.

D. D. Palmer, the grocer: 1885

The time and place presented a perfect opportunity for an entrepreneur to start a business venture, which D.D. did in his late 30s. He opened a grocery store and sold live chickens, fresh fish, fruits and vegetables among other necessities.[2] He also sold both local and tropical fish.[10] Apparently, this fish vending enterprise provided a significant income for D.D. and his family.[2] In the burgeoning town of What Cheer, he operated a typical grocery[2] that bought and sold local merchandise as well as products from afar shipped in by train. Gielow notes that D.D.'s grocery store was one of nine in town.[2] Although this may seem like a competitive number, the population of 8,000 residents in 1882[11] made this a reasonable ratio of buyers to sellers. Gielow also adds that the pay of the one thousand miners working in and around What Cheer ranged from eighty to a hundred dollars every two weeks. This

is equivalent to $1,755 to $2,193 dollars bi-monthly in today's dollars.[23]

These business and community conditions were ideal for the Palmer household to thrive. While operating the grocery, D.D. and his family lived in the back of the store.[2] It would appear plausible that he had some help from his family in the day-to-day operations of the store. During the years he operated the grocery store, he also continued to teach school in What Cheer and Letts.[2] It is not known whether he taught purely for financial reasons or if there was a lack of qualified teachers in the area. One thing that is certain is that he enjoyed teaching and kept meticulous records of his lesson plans and business dealings.[9]

D.D. Palmer, the magnetic healer: September 3, 1886

D.D.'s transition to magnetic healing from his grocery business did not occur overnight. His entrepreneurial nature in combination with his teaching position, inclined him to read and explore other practices and happenings of the time. Wardwell writes that D.D. studied many other health practices such as Christian Science, Mind Cure, Metaphysics, Magnetic Healing, Osteopathy, and Phrenology.[10] According to Gielow, the treatment of magnetic healing paralleled D.D.'s religiosity.[2] D.D. was a deeply religious God-fearing man. He read the Bible on a daily basis in addition to reading books on spiritualism. Spiritualism, a way of communicating with the dead, brought comfort to some and intellectual curiosity to others[9] in the post-civil war American Midwest.

In 1987, Joseph Donahue authored a paper in *Chiropractic History* which stated that D.D.'s involvement in spiritualism in the 1870s was a stepping-stone to his magnetic healing in the 1880s.[18] Another likely possibility for D.D.'s involvement in magnetic healing is attributable to another successful magnetic healer in the nearby town of Ottumwa, located approximately 30 miles south of What Cheer. Paul Caster was a widely successful and popular "faith healer"[4] in Ottumwa. D.D., with his voracious appetite for reading and learning, became interested in Caster's work.[2]

Examining the works written by and about D.D. Palmer, the reader perceives an impression of respect and leadership that resonates throughout the writings. He always seemed to be attracted to positions that demanded respect and a sense of authority in the community. Therefore, it is no coincidence that D.D. was impressed by Paul Caster's procedures, magnitude of his practice and the public perception of this Ottumwanian.[2]

In 1886, D.D. at the age of 42, opened his first clinical office in Burlington, Iowa.[9] Burlington was the home of Paul Caster's son, and D.D. continued the family business of magnetic healing there.[9] The reason why D.D. stayed in Burlington for only a short time is assumed to be due to business competition.[9] Realizing the potential for a new, exciting and less competitive business venture, D.D. moved to the bustling Mississippi River port of Davenport, Iowa in 1887 and began a "cure without medicine" practice.[10]

Davenport and the beginnings of Chiropractic: 1886

During D.D.'s time in Iowa, three cities in the area were burgeoning and became popular commercial centers: Rock Island, Moline, and Davenport.[2] Rock Island and Moline were in the state of Illinois, and Davenport was just across the Mississippi River in Iowa. The proximity of these cities provided a good blend of manufacturing, agriculture, and business that encouraged their growth and development.[2] D.D.'s patients were not only coming to his office from the three major cities in the area, but also from many other communities that were a short trip away by horse and buggy.[2] According to the Lerner Report, Davenport was also a city that attracted entertainment such as musicians, lecturers, and the circus.[13]

The population of Davenport, Iowa, in 1890 was 26,872.[5] D.D.'s practice flourished in this growing city. His success, at the age of 45, was due not only to his healing ability, but also to his ingenious marketing strategies. In 1888, D.D. listed his expenses for 30,000 circulars and cards; five signs, including three to be put on boats; 100 photos (he does not mention of what); and in 1889, at least 15,000 copies of his brochure "The Sick Get Well by Magnetism".[10] According to D.D.'s records, his promotional expenses totaled less than $150.00.[2] Clearly, his seriousness in the business and in marketing aspects were meticulously planned and successfully executed. That is not to say that D.D. cared only about financial gain. In 1888, the advertisement for his practice included the following statement: "Consultations and treatment for the deserving poor are free".[10]

Another contributing factor to D.D.'s success was the location of his office. The clinic, now famous in chiroprac-

tic history literature, was located on the corner of Second and Brady Streets in Davenport.[12] The building was located only two blocks from a Mississippi River ferry.[12] D.D. not only drew clientele from Iowa towns, but also from several places in Illinois.[12] Not only did the location serve him well, but almost a decade earlier, an American by the name of Thomas Edison had filed a patent for an invention[21,22,24] that likely increased the available time D.D. could spend in his office working or treating patients. The invention of the light bulb possibly gave him the ability to work later into the night than would normally have been feasible with simple candlelight. Speculation has it that with more time to dedicate to his clinic after sundown, he likely spent more time building his practice, although no research was found to support this claim.

D.D.'s success in Davenport made him a target for ridicule by the local media. On May 13, 1894, an article appeared in the local newspaper, the *Davenport Leader*.[12] The piece was entitled "Dr. Palmer" and it went on to say that he was a quack and that he deceived people with his magnetic powers.[12] The article stated that "His [D.D.'s] increase in business shows what can be done in Davenport even by a quack."[12] This article, considered an attack ad of the time, demonstrates that D.D. was in fact a successful businessman. There is no evidence that states that D.D. was not an accomplished entrepreneur in Davenport during that time.

In spite of these charges, his entrepreneurial and humanitarian nature made D.D. a well-respected health leader within the Davenport community at large. Initially, he was very secretive about his clinical procedures. However, in July of 1896, ten years after establishing his first clinical office, D.D. established the Palmer School of Magnetic Cure.[9,19] The following January in 1897, at the age of 51, he started teaching chiropractic.[9]

D.D.'s shift from magnetism to the adjustment is neither abrupt nor clear. D.D.'s chiropractic "discovery" slowly evolved from his magnetic healing practice. What he thought separated his healing practice from other magnetic healers was the idea of specificity.[9] He considered his method to be superior because "he did not waste his vital energy by distributing it diffusely over the entire body of the patient".[9] By palpating specific sites of the body, using his magnetic fingers, and delivering a thrust to those tissues, he separated magnetic healing from the chiropractic adjustment. D.D. confirmed that "Chiropractic is an outgrowth of magnetic healing, it is not magnetic healing advanced, it is not the climax of magnetism or any other method."[7]

The shift from magnetic healing to chiropractic was gradual as he adjusted a number of people before Harvey Lillard. According to D.D. Palmer, Harvey Lillard was a janitor in the building in which D.D. had his office.[7] The short story goes that Lillard had been deaf for seventeen years.[7] Apparently his deafness started when he exerted himself and felt a sensation of "giving way" in his back.[7] He adjusted Lillard's back in September of 1895, and restored his hearing.[7]

Teaching and Business: 1896

D.D. was in clinical practice for a decade before he began teaching again. Although it is virtually impossible to determine the exact reason, whether financial or altruistic, as to why he opened a school and started teaching his practices, it might be presumed that he did it for both reasons. Another possible explanation as to why he started teaching might be because he already had experience in this field. Transmitting knowledge to others was something he was familiar with and was comfortable in doing. Teaching his practices would provide him with financial stability, and at the same time, pass on his gift to future generations and thus give back to the community.

"Early training involved little more than an apprenticeship at Palmer's 40-bed infirmary and clinic in downtown Davenport".[9] The tuition was set at $500 and only two students were allowed initially.[2] D.D.'s clinic, and later his school address, were found at the same location as his first magnetic healing practice on the corner of Second and Brady streets.[2] An important aspect about his business achievement in his magnetic healing and chiropractic practice is that his success came gradually. In 1887, his annual income was $700 and in 1898 it was $9,276.[2] As his patient volume grew, he expanded his practice to include more rooms to accommodate his growing operation. Once he had established chiropractic, he started teaching it to others.

Family Business

Throughout D.D.'s life, his marital and personal relationships were just as intriguing as his occupations. He had five wives, some died, some he divorced, and he fathered three children.[25] His two daughters were May Palmer

(Brownell) born in 1878, and Jessie Palmer (Wall) born in 1888.[25] D.D.'s only son was Joshua Bartlett (B.J.) Palmer, born on September 14, 1882 in What Cheer, Iowa.[11] Much more is known about D.D.'s son than about his two daughters, but this is beyond the scope of this paper.

While this paper does not focus on the personal relationships D.D. was involved in, it is worth mentioning in the context of his business undertakings. His family members, mainly his wives, were able to stay at home, take care of the children and perform household chores, while he was exploring numerous business projects. In fact, one of his wives served as a manager of his clinic and helped him in the preparation of his advertising circulars.[11] His family was a contributing factor to his success, providing him with the time and patience to devote his skills to the family's financial improvements.

Discussion

There is no question that Daniel David Palmer was a remarkable man. His diversification in various occupations shows that he always wanted to improve something, whether a process, himself or his financial situation. His childhood difficulties, particularly being left by his family, forced him to become a survivor in the world and also perhaps in the business domain. Although his early education was cut short, his intelligence and wit never left him.

One question this paper did not address perhaps because of credible information is why D.D.'s parents left him and his brother Thomas Jr. to their own devices in Canada, in 1856 when D.D. was only eleven years old and his younger brother, nine.[2] Speculation suggests that they may have been left with extended family members because they had employment. Future research focusing on the exploration of this question would be helpful in understanding D.D.'s relationship with his family in his younger years. Nine years after the family was separated, D.D. and his brother rejoined it in Iowa in April, 1865.[2] Why the two boys waited nine years to see their family again, is unknown. The date of the young brothers' departure is possibly very significant. April 1865 was the time when the American Civil War finally ended. The boys did not make their way during the war perhaps due to the fear of being drafted, or perhaps because the war made travel dangerous. Although this may not be the exact reason, it is the best explanation the authors of this paper could hypothesize.

This was a fruitful time in the history of the United States, a time optimal for new ideas and for ingenious ways of implementing them. It was during this time that D.D. made his mark, allowing him to be innovative and productive. With the inequality of gender demographics in the country, educated male teachers were in high demand. This particular set of circumstances secured D.D. a position within the field of education. Here he was able to work not only with his hands, but also with his mind and develop his skills at teaching, reading and writing. Although these skills are taken for granted today, they were an essential tool for entertainment and communication during that time. In fact, D.D.'s ability to write was critical to his business strategies. When he was providing goods and services locally and abroad, his ability to write clear and persuasive advertisements was essential to his livelihood. D.D.'s business thrived with more and more people responding to his newspaper advertisements and product flyers.

Whether it was farming bees, maintaining a grocery store, or healing people through magnetism, D.D. continuously demonstrated his scholarly nature by documenting his progress and procedures. His records were carefully filed. This is further evidence that D.D.'s scholarly nature is apparent in his writings about developments in his work.

Whether D.D. entered into magnetic healing for financial gain or as a result of his personal beliefs, he demonstrated that he was very successful at it. He was able to grow his magnetic healing practice into a sustainable and profitable business. His optimally located clinic in downtown Davenport, close to the Mississippi river port, allowed for easy access to clientele from other areas. D.D. also extensively advertised his goods and services. Marketing was beneficial in acquiring new patients for his practice. The advertisements that he composed were eloquently worded to capture a broad audience.

Although this paper touches only briefly on the subject of D.D. teaching chiropractic, his experience working in schoolhouses across the Midwest made him a very successful communicator and teacher. Future research on D.D., focusing on the early teaching of chiropractic, and possibly his personal life, would be beneficial for the history of chiropractic. One of the aspects this paper did not discuss is the relationship between the medical profession and other healing professions. The formation of the

American Medical Association (AMA) in 1848[9] brought many laws and regulations regarding health practices in the United States. With this change, medicine did not look too kindly on those using non-medical practices. Nevertheless, if D.D. found himself in this climate, he was able to adapt by travelling and continuously changing places. Once he entered into healing, he did not leave Davenport for many years. Therefore, further research examining the relationship between the medical profession and other non-medical professions during D.D.'s time, might help in understanding some of D.D.'s career choices.

Due to the lack of previous formal investigation into the life of D.D. as entrepreneur, the available information pertinent to this study is scattered throughout the literature. Hence, this paper only examined his early life from 1865 to 1898. His later life was more prone to extraneous influences other than social and economic factors. The limitation of this historical study is the lack of sources such as other historical records of the time. Another limitation of this paper is the absence of greater detail in the available historical records and in the published literature.

Conclusion

The life and times of Daniel David Palmer the businessman, as discussed in this paper, represent only a fraction of this multifaceted individual. Other than discovering and developing chiropractic, the persistence of his beliefs and his strength in grasping opportunities has made D.D. a relevant figure in chiropractic history. The discussion about D.D. and his early business accomplishments has largely been absent from the chiropractic dialogue. If this paper helps characterize D.D. in a new perspective, it may lead to further investigation. Nevertheless it appears that the American social and economic events of the time provided favourable circumstances for his entrepreneurial successes. All of the events in the United States from the time of D.D.'s relocation from Canada have been shown to be very hospitable for D.D's business ventures. Further research is warranted since deeper investigation of the Palmer College archives would more than likely yield other insights into different aspects of D.D.'s early life. Nevertheless the evidence does show that he was a prosperous entrepreneur. If, on the other hand, D.D. was not a successful practitioner and a failure as a businessman, there is no evidence available to support this claim.

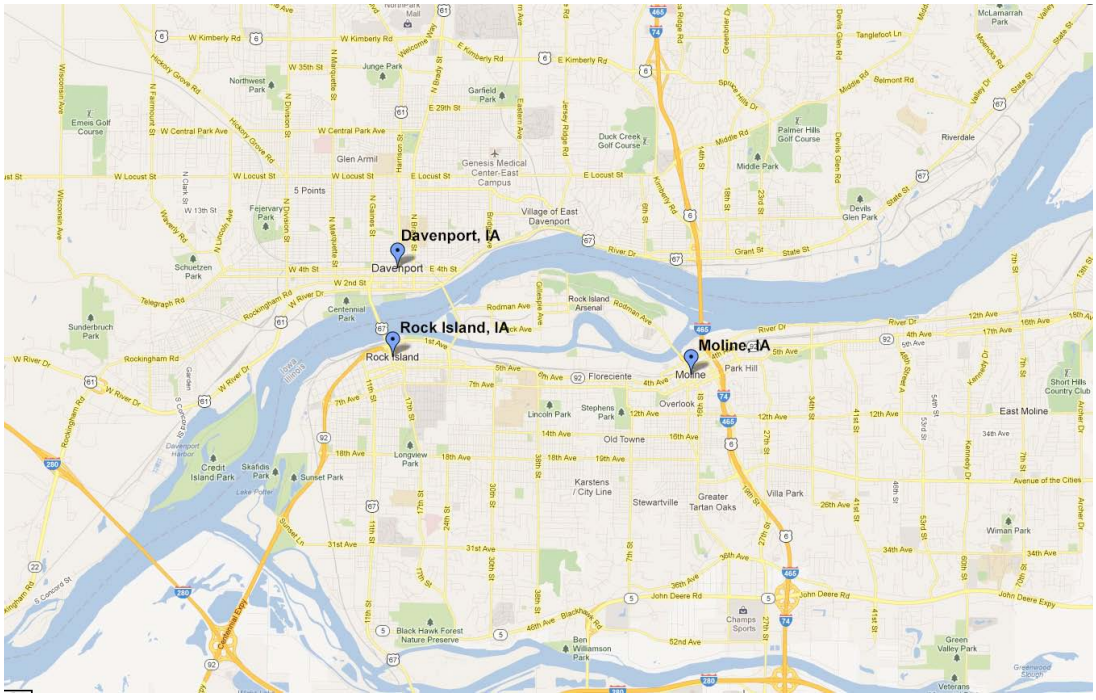
References

1. Peters R. The Subluxation – Historical Perspectives. Chiropractic J Austr. 2009; 39(4): 143-150.
2. Gielow V. Old Dad Chiro: a Biography of D. D. Palmer, Founder of Chiropractic. Davenport, IA: Bawden Bros., Inc.; 1981.
3. In memoriam: Joseph C. Keating, Jr, PhD, Litt.D., 1950-2007. Chiropractic History. 2007; 27(2): 19-20.
4. Schwieder D. History of Iowa. [Internet]. 2011. Available from: http://publications.iowa.gov/135/1/history/7-1.html
5. Total Population for Iowa's Incorporated Places: 1850-2000. [Internet]. 2011. http://data.iowadatacenter.org/datatables/PlacesAll/plpopulation18502000.pdf
6. Morain T. Iowa in the Civil War. [Internet]. 2011. Available from: http://www.iptv.org/iowapathways/mypath.cfm?ounid=ob_000322
7. Palmer DD. The Science, Art and Philosophy of Chiropractic: The Chiropractor's Adjuster. Portland, OR: Portland Printing House, 1910.
8. American Bee Journal. 1878; 14.
9. Haldeman S. The Principles and Practice of Chiropractic. 2nd ed. Norwalk, CT: Appleton and Lange; 1992.
10. Wardwell WI. Chiropractic: History and Evolution of a New Profession. St. Louis: Mosby-Year Book; 1992.
11. Keating JC. B. J. of Davenport: The Early Years of Chiropractic. Davenport: Association for the History of Chiropractic; 1997.
12. Moore JS. Chiropractic in America: the History of Medical Alternative. Baltimore: The Johns Hopkins University Press, 1993.
13. Lerner C. The Lerner Report: A History of the Early Years of Chiropractic. New York: Foundation for Health Research, Inc., 1952.
14. Krick RK. The American Civil War: The War in the East 1863-1865. Wellingborough, UK: Osprey Publishing Limited, 2001.
15. Keating J. Several pathways in the evolution of chiropractic manipulation. J Manip Physiol Thera. 2003; 26(5): 300.
16. Keating Jr. J. The Meanings of Innate. J Canadian Chiropr Assoc. 2002; 46(1): 4.
17. Keating J. Chiropractic history. A brief history of historical scholarship in chiropractic. J Canadian Chiropr Assoc. 2001; 45(2): 113-136.
18. Donahue J. D. D. Palmer and the metaphysical movement in the 19th century. Chiropractic History: The Archives and Journal of the Association for the History of Chiropractic. 1987; 7(1): 23-27.
19. Wiese GC. New questions: Why did D.D. not use "chiropractic" in his 1896 charter? Chiropr Hist. 1986; 6:63.
20. Gielow V. Daniel David Palmer: rediscovering the frontier years, 1845-1887. Chiropractic History: The Archives and

Journal of the Association for the History of Chiropractic. 1981; 1(1): 11-13.
21. Montalto M, Cartwright G. From the Incandescent Light Bulb to Digital Pathology. Archives of Pathology & Laboratory Medicine. 2009; 133(4): 550-552.
22. Iowa History Timeline: Text Version [Internet]. 2012. Availablefrom:http://www.iptv.org/iowapathways/timeline_text.cfm?timeChunkStart=1880&timeChunkEnd=1889
23. Historical Currency Conversion [Internet]. No Date. Available from: http://futureboy.us/fsp/dollar.fsp?quantity=100&currency=dollars&fromYear=1880
24. Edison's fit pique lit the way for Science. Nature. 2002; 417(6885): 111.
25. D. D. Palmer [Internet] 2012. Available from: http://www.nndb.com/people/816/000166318/

Appendix A

Map of Iowa (2013 data) – Places of Significance



Enlarged map of Davenport area

Appendix B
Timeline

1845	D.D. is born.
1865	D.D. and his brother T.J. leave Canada and relocate to Muscatine County, IA.
1871	Moves, with his wife Abba Lord, to Eliza Township just north of New Boston and purchases 10 acres of land.
1874	Purchases Lumm's Everbearer plant, begins selling across the nation; begins bee farming shortly after.
1878	D.D. is president of the Western Illinois Bee-Keepers' Society; when he became president and for how long the position was held is uncertain.
1880	Bee farm perishes due to unusual weather; relocates to What Cheer, IA, opens a grocery store.
Mid-1880s	While running the grocery store, continues teaching in What Cheer and nearby town of Letts; takes interest in a "faith healer" in Ottumwa named Paul Caster; soon takes up magnetic healing.
1886	Relocates to Burlington, IA to open a magnetic healing practice; begins seeing patients on September 3.
1887	Moves to Davenport, IA to start a new magnetic healing practice.
1888-1890	Advertises his magnetic healing practice.
1895	D.D. adjusts Harvey Lillard's spine and restores his hearing; Chiropractic is born.
1896	Establishes Palmer School of Magnetic Cure.
1897	Begins teaching Chiropractic.
1898	D.D.'s annual income increases to $9,276 (approximately $250,279 by 2012 standards).

Appendix C

Pattern-matching chart summarizing significant events in the United States of America from 1860-1895.

Date	Social	Economics	D.D. Palmer
1860	Abraham Lincoln becomes president (**1860**) American Civil War (**1861**-**1865**)		
1865	President Lincoln assassinated (**1865**) (**1867**) Grasshopper invasion occurred, crops damaged; first railroad completed through Iowa The Iowa Board of Immigration published booklets in several languages (English, German, Dutch, Danish, and Swedish) to encourage European immigration to Iowa (**1869**) The First Transcontinental Railroad was completed (**1869**)	**1868** – The invention of refrigerated railcars allowing Iowa products to be shipped around the country without spoiling.	April 3, **1865** – DD and his brother TJ begin their trip to US. Feb or Mar **1866** – DD starts teaching school in Muscatine County, IO. Teaches for 5 more years in different locations places.
1870			Nov 8, **1871** – DD and his wife, Abba Lord, Purchase 10 acres in Eliza Township (several miles north of New Boston, IL). They call the property "Sweet Home". **1871-1881** – DD is a beekeeper **1874** (Spr): DD purchases plant (Lumm's Everbearer raspberry), begins nursery business and develops: "Sweet Home" raspberry (Gielow, 1981, p. 20)
1875	Civil Rights Act of **1875** Alexander Graham Bell invented the telephone (**1876**) Thomas Edison invented the light bulb (**1879**) and electricity became practical		
1880	The Population of the United States passed fifty million (**1880**) **1880** – Until 1880 the number of rural residents outnumbered city or urban residents in Iowa. From 1880 on, the number of rural residents began to drop.	**1880** – Farmers made up 49% of the labor force in America, by comparison, in 1790 farmers made up 90% of the work force. By **1880** every town in Iowa was no more than 25 miles from a railroad depot. **1884** – Americans began using mail order catalogues to purchase merchandise for the first time. Montgomery Ward and Sears, Roebuck and Company were the first mail order companies.	**1882** (Sept 14): BJ Palmer is born in What Cheer (Rehm, 1980, p. 271; Gielow, 1981, p. 32)
1885			**1885**: DD operates "mercantile store" (Rehm, 1980, p. 271) **1885**: DD begins career as magnetic healer in Burlington, then Davenport IA on 4th floor of Ryan building at corner of Second and Brady Streets (Rehm, 1980, p. 271; Palmer, 1967, p.5) **1886** (Sept 3): According to DD's journal, he begins career as magnetic healer (Gielow, 1981, p. 43, 105) **1887-98**: DD's cash intake grows from $700 to $9,276 annually (Gielow, 1981, p. 59)
1890	**1890** – Steam powered engines started to replace horses on the farm.	**1892** – Froelich's invention of the gasoline-powered tractor revolutionized the farm machinery industry.	
1895	**1895** – Guglielmo Marconi invented the radio in 1895 and opened the world's first radio factory in England in 1898.		**1895** (Sept): Chiropractic is "discovered" by D.D. Palmer (*The Chiropractor*, 1904, p. ii) **1895** (Sept 18): "On September 18, 1895, Harvey Lillard called upon Dr. Palmer" (*The Chiropractor*, 1904, p. 11) **1898** – D.D. Palmer and his son "B.J." founded the Palmer School of Chiropractic in Davenport, Iowa.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/233–242/$2.00/©JCCA 2013

Wm. Lloyd Stackhouse & Robert E. Kinsman: A tale of two chiropractors

Douglas M. Brown, DC*

This paper reviews the story of two childhood friends, Dr. Wm. Lloyd Stackhouse and Dr. Robert E. Kinsman, who attended the Canadian Memorial Chiropractic College (CMCC) together, graduated in 1953 to form an enduring partnership that included their immediate relatives, and to this day persists as a supportive tribe.

KEY WORDS: Stackhouse, Kinsman, chiropractic

Cet article examine l'histoire de deux amis d'enfance, le Dr Wm. Lloyd Stackhouse et le Dr Robert E. Kinsman, qui ont fréquenté ensemble le Canadian Memorial Chiropractic College (CMCC), d'où ils ont obtenu leur diplôme en 1953 pour enfin établir un partenariat solide et durable qui a aussi inclus leurs proches, et qui continue à exister jusqu'à nos jours comme un clan soudé et solidaire.

MOTS CLÉS : Stackhouse, Kinsman, chiropratique

Background

Lloyd Stackhouse and Bob Kinsman hailed from Ridgeway, Ontario, a small suburb of Fort Erie, just 14 kilometers from the Peace Bridge to the Canada/United States border and Buffalo, New York. Lloyd and Bob's families were neighbours with similar interests. Lloyd's father was a medical doctor, his mother a nurse and both had served in the Canadian Armed Forces during World War I. Although chiropractic was in its infancy, Lloyd's father understood its value and frequented one in Buffalo. Bob's mother's maiden name was Evelyn G. Ellsworth. She and her sister Eleanor H. Ellsworth were reared in Winona, Ontario, a rural town between Stoney Creek and Hamilton. Both can be found among the 76 students in the Toronto College of Chiropractic (TCC) group photo of 1922 (see Figures 1 and 2).[1] Graduating in 1924,[2] Evelyn had an office in Fort Erie for a year before marrying Donald Kinsman and Eleanor worked in Hamilton for 42 years.[3]

Then located at Charles and Yonge Streets, the TCC was founded in 1920 by John S. Clubine (Canadian CC, 1919) and John A. Cudmore (Palmer c. 1920). Dr. Clubine was the TCC President from 1920 until its demise in 1926 and would become the first President and Dean of CMCC in 1945.

*President, Canadian Chiropractic Historical Association
281 Ridgewood Road,
Toronto, Ontario, Canada M1C 2X3
Tel.: 416-284-1168
Email: browndouglas@rogers.com

Figure 1
Evelyn G. Ellsworth

Figure 2
Eleanor H. Ellsworth

Education

Lloyd Stackhouse was born in Buffalo, July 9, 1925. His parents chose a hospital there because it was more convenient than the one in Ontario, providing Lloyd with dual citizenship. At age 18, Lloyd left high school after grade 12 to enrol in the Royal Canadian Air Force, attaining the rank of Sergeant Air Gunner, just before World War II ended, September 2, 1945. Lloyd returned to rehab school for grade 13 and earned a Bachelor of Arts degree from the University of Western Ontario, in the Spring of 1949.

Bob Kinsman came into the world January 27, 1931, and was graduating from high school the same year Lloyd was emerging from university. Lloyd was looking at a medical career but didn't qualify. His father suggested he think about chiropractic, which Bob was already considering and they both registered at CMCC, 252 Bloor Street West, in Toronto, on September 6, 1949. The 4,400 (50 minute) hour curriculum was spread over four years. Each year contained two 18 week semesters and classes ran from 8:00 am to 2:00 pm, Monday through Friday. Bob and Lloyd's earliest College memory is of the Dean, Rudolph O. Muller (Lincoln CC 1937) addressing the student body and filling them with pride in their chosen profession. In their freshman year, Dr. Muller's 90 hour course in the Principles and Theory of Chiropractic made an indelible impression which later shaped their clinical procedures.

By the second semester (1950) Lloyd and Bob had begun palpation, the first step in the art of spinal adjusting and in their fourth semester they were introduced to chiropractic techniques. This subject consumed 300 hours of formal study and was a major component in 500 hours of clinical training. It required manual dexterity and daily, repetitive effort to master and retain these psychomotor skills.

Back in 1943 CMCC's founders determined to teach the major "straight" techniques.[4] In 1945 Herbert K. Lee (National CC 1941), one of those founders, began instructing the freshman class in "Meric" procedures as advocated by the National College. In addition, by 1949 Dr. Lee was handling extremity, accessory, paediatric and geriatric adjusting.[5] Keith B. Kennedy (Logan CC 1943) was the main proponent of the "Logan Basic" method. Several Palmer alumni had tried to generate interest in BJ Palmer's "Specific Upper Cervical" system, but it was not a priority at CMCC and did not resonate with the student body until Vera Littlejohn (Palmer CC 1932) was hired in the fall of 1954. Swamped by his new duties as Administrative Dean in 1953, A. Earl Homewood (Western States CC 1942) somehow managed to continue his "Carver" technique course, as developed by Willard Carver, LLB, DC, and taught at the Carver Chiropractic College, Oklahoma City, Oklahoma, 1906-1958.

Since its inception, the College's basic sciences program has been centred on anatomy. Dr. Homewood chaired that department, virtually conducting all of the 900 hours it comprised. In April 1950, Homewood added embalming cadavers to his chores when CMCC was placed on the short list of Ontario institutions eligible to receive human bodies for dissection.[6] Before long, Homewood, who, like most of the faculty, did not have a recognized university degree, was being hailed as a world class anatomist and professors from the University of Toronto (U of T) were visiting the College to admire his specimens.

Lloyd and Bob were always on the go. In June 1951, Lloyd married C. Elizabeth (Betty) Powell and after 18 months they had their first child. Bob wed Rita Barrett in January 1953 and their first born arrived the following year. 1953 was the year the boys decided to partner with Bob's aunt, Dr. Eleanor Ellsworth, after graduation.[7] May 20, Drs. Kinsman and Stackhouse were among 35 members of the Class of '53 to receive their diplomas in the Eaton Auditorium. June 20, they obtained certificates of registration to operate in Ontario, from the Board of Directors of Chiropractic and were soon driving down the highway to Hamilton.

The Hamilton Experience

Dr. Ellsworth's first office was situated in Hamilton's "historic Lister Block on James Street North." Among her patients was Ronald A. Oswald, a young lad who suffered from asthma. He "received such wonderful results" that at age 11 he "made up his mind to become a chiropractor" and subsequently graduated from CMCC in 1957. [Phone call, the author to RA Oswald, May 21, 2012].

In anticipation of Lloyd and Bob arriving on the scene, Ellsworth purchased "a handsome old brick building at 240 James Street South" and converted it into a clinic to accommodate her new partners. Bob and Lloyd contributed $5,000, namely all the money they had, to help defray Ellsworth's expenses.

This union started with high expectations that were deflated when these neophyte graduates grew dissatisfied with the clinic's treatment protocols. Bob's Aunt Ellsworth took spinal x-rays, did blood and urine analysis and applied a variety of therapeutic modalities before finishing each session with a spinal adjustment. She also used Radionics, a controversial system for diagnosing and treating patients. Bob and Lloyd wanted to be "straight," chiropractors, who adjusted the spine by hand only and resolved to move on after a year in Hamilton. Eleanor wished them well and graciously returned their $5,000.

Upon graduating from CMCC in 1957, Dr. Ron Oswald assisted Dr. Ellsworth while opening his own office in Stoney Creek. He took x-rays and performed diagnostic tests, as well as treating patients. "Eleanor was the epitome of professionalism. Her manner was frank, she wore crisp, white uniforms and her office was immaculate." In 1964, Oswald surprised her with a celebration of her 40th year in business. Robert M. Wingfield (CMCC 1958) collaborated with Ellsworth for a few weeks in 1958, prior to opening his own clinic in Burlington. "She had a very busy practice which she ran by herself, aided by her secretary, who applied various modalities... to most patients." Dr. Wingfield "was responsible only for adjusting," using a modern Zenith Hylo table. Visits were usually $3 and "patients were fiercely loyal and conscientiously took her advice... in the early years she had a three week waiting list for new patients." Though Eleanor "used Radionics with many patients... she was emphatic in advising them that it was the adjustment that really got them better."

Eleanor was an active member of the Women's Advertising and Sales Club of Hamilton. "This was the pre-

Figure 3
Preston Chiropractic Clinic

eminent national women's club of the day," giving her access to notables such as Cabinet Minister the Hon. Ellen Fairclough, MP, who represented Hamilton. Training with Eleanor enabled Wingfield to understand how a successful practitioner functions and observe "the wide cross section of health problems seen by chiropractors of the day." He realized that "Dr. Ellsworth had very strong convictions about the very nature of illness and the therapeutic effect of spinal adjustments in the restoration of health." [Email, RM Wingfield to the author, Sept 17, 2012]

Dr. Ellsworth died suddenly on June 24, 1966, while attending a convention in Edmonton, Alberta. She was 62 years old.

The Move to Preston

Following their exodus from Hamilton, Bob and Lloyd were searching for a different locale when Neil Harris (CMCC 1951), a third cousin of Bob's who was doing well in Waterloo, suggested Preston as a promising site. Close to Hespler and Blair, there were no chiropractors in the vicinity until you reached Galt. [Now known as Cambridge, the Towns of Preston and Hespler were amalgamated with the Village of Blair and the City of Galt, January 1, 1973.]

Nosing around Preston, Lloyd and Bob discovered the residents they met had no idea what chiropractic was about and little inclination to learn. Fortunately, a piece of land containing a duplex was for sale and the builder was willing to start erecting a health care facility on the vacant portion, with no money down. Once construction

Figure 4
Rita, Bob, Lloyd, Betty 1954

was underway Lloyd and Bob used their $5,000 to take out a mortgage and complete the project. The clinic contained a reception area, two adjusting rooms, some change rooms with rest cots, x-ray equipment and storage space. As planned, there were no modalities. Later the structure was enlarged by two additions. [Interview, Stackhouse & Kinsman, by the author, May 7, 2012] (see Figure 3)

The grand opening was held September 20, 1954. That day, Bob and Lloyd had not finished painting the premises and the walls were damp when over 50 inquisitive neighbours landed at the front door to be greeted by their wives. Shortly after, the local dentist invited both couples to his home to play bridge, where they were introduced to 30 more people, who also welcomed them to parties in their homes. Next they became "joiners," attending church and service clubs. Careful planning and confident expectations paid dividends. "Our clinic grossed $1,000 its first full month and never looked back." (see Figure 4)

Continuing Education

Lloyd and Bob were attending annual Ontario Chiropractic Association (OCA) conventions before graduating from CMCC and don't recall missing any during their active careers. Here they met hundreds of chiropractors with similar interests. In the 1950s to 70s the Canadian Chiropractic Association (CCA) hosted meetings which were held in a different province each year, giving delegates a chance to see the country and observe chiropractic in action, from coast to coast. The OCA and CCA held business conferences, explained government issues affecting our profession and offered informative seminars on a wide spectrum of subjects. Alternative sources of knowledge were CMCC and the College of Chiropractors of Ontario (CCO). Bob's curriculum vitae details his interest in courses on a variety of adjustive techniques, rehabilitation, nutrition, paediatrics, applied neurology, clinical protocols and record keeping.[8]

In 1943 Dr. Kennedy was introduced to James W. Parker, (Palmer CC 1946). Kennedy saw Dr. Parker's practice building program as a way to solidify the profession and expand its influence, through standardized office procedures and sent a letter to his "Friends and Officials of Canadian Chiropractic."[9] Bob took the Parker course in 1955, Lloyd in 1956, and the two of them attended annual homecomings in Fort Worth, Texas, for many years.

Chiropractors who attended Parker seminars were called "Brown Baggers." In Ontario they met once a month at the Fisher Hotel in downtown Hamilton, refreshing procedures, examining other concepts and renewing enthusiasm. Ed Reinhart (CMCC 1950) was the feature attraction for 15 years. "He was charismatic; an authoritative and entertaining, motivational speaker who used metaphors and analogies to paint vivid pictures in our minds."[10] Lloyd and Bob looked forward to these invigorating, interactive gatherings.

Professional Involvement

In 1952, the Canadian Council of Chiropractic Roentgenology (CCCR) was formed by four early CMCC graduates; Drs. Donald MacMillan, Colin Greenshields, William Sundy and Wilmer (Bill) Trelford. This was a national organization with provincial divisions, whose prime purpose was to improve the quality of chiropractic x-rays and the safety of its installations. Members received informative monthly bulletins and annual educational gatherings that became the largest chiropractic conventions in Canada.[11] The "Pair from Preston" were vitally interested in radiology and 1963-65, Bob was President of the CCCR's Ontario Division and 1965-68, President of CCCR Canada.

Established in 1929, the OCA is a voluntary professional organization, whose mission is to serve its members and the public, by advancing the understanding and use of chiropractic care. In 1965 Lloyd was elected to the OCA Board of Directors. He became Inter Council Chair

Figure 5
Bob CCA Honourary Member 1986

Figure 6
Lloyd Stackhouse

Figure 7
NCA Convention Port Perry 1938

in 1966, then Chair of Membership, Advertising, Publications and Conventions, before stepping down in 1971.[12] By 1971, Bob had followed Lloyd to the OCA Board where he climbed from 2nd Vice-President 1971-73, to 1st Vice-President 1973-74 and President 1974-76

January 10, 1943, the Dominion Council of Canadian Chiropractors (now the CCA) was inaugurated[13] and on September 18, 1945, achieved its chief objective, "to establish schools for the study of chiropractic" when CMCC opened its doors in Toronto.[14] Bob landed on the CCA Board of Directors in 1980, heading half a dozen committees before assuming the Presidency for 1982-83. One serendipitous weekend President Kinsman and Jim Watkins (CMCC 1966), CCA's Executive Vice-President, were waiting to fly to Newfoundland for an important meeting with Roly Bryans (CMCC 1982), President, Newfoundland/Labrador Chiropractic Association, regarding chiropractic licensure for Canada's 10th province. Unexpectedly, they were told the plane was overbooked and they would be grounded until the next day. Just then the pilot walked by, recognized Dr. Watkins as a fellow aviator and squeezed them aboard. Another satisfying experience occurred in 1984, when Past-President Kinsman travelled to Ottawa and successfully lobbied the Honourable George Hees, MP, Minister of Veterans Affairs, to include chiropractic care among the benefits available for Canada's war vets. (see Figures 5 and 6)

Life in the Duplex

From the beginning, the two families got along famously, residing in the duplex as a harmonious unit. Betty and Lloyd occupied the downstairs, Rita and Bob the upstairs. This was decided by tossing a coin. Each household expanded to four children, three boys and a girl, who grew up studying, playing and spending holidays together. Both wives totally supported their husbands' professional activities while taking good care of their progeny. For instance, Betty had graduated from the first course in physiotherapy at the U of T in 1949 and participated in a home care program in Kitchener-Waterloo but stopped working until the youngsters were in university and even then, took the summers off, to be with Rita and all the kids, at their cottage on Georgian Bay. Favourite activities were those the whole clan could enjoy. Summers were filled with swimming, boating and golfing at Wasaga Beach. Winters were spent skiing at Chicopee, near Kitchener and Blue Mountain at Collingwood. One year Rita and Bob flew to the French Riviera for two glorious months, while Earl Sawyer (CMCC 1950) looked after the clinic.

Bob and Lloyd remember the 1950's and 60's as exciting years when the OCA Societies were strong and the Ontario Chiropractic Women's Auxiliary (OCWA) sponsored a lot of events.[15] In 1937 "the founding members included six doctors and three lay members." Later this became an organization of wives of chiropractors, yet its objects are nearly identical to what they were originally: To promote chiropractic; to raise money for chiropractic and CMCC; to promote and sponsor sociability among the members; and to assist in promoting the objects and purposes of the OCA.

The OCWA's initial meetings were convened in Toronto and in 1938, Mrs. CC (Myrtle) Clemmer was elected its first President, a post she would dominate with energy, "spunk" and vision, for nine years. 1938 was the year the

Auxiliary played a large role in organizing the National Chiropractic Association (NCA) convention at Toronto's Royal York Hotel. During the week 1,200 delegates travelled by a caravan of cars to Port Perry (see Figure 7) where they announced plans to dedicate a monument to DD Palmer on the banks of Lake Scugog.[16] This was finally accomplished in August 1946, thanks to Mrs. Clemmer and Dr. John Clubine, who had launched a joint project to collect $10,000 in Canada and the United States.

From 1963 to 1971 the OCWA created affiliate branches throughout the province. Rita and Betty became ardent backers in the Waterloo-Wellington district. Other branches opened in Hamilton, Toronto, Niagara and the Tri County (St. Thomas, Aylmer, Tillsonburg and Woodstock). The Northern Ontario Auxiliary was the last one to form in 1981. Despite the barrier of distance, seven wives managed to meet twice a year. If they gathered in Sudbury, four women travelled 2,000 miles round trip; if they met in Timmins, it was 3,200 miles for all seven.

By 1970, much of the OCWA's profits were going into the CMCC Bayview campus library and in 1972 it was renamed the CC Clemmer Library, in honour of Cecil C. Clemmer (Palmer 1912) and his wife Myrtle. Dr. Clemmer died in 1973 and Myrtle in 1978. "On her death, most of their estate (in excess of $300,000) was willed to the College for the CC Clemmer Library."[17]

The Next Generation

William P. Stackhouse entered the world December 22, 1952. His parents, Betty and Lloyd, were consummate professionals and instilled a caring attitude in Bill.

"Dad loved chiropractic. It was almost a religious experience," yet he found time for his children. "He had breakfast with us in the morning and made us walk the two miles to school because he believed in physical activity and came home for dinner before going back to the clinic for evening hours." Bill's mother was a physiotherapist, "a special woman who volunteered with the United Nations International Children's Fund (UNICEF), the Boy Scouts, the church and the library. She regularly wrote letters to the Prime Minister with her concerns, enjoying what she called 'discussions' and I termed arguments." [WP Stackhouse interview by the author, Sept. 13, 2012] (see Figure 8)

Following high school, Lloyd handled all his son's academic expenses to earn his Bachelor of Science degree at Western University before enrolling at CMCC in 1975, where Bill decided his father had done enough and paid his own College tuition. "There was a lot of turmoil during my tenure at CMCC but in the end this was the best thing that ever happened to me." Bill received a fine education, felt competent and prepared on graduation and gained some outstanding friendships. One of them was Dr. Tom Gaw (CMCC 1978), who spearheaded student loans for College applicants. Another is classmate Dr. Larry Laughlin. Larry introduced Bill to the game of hockey (one of the few sports he hadn't played) and they organized the first CMCC hockey tournament in their fourth year. Graduating in 1979, Bill and Larry formed the Halton Chiropractic Clinic and Wellness Centre, in Oakville and have been partners for 34 years. This attractive, centrally located structure, houses three chiropractors, two physiotherapists, four massage therapists, one reflexologist and a nutritionist.

Figure 8
Wm (Bill) Stackhouse

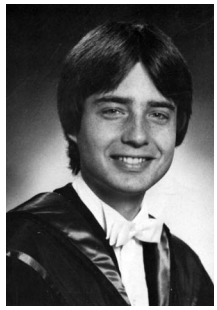


Figure 9
Jeff Stackhouse

Figure 10
John Greg Kinsman

Jeffrey L. Stackhouse arrived on the scene November 3, 1956. Jeff remembers the Stackhouse and Kinsman families as large, congenial and fond of doing things together. He says, "Growing up in a chiropractic household was a great blessing because at an early age I gained confidence in the ability of the body to heal itself." In high school, Jeff decided on a career in chiropractic. Following Grade XIII, he entered the University of Waterloo for the prerequisite two years training in basic sciences and after, took a year off before enrolling at CMCC in 1978. "Mine was a great class, containing the sons of five chiropractors I was familiar with: Peter Magee, Ted Luck, Brett Moore, Steve Soloduka and Scott Stevenson." [JL Stackhouse, interview by the author, Sept. 24, 2012] (see Figure 9)

Following convocation in May 1982, Jeff married Anita Knibutat, who had graduated as an occupational therapist from the U of T that year, and they left for Cambridge, where Jeff was employed in the Preston Chiropractic Clinic. "Bob and Lloyd were easy going, non-judgmental and pleasant to be with. Despite the fact I had been a mediocre student, I quickly became a 'know it all' who was discontent with the status quo and quit the clinic after two years." In 1984 Jeff travelled with Anita to Australia, where he spent 18 months working as a locum and visiting Ray Sherman (CMCC 1960), in New South Wales. Dr. Sherman had been Clinic Director during both Jeff and Bill's training at the College.

Anita and Jeff moved back to Canada in 1984, settling in Collingwood, Ontario, where they run a prosperous office downtown.

John G. (Greg) Kinsman, a nephew of Bob's, was another of Jeff's classmates at CMCC (1976-82). Born June 14, 1954, Greg emerged from a four year course at McGill University in Montréal in 1976. Accepted for law school, Greg travelled instead to Calgary, Alberta, where he worked for a year before deciding against becoming a lawyer. Greg credits his Uncle Bob and grandmother, Evelyn Kinsman, with being the prime influences on him choosing chiropractic. When Greg told his grandmother he "had no idea" what he wanted to do, she replied, "Have you ever thought of being a chiropractor?" That question jarred Greg's thinking and he spent a week at his "Uncle Bob's practice to see if that was for me. He was so gracious, busy and loved by his patients that it made my decision to study chiropractic, simple. From then on, Uncle Bob was my model for what I wanted to do and who I wanted to be." [Email, JG Kinsman to the author, Jan 23, 2013] (see Figure 10)

Greg describes his education at CMCC as "great, partially because most of the guys I hung out with were sons of 2nd and 3rd generation chiropractors." Greg declares the College gave him "an excellent scientific basis for chiropractic and Adrian Grice (CMCC 1959) taught me a lot about motion palpation, spinal mechanics and the basis of what to adjust and why. Most of my philosophical concepts came from my extended chiropractic family." In 1982, Greg left Toronto for Massachusetts, USA, wrote his board exams and established his own practice. In the late 80s and early 90s he was President of the Middlesex Chiropractic Society and at one juncture had three offices.

Figure 11
Blue Heron Motel

Currently (2013), Greg is a solo practitioner in Concord, Massachusetts.

Winding Down

In 1989, Bob sold his interest in the Preston Clinic to Dr. Ernest Morin (CMCC 1984) and moved to Milford Bay on Lake Muskoka, where he and Rita bought and ran the Blue Heron Lodge and Bob continued to practice. The Lodge consisted of eight motel units and a separate restaurant, with access to docks at the water's edge where guests could moor their boats. (see Figure 11)

In September 2010 Bob stopped practising and the couple settled into a home in Bracebridge. That December, a fire of unknown origin broke out in an enclosed porch, burning the house to the ground and destroying most of their records and memorabilia. Fortunately nobody was injured. A year later, Rita and Bob took possession of a brand new ranch-style bungalow. Erected on the foundations of their previous home, it has a spacious living/dining area overlooking tranquil Lake Frau and backing onto 90 acres of forest, traversed by walking trails. (see Figure 12)

Lloyd remained in the Preston Clinic until 1994 when he sold his interest to Dr. Morin and retired from practice, knowing his patients were in capable hands. Morin notes that, "Bob and Lloyd were very supportive when I took control of the business, providing explicit informa-

Figure 12
Frau Lake Home

tion regarding the steps I must take to maintain the level of practice and degree of satisfaction they had attained." [Phone call, Morin to Brown, June 6, 2012]

Perceptions

Lloyd and Bob's fidelity to their alma mater is remarkable. They have been dues-paying Members of the College since 1953, signed on as Founding Members of the Governors' Club in 1982, attended all the alumni fund raising dinners with their wives, contributed to the Capital Campaign for our Leslie Street campus, belong to the Canadian Chiropractic Historical Association and are now Life Members of CMCC.

This devotion extends to the Stackhouse/Kinsman alliance which has existed just as long, and whose bonds of mutual affection and respect remain just as secure. Lloyd's sons, Bill and Jeff, agree that their parents "could not have been two more perfect role-models... Everything we have we owe to our parents and the profession... and we still think of Rita and Bob as another father and mother, and their children as brothers and sisters."

These families possess a serenity which enables them to cope with the unpredictable turmoil that can strike anyone. The horrendous fire that destroyed the Kinsman home in 2010 is a classic example. This had to be devastating, however Rita and Bob calmly replaced their gutted residence with a new abode, seldom mentioning the ordeal and acting as if nothing had happened. Lloyd and Bob feel their composure stems from confidence in the philosophy of chiropractic which espouses reliance on a natural life style. (see Figure 13)

OCA Leadership

The Kinsman/Stackhouse union is an inclusive fellowship, sheltering those within and welcoming outsiders. Its inhabitants view themselves as individuals who are part of a harmonious coalition. Bob's letters to the profession as President of the OCA reflect his desire for chiropractors to follow suit. His "President's Message" to the membership of October 1974 stresses the importance of change, hope for passage of a new Regulated Health Professions Act (RHPA) "in the near future" and the urgency for Ontario chiropractors to get involved and convince their colleagues to join the parade.[18]

In 1952, the Board of Directors of Chiropractic (BDC) was the first independent regulatory body for the profession in Ontario. Stephen E. West (CMCC 1950), sat on this body from 1966 to 1999 and recorded, "The inadequacies of the Drugless Practitioners Act (DPA) have made it difficult for past Boards to effectively regulate chiropractic... The laws were vague... and the Ministry of Health lacked enforcement."[19] In retrospect, it was premature for Bob to "hope for" early passage of Ontario's New RHPA. The first six parts had been ratified in 1974 but it wasn't until November 25, 1991, that the RHPA, containing the Chiropractic Act, was proclaimed, awarding Ontario chiropractors a defined scope of practice that included diagnosis and the right to use the title "doctor."[20] This specific Chiropractic Act was worth the wait, though Dr. West "knew that once chiropractic was included within the RHPA the BDC as it existed would be replaced by a new body. That took place on March 26, 1994, when the College of Chiropractors of Ontario held its inaugural meeting." Appropriate regulation followed.

CCA Leadership

By the time he stepped into the CCA President's shoes in 1982, Bob's outlook had expanded to perceive our national body not just "as an umbrella under which function all the divisions across Canada," but as one of the vehicles for enabling chiropractic to assume "its rightful place in the health complex of the world."[21]

Fred W.H. Illi, DC, is credited with being the person

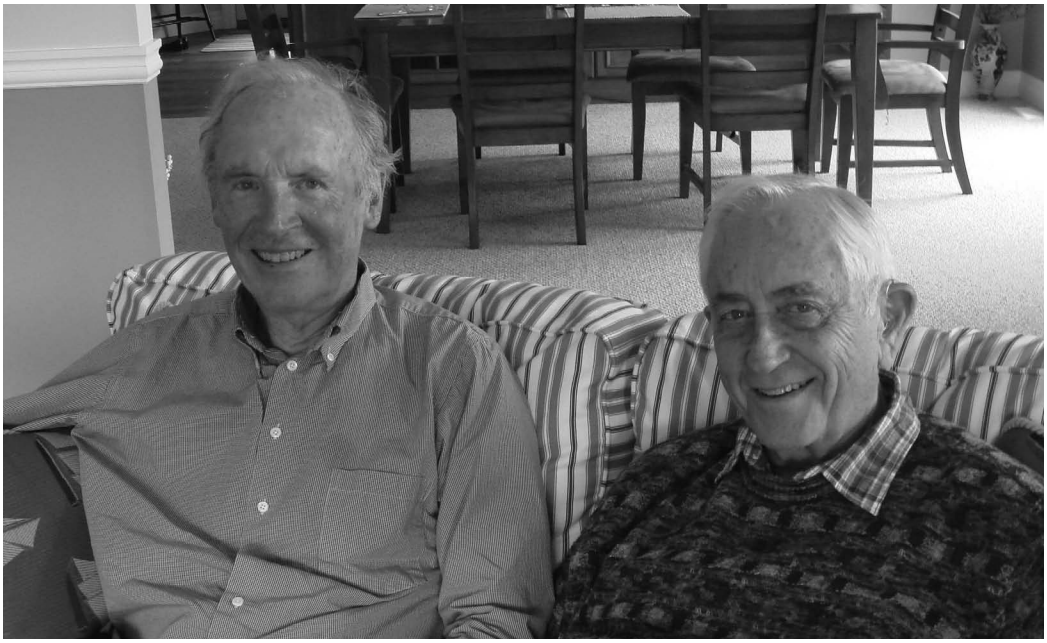


Figure 13
Bob Lloyd 2012

who introduced the concept of a world body of chiropractors at an international congress in Geneva, Switzerland, July 7-12, 1962.[22] The next meeting was organized by Donald C. Sutherland, DC (CMCC 1950), who was then Executive Secretary of the CCA. Held during a World Chiropractic Congress, hosted by the CCA, July 23-29, 1967, in Montréal, Québec, it was the World Chiropractic Organization's (WCO) formative year.[23] June 5, 1968, the WHO gathered in Geneva, Switzerland. Dr. Sutherland chaired the meeting and was named Executive Secretary, formally recognizing he was willing and able to move this body forward. Despite Sutherland's repeated attempts, there were no more meetings and the WHO file of correspondence ended in 1975. Various reasons for its passing have been given, "but in essence, it was premature for the chiropractic profession to operate effectively on a global basis and support that effort financially." [DCS, Background facts, Unpublished]

Twenty years passed before Gary A. Auerbach (Palmer CC 1975), while attending a meeting of the World Health Organization (WHO), thought of building a world governing body for chiropractic. In 1986 Dr. Auerbach asked David Chapman-Smith (DCS) to accompany him to Geneva, Switzerland. DCS drafted an agreement and the premier World Federation of Chiropractic (WFC) Council meeting was held in Toronto, Ontario, August 31 to September 2, 1989. Auerbach was elected as the first President and DAC became Secretary-General, with head offices in Toronto. Council meetings are scheduled annually. Combined World and Association of Chiropractic Colleges (ACC) Conferences are held biennially. "The WFC's strength comes from its partnerships with and support from the national and international organizations representing all aspects of the profession – education, accreditation, research, examining and licensing boards, and specialty areas of practice."[24] Its voting and non-voting members currently reside in over 92 countries.

The CCA and CMCC have made substantial financial and intellectual contributions to the WFC since 1985. David Chapman-Smith is grateful for Canada's input and offers that, "At the WFC/ACC conference in Toronto (2006), President Jean Moss chaired the final session, with its development and consensus statements. Dr. Moss performed so well, she has been pressed into that service ever since."

Final Ruminations

Since 1949, when Lloyd Stackhouse and Bob Kinsman joined forces in their quest to become chiropractors, they have had the insight to know where they wanted to go, the ingenuity to determine what path to take, the agility to alter their course when necessary and the ethics to arrive without transgressing the rights of others. Three of their nuggets of wisdom can be found in these paraphrased excerpts from Bob's April 1975, OCA Newsletter:

- Many of us jog through life with little consideration of reaching a definite goal
- Without a plan we could wander aimlessly and never reach our full potential
- We are on the threshold of a new era in chiropractic. Let us take the right steps now to assure continued growth and prosperity of chiropractic and chiropractors

These thoughts are as relevant now as they were thirty-eight years ago.

References

1 Toronto College of Chiropractic, Class of 1922 photo. CMCC Archives.
2 Vear HJ, Lee HK, Keating JC. Early Canadian chiropractic colleges. JCCA. 1997; 17(2): 64-67.
3 Eleanor Ellsworth obituary. Hamilton Spectator: June 27, 1966: 21.
4 Brown DM. The Kennedy clan of inquisitive chiropractors:1911-2010. Chiropractic History Summer. 2011; 31(1) 23.
5 Brown DM. Herbert K. Lee, DC: An accomplished professional. JCCA. 1990; 34(3): 154.
6 Brown DM. A. Earl Homewood, DC: Chiropractic educator. JCCA. 1989; 33(3): 143.
7 CMCC 1953 Cornerstone Yearbook. CMCC archives.
8 Kinsman RE. CCO professional profile/curriculum vitae, undated. CMCC archives.
9 Brown DM. The Kennedy clan of inquisitive chiropractors. Chiropractic History Summer 2011; 31(1): 24.
10 Brown DM. Letter to the editor re: ER Reinhart. Primary Contact. 2011; 43(3): 24.
11 Brown DM. Colin L. Greenshields, DC: The Canadian Memorial Chiropractic College's first graduate. JCCA. 2012; 56(2): 149-50.
12 OCA board minutes, 1971-2010. OCA archives.
13 Minutes of the organization meeting of the Dominion Council of Canadian Chiropractors, January 10, 1943. CMCC archives.
14 Lee HK. Honoring the founder in his country: Conception and struggle for Canada's Memorial College. Chiropractic History. 1981; 1(1): 43-45.
15 Dadson K. Ontario Chiropractic Women's Auxiliary: St. Jacob's Printery Ltd. Spring 1988. CMCC Archives.
16 Keating JC. Chronology of CMCC, undated, p.6. 1938 letter from JN Haldeman. CMCC Archives.
17 Lee HK. History of manipulation: CC Clemmer, DC. JCCA. 1981; 25(2): 75-76.
18 OCA Newsletter, October 1974. CMCC archives.
19 BDC Information for Ontario chiropractors. December. 1988; 1(2): 2.
20 Chiropractic self-regulation timeline. CCO June 2000.
21 CCA News, December 1982; 4(4): 1. CMCC archives.
22 Leiter TR. World chiropractic congress formed. NCA Journal. September 1962; 32(9): 9-11.
23 Vear HJ, Keating JC. Donald Campbell Sutherland: Chiropractic statesman and diplomat. JCCA. 1999; 43(3): 5.
24 WFC history. http://www.wfc.org/website/index. Retrieved January 15, 2013.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/243–250/$2.00/©JCCA 2013

Association between heart rate variability and manual pulse rate

John Hart, DC, MHSc*

Introduction: *One model for neurological assessment in chiropractic pertains to autonomic variability, tested commonly with heart rate variability (HRV). Since HRV may not be convenient to use on all patient visits, more user-friendly methods may help fill-in the gaps. Accordingly, this study tests the association between manual pulse rate and heart rate variability. The manual rates were also compared to the heart rate derived from HRV.*

Methods: *Forty-eight chiropractic students were examined with heart rate variability (SDNN and mean heart rate) and two manual radial pulse rate measurements. Inclusion criteria consisted of participants being chiropractic students. Exclusion criteria for 46 of the participants consisted of a body mass index being greater than 30, age greater than 35, and history of: a) dizziness upon standing, b) treatment of psychiatric disorders, and c) diabetes. No exclusion criteria were applied to the remaining two participants*

Introduction : *Un des modèles d'évaluation neurologique en chiropratique est lié à la variabilité autonome, testée habituellement avec la variabilité de la fréquence cardiaque (VFC). Puisque l'usage de la VFC n'est pas toujours convenable à toutes les visites médicales, d'autres méthodes plus conviviales peuvent aider à combler les lacunes. Alors, cette étude examine la relation entre la prise de pouls manuelle et la variabilité de la fréquence cardiaque. Les rythmes manuels ont aussi été comparés au rythme cardiaque dérivé de la VFC.*

Méthodologie : *Quarante-huit étudiants en chiropratique ont été examinés par la mesure de la variabilité de la fréquence cardiaque (SDNN et fréquence cardiaque moyenne) et par deux mesures manuelles du pouls radial. Les critères d'admissibilité étaient le fait d'être des étudiants en chiropratique. Un participant n'était pas admissible s'il avait un indice de masse corporelle supérieur à 30, s'il était âgé de plus de 35 ans, et s'il avait des antécédents : a) d'étourdissements en position debout, b) de traitement pour des troubles psychiatriques, et c) de diabète. Aucun critère d'inadmissibilité n'a été retenu contre les deux participants restants qui étaient aussi des bénévoles servant d'échantillon de commodité. Les rapports*

Assistant Director of Research
Sherman College of Chiropractic
P.O. Box 1452
Spartanburg, SC 29304
Phone: 864-578-8770, Ext. 232
Email: jhart@sherman.edu

who were also convenience sample volunteers. Linear associations between the manual pulse rate methods and the two heart rate variability measures (SDNN and mean heart) were tested with Pearson's correlation and simple linear regression.

Results: *Moderate strength inverse (expected) correlations were observed between both manual pulse rate methods and SDNN (r = -0.640, 95% CI -0.781, -0.435; r = -0.632, 95% CI -0.776, -0.425). Strong direct (expected) relationships were observed between the manual pulse rate methods and heart rate derived from HRV technology (r = 0.934, 95% CI 0.885, 0.962; r = 0.941, 95% CI 0.897, 0.966).*

Conclusion: *Manual pulse rates may be a useful option for assessing autonomic variability. Furthermore, this study showed a strong relationship between manual pulse rates and heart rate derived from HRV technology.*

KEY WORDS: heart rate, chiropractic, pulse rate, adjustment, manipulation

linéaires entre les méthodes de mesure de pouls manuelle et les deux mesures de variabilité de la fréquence cardiaque (SDNN et fréquence moyenne) ont été testés à l'aide d'une analyse de corrélation de Pearson et de régression linéaire simple.

Résultats : *Des corrélations inverses de niveau modéré (prévues) ont été observées entre les deux méthodes de mesure de pouls manuelle et la SDNN (r = -0,640, 95 % CI -0,781, -0,435; r = -0,632, 95 % CI -0,776, -0,425). Des relations directes de niveau élevé (prévues) ont été observées entre les méthodes de mesure de pouls manuelle et le rythme cardiaque dérivé de la technique de VFC (r = 0,934, 95 % CI 0,885, 0,962; r = 0,941, 95 % CI 0,897, 0,966).*

Conclusion : *La prise de pouls manuelle peut se présenter comme une option pratique dans l'évaluation de la variabilité autonome. De plus, cette étude démontre une relation importante entre le pouls manuel et le rythme cardiaque dérivé de la technique de VFC.*

MOTS CLÉS : fréquence cardiaque, rythme cardiaque, chiropratique, pouls, ajustement, manipulation

Introduction

One approach in chiropractic care of patients pertains to the analysis and adjustment of *vertebral subluxation*, a condition with various theoretical underpinnings. Others may prefer to call the target of chiropractic intervention a "functional articular lesion," where the purpose of the intervention is to "produce (a) beneficial neurologic effect."[1] In either case, a measurable neurological outcome of some type is presupposed. For purposes of this study, the "adjustable lesion" is referred to as *vertebral subluxation* since the author considers this to be a more familiar term within the profession. Briefly, vertebral subluxation is theorized to consist of some type of minor biomechanical aberrancy between two vertebrae, resulting in some type of (and yet still-to-be defined) neurological disturbance. The present study focuses on a potentially useful neurological predictor, if not also a useful outcome variable that may be related to putative subluxation.

One aspect of subluxation theory involves the potential effect of subluxation on the autonomic nervous system (ANS), the health of which can be assessed in terms of "autonomic variability" measures.[2]

R.W. Stephenson advanced the idea that subluxation interferes with the body's ability to adapt.[3] In current day terminology, neurological adaptability, particularly in regard to the ANS is described by the *complexity* model as it is known in medicine.[4] In chiropractic, *neuro-adaptabilty* is typically analyzed with *pattern analysis*.[5] Briefly, the concept is that variation in certain autonomic functions, such as heart rate, is considered to represent a healthy nervous system. A higher amount of heart rate variability is neurologically healthier than lower heart rate variability in terms of various cardiological and noncardiological diseases.[2] There are exceptions to this concept. For example, higher variation in blood pressure has been correlated with atherosclerosis and diabetic nephropathy in patients with Type 2 Diabetes.[6]

Many chiropractors who focus on vertebral subluxa-

tion may wish to choose from a variety of options for assessing ANS adaptability/variability. The number of these options is currently limited. Thus, additional evidence-based options would seem helpful to increase feasibility in chiropractic practice for assessing ANS adaptability.

One way to test a potentially useful option for assessing autonomic variability is to compare it to a gold standard for autonomic variability such as heart rate variability (HRV). One of the main measures in HRV is the standard deviation of normal-to-normal beats (SDNN),[7] having a unit in milliseconds (ms), representing the amount of variability of the heart rate. A higher SDNN value is considered healthier than a lower SDNN value.[2] Another main measure in HRV is mean heart rate. Both of these measures (SDNN and mean heart rate) are considered as ANS markers.

Sessions for HRV testing are typically either 5 minutes or 24 hours. The shorter time frame is an approach commonly used in chiropractic research, in regard to: a) before and after care findings for HRV and pain,[8] b) correlation with health perception,[9] and c) correlation with area of the spine that was adjusted.[10]

One medical study that used the 5 minute approach for HRV found a moderate strength, statistically significant inverse correlation between SDNN and heart rate that was derived from a 10 second electrocardiogram (ECG) recording.[11] While that study used a technology-based method to obtain the resting heart rate (10 second ECG recording), the authors commented on the practical appeal of employing manual methods of heart (pulse) rate for autonomic assessment in routine clinical practice.[11] Other studies using heart rate variability have also shown the inverse relationship between resting heart rate and heart rate variability,[12-15] again using technology-based methods for the derivation of the heart rate. The inverse relationship between SDNN and heart rate means that as heart variability *increases* (considered a neurologically healthy occurrence), pulse rate *decreases* (also considered a neurologically healthy occurrence).

Manual pulse rate as obtained with, say, radial artery palpation, is used for a variety of purposes, including the assessment of "autonomic nervous system tone."[16] A lower pulse rate is considered healthier than a higher pulse rate.[17] One previous study compared the average of four 15 second pulse readings taken manually to HRV (SDNN) and found a moderate strength, statistically significant inverse (expected) correlation between SDNN and the manual pulse rates.[18] The present study further tests this correlation with: a) a different sample of participants, and b) different methods for obtaining the manual pulse readings (two 15 second times instead of four).

The present study further builds on the aforementioned study[18] by comparing: a) SDNN to the mean heart rate derived from the HRV session itself and b) mean heart rate derived in HRV to the manual pulse rates. The manual pulse rate has been shown to be strongly correlated with heart rate derived from technology.[19-20]

The manual pulse rate times used in the present study were 15 seconds. Although 30 seconds is a more common time frame for manual pulse measurement in a health care setting, the differences between pulse rates taken with 15-, 30-, or 60-second time frames have not been found to be statistically significant.[21]

The aim of the present study is to determine what, if any, relationship exists between manual pulse rate and HRV. In particular, pulse rate is compared to the HRV values of SDNN and heart rate (derived from the HRV recording).

Research hypotheses

An inverse relationship was expected between SDNN and pulse rate since lower heart rate is considered neurologically healthier than a higher pulse rate, and a higher SDNN value is considered neurologically healthier than a lower SDNN value. A direct relationship was expected in the secondary analysis comparing the different methods of heart rate measurement.

Methods

Sample characteristics

The study was approved by the Institutional Review Board at Sherman College of Chiropractic. The recruitment of participants at the College consisted of a combination of global emails to all students, along with invitations in the classrooms from the author. Most of the participants within the sample (n = 46) ended up being part of another study on subclinical orthostatic hypotension, the exclusion criteria for which consisted of: a) body mass index greater than 30, b) dizziness upon standing, c) past treatment of psychiatric disorders, d) history of diabetes, and e) age greater than 35 years. No formal exclusion cri-

teria were applied to the two additional participants. All participants were chiropractic students who participated on strictly a voluntary basis.

Examination

The two examination procedures consisted of: 1) A 5 minute HRV exam using a Biopac Heart Rhythm Scanner (Version 1, Clinical Edition, Biocom Technologies, Poulsbo, WA); and 2) Two manually-palpated radial pulse measurements, each taken over a 15-second interval, 15 seconds apart. The readings were timed with a digital timer with the first pulse count beginning on the first target second number on the timer (i.e., starting with beat #1 on the zero second mark). The 15 second results were multiplied by 4 to obtain a beats per minute (BPM) measurement.

After a minimum of 5 minutes rest in the seated position, the two tests (HRV and manual pulse) were performed with the participant continuing to be seated. For pulse rate, the first pulse rate (Pulse 1), as well as the mean of Pulse 1 and the second pulse rate ("mean of Pulse1 and Pulse2") were used in the analysis. From the HRV data, SDNN and mean heart rate ("mean heart rate in HRV") were used.

Data analysis

Pearson's *r* was used to test for a linear association between SDNN and each of the following heart rate methods:

1) Mean heart rate, derived from the 5 minute HRV session (the gold standard measurement of resting heart rate in the present study);
2) Pulse 1;
3) Mean of Pulse1 and Pulse2.

Patient characteristic were also measured. Spearman's correlation coefficient was used to assess for nonlinear, but still monotonically trending, associations between body mass index (BMI) and age. An association between SDNN and sex was examined using a t-test for independent samples. BMI was calculated using the formula cited by the Centers for Disease Control and Prevention based on height, weight, and a conversion factor. [22] In addition, simple linear regression (rather than multiple linear regression, which showed problems with collinearity) was used to test the linear relationship between dependent variable heart rate derived from HRV and the two manual pulse rate methods and to examine the magnitude of the difference in HRV-derived heart rate for every one-unit change in manually assessed pulse rate. Since HRV and pulse rates typically are different for male and female,[23] correlations were also performed by sex.

Analyses were performed in Stata IC 12.1 (StataCorp, College Station, TX). Confidence intervals for correlation coefficients were obtained, and comparisons of correlation coefficients between sexes were performed using an online calculator.[24] Two tailed p-values less than or equal to the traditional alpha level 0.05 were considered statistically significant.

Table 1.
Summary statistics, including patient characteristics. BMI = body mass index. SDNN = standard deviation of normal-to-normal beats in HRV. Pulse 1 and mean Pulse1 Pulse2 are manual methods of pulse measurement.

Variable	n	mean	SD	Min	Max
Age	48	26.4	4.3	20.0	34.0
BMI	48	24.7	3.0	18.8	31.4
SDNN (ms)	48	62.2	31.8	11.9	155.0
Mean HR in HRV	48	71.5	12.3	50.2	106.2
Pulse 1	48	71.9	12.6	48.0	112.0
Mean Pulse1 Pulse2	48	71.7	12.2	50.0	112.0

Results

Data were collected from a total of 48 chiropractic student volunteers (19 female, 29 male; 39.6% and 60.4% respectively), each of whom underwent both HRV and manual radial pulse rate assessments during a single visit. The mean age of the participants was 26.4 years (SD 4.3), with a mean BMI of 24.7 (SD 3.0; Table 1).

Correlation of SDNN and patient characteristics

BMI and age exhibited nonlinear relationships with SDNN according to scatter plot inspection (Figures 1 and

Figure 1.
Scatter plot for SDNN and age.

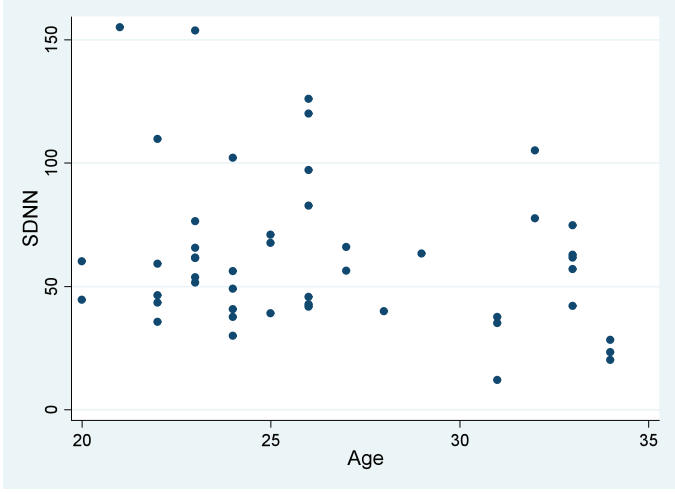


Figure 2.
Scatter plot for SDNN and BMI.

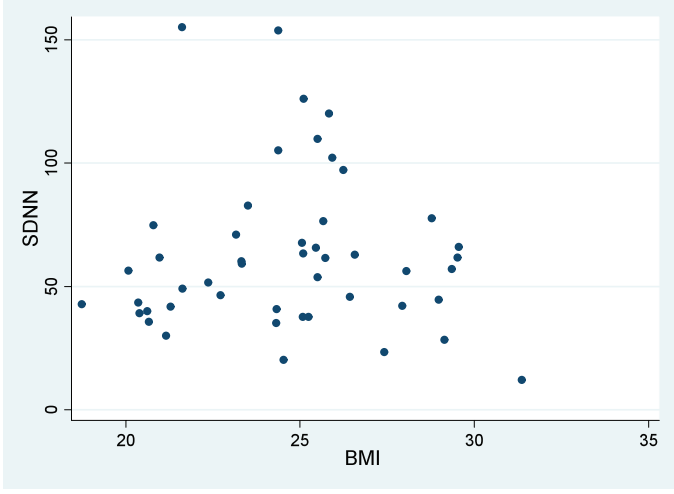


Figure 3.
SDNN and Pulse 1.
As manual pulse rate increases (horizontal axis), SDNN decreases (vertical axis), as expected.

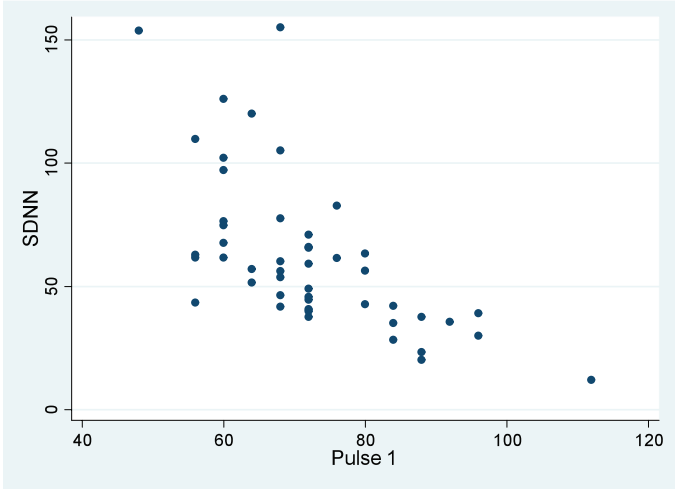


Figure 4.
Mean heart rate (HR) in HRV versus Pulse1 manual pulse rate. As manual pulse increases (horizontal axis), so too does mean heart rate derived from technology in HRV vertical axis), as expected.

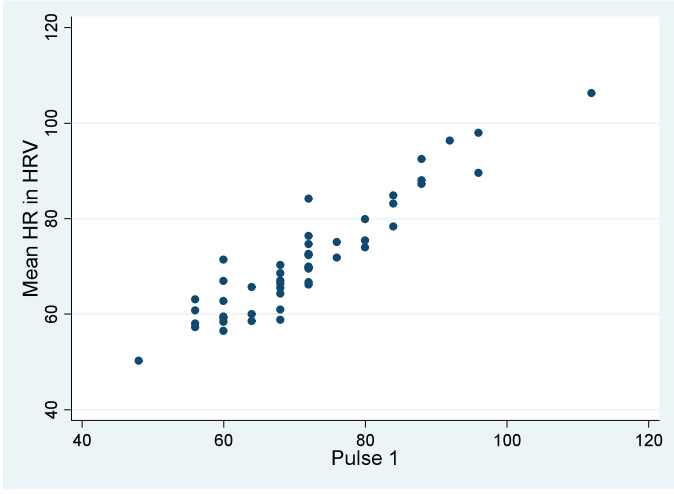


Table 2.
Testing SDNN against three pulse predictors and three patient characteristic variables. Pearson correlation is used for continuous variables exhibiting a linear relationship in their scatter plots (#s 1-3 in list) while Spearman is used for correlations where nonlinear relationships were observed (variables 4-5). CI = confidence interval

Variable	n	r	95% CI for r	p
1) Mean HR in HRV	48	–0.661	–0.795, –0.465	< 0.0001
2) Pulse 1	48	–0.640	–0.781, –0.435	< 0.0001
3) Mean Pulse1Pulse2	48	–0.632	–0.776, –0.425	< 0.0001
4) Age	48	–0.199	–0.457, 0.090	0.1761
5) BMI	48	0.103	–0.186, 0.376	0.4845

2). Correlation coefficients are provided in Table 2. The correlations of age and BMI with SDNN were not statistically significant ($p > 0.05$; Table 2). Mean SDNN for females was 52.8 (95% CI 42.1, 63.4) compared to 68.4 (95% CI 54.8, 82.0) for males, a difference that was not statistically significant ($p = 0.0678$) but potentially clinically important given that the mean difference was 15.6.

Correlation of SDNN and pulse rate

Mean SDNN was 62.2 milliseconds (SD 31.8; Table 1). The different pulse rate measurements showed essentially the same correlations with SDNN. These associations were statistically significant and reflected moderate-strength inverse (expected) relationships between SDNN and the following variables: Mean heart rate in HRV ($r = -0.661$, $p < 0.0001$); Pulse 1 ($r = -0.640$, $p < 0.0001$); Mean Pulse1 and Pulse2 ($r = -0.632$, $p < 0.0001$). The scatter plot in Figure 3 shows, graphically, the relationship between SDNN and Pulse 1.

Since the correlations of the manual methods were so similar, Pulse 1 was arbitrarily selected as the manual pulse method to be correlated with SDNN, stratified by sex. Here, correlation with SDNN revealed similar correlations: $r = -0.676$, $p = 0.0015$ for females; and $r = -0.630$, $p = 0.0003$ for males. The difference between these two correlation coefficients was not statistically significant ($p = 0.8026$).

Relationships between mean heart rate in HRV and manual pulse rate

Mean heart rates for the three methods studied were as follows: a) mean heart rate in HRV: 71.5 BPM (SD 12.3); b) Pulse 1: 71.9 BPM (SD 12.6); and c) mean of Pulse1 and Pulse2: 71.7 BPM (SD 12.2). Very strong and direct correlations were observed between mean heart rate in HRV and both Pulse 1 ($r = 0.934$, $p < 0.0001$; Figure 4) and the mean of Pulse1 and Pulse2 ($r = 0.941$, $p < 0.0001$; Table 3). Since the correlation coefficients were similar for both manual methods, Pulse 1 was again used for correlations by sex with mean heart rate in HRV. Here, similar correlations were found between sexes: $r = 0.950$, $p < 0.0001$ for females; and $r = 0.919$, $p < 0.0001$ for males. The difference between these two correlations was not statistically significant ($p = 0.4354$).

In linear regression analyses using mean heart rate in HRV as the dependent variable, the R-squared value was 0.877 for Pulse 1 and 0.887 for the mean of Pulse1 and Pulse 2. The regression coefficient was 0.91 for Pulse 1 ($p < 0.005$; 95% CI 0.8, 1.0) and 0.95 for the mean of Pulse1 and Pulse2 ($p < 0.005$; 95% CI 0.86, 1.05). This means that for every 1 BPM change in manual pulse rate, the mean heart rate in HRV would also expected to change in the same direction by approximately 1 BPM.

Discussion

In regard to SDNN, the heart rates (mean heart rate in HRV, Pulse 1, and mean Pulse1 and Pulse2) revealed the

Table 3.
Testing mean heart rate in HRV against the two manual pulse methods using Pearson correlations (r, p for r) and linear regression (coefficient, p for regression coefficient). MP1P2 = mean pulse 1 pulse 2. P1 = Pulse 1. CI = confidence interval.

		Pearson			*Linear regression*		
Covariable	**n**	**r**	**95% CI for Pearson r**	**p**	**Coefficient**	**95% CI for regression coefficient**	**p**
MP1P2	48	0.941	0.897, 0.966	< 0.0001	0.95	0.86, 1.0	< 0.001
P1	48	0.934	0.885, 0.962	< 0.0001	0.91	0.82, 1.0	< 0.001

expected (inverse) relationships with SDNN. That is, a lower pulse (considered neurologically healthier than a higher pulse) is related to higher heart rate variability (considered neurologically healthier than lower HRV). Age, sex, and BMI did not have associations with SDNN that were statistically significant, although there was a nearly statistically significant difference in SDNN between males and females. This nearly significant finding is consistent with findings in another study that used a 24 hour monitoring protocol.[23] There, a significant mean difference of 35 milliseconds SDNN was observed between males and females aged 10-29 years, and a smaller mean difference of 17 milliseconds SDNN was observed between males and females aged 30-49 years.[23] In the present study, the analysis was not stratified by age group, however a difference of 15.6 milliseconds SDNN was observed between sexes. Interestingly, other research using the same HRV technology used in the present study did not find a statistically significant mean difference in SDNN between sexes.[25] In any event, the present study did not show that sex had an effect on the strength or significance of the correlations between manual pulse rate with the HRV findings (SDNN and mean heart rate in HRV).

The present study revealed statistically significant correlations between manual and technology based pulse rate measurements, which may in turn be useful proxy measures of autonomic variability, and potential changes in autonomic variability after vertebral adjustment. Even aside from its correlation with heart variability, manually assessed pulse rate stands on its own as a marker for autonomic health in other studies. Correlations between the manual pulse rate methods and mean heart rate in HRV were very strong (and statistically significant) as expected.

One of the strengths of the current study is that the count method for the manual pulse reading began with "1" instead of "zero" on the zero second mark. In this regard, pulse rate measurement using the former method (starting with "1" count on the zero second mark) has been shown to be more strongly associated with heart rate derived from ECG.[21]

Admittedly, a formal sample size calculation was not conducted in advance of the study. However, *a posteriorly*, it was determined that in order to detect a statistically significant, moderate-strength correlation (e.g., absolute value of *r* between 0.400 and 0.700), a sample size of 24 would be needed.[26] Consequently, for at least a moderate strength correlation, the sample size in the present study appeared to be adequate.

In linear regression, the average change in pulse rates was essentially a 1:1 ratio between mean heart rate in HRV and either of the manual pulse rate methods. However, mean Pulse1 Pulse2 showed a slightly stronger association with the presumed gold standard for heart rate in this study (i.e., heart rate derived from HRV), which suggests that the average of two pulse rate measurements may be the preferred method over any single determination in future studies.

Limitations to the study are that the participants comprised a convenience sample and were relatively healthy, making the generalizability of these findings to other patient populations limited. Additionally, p-values were not adjusted for multiple hypothesis tests. However even if multiple testing had been adjusted for, these findings

would remain statistically significant due to the already-existing very low p-values in correlation and regression results.

Conclusion

In this study of relatively healthy chiropractic students, manual pulse rates showed: a) a moderate inverse correlation with the SDNN value in heart rate variability, and b) a strong direct correlation with heart rate derived from HRV technology. Manual pulse rate determinations may be a useful proxy measure for chiropractors and chiropractic researchers seeking to assess the global neurological effect of vertebral adjustment on putatively diagnosed vertebral subluxation. Additional research involving more representative patient populations are needed to verify the findings derived from the current study. Further studies to assess the association between manual pulse rate and both health status and clinically significant changes in health status following vertebral adjustment are also needed.

References

1. Winterstein J. Semantics. Outreach. National university of Health Sciences. October/November 2003: 1, 3.
2. Lauer MS. Autonomic function and prognosis. Clev Clin J Med. 2009; S18-S-22.
3. Stephenson RW. The Chiropractic Text Book. Davenport, IA: Palmer School of Chiropractic. 1927, p. 203.
4. Lipsitz LA, Goldberger AL. Loss of 'complexity' and aging. Potential applications of fractals and chaos theory to senescence. JAMA. 1992; 268(8):984.
5. Hart JF, Boone WR. Pattern analysis of paraspinal temperatures: a descriptive report. J Vert Sublux Res. 1999-2000; 3 (4):1-8.
6. Okada H, et al. Visit-to-visit variability in systolic blood pressure is correlated with diabetic nephropathy and atherosclerosis in patients with type 2 diabetes. Atherosclerosis. 2011; 220:155-159.
7. Szajzel J. Heart rate variability: a noninvasive electrocardiographic method to measure the autonomic nervous system. Swiss Med Wkly. 2004; 134: 514-522.
8. Zhang J, Dean D, Nosco D, Strathopulos D, Floros M. Effect of chiropractic care on heart rate variability and pain in a multisite clinical study. J Manip Physiol Ther. 2006; 29: 267-274.
9. Hawk C, Zhang J. The relationship of heart rate variability to health status and health behavior. Top Integr Health Care. 2011; 2(2) ID: 2.2004.
10. Welch A, Boone R. Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine. J Chiropr Med. 2008; 7(3): 86-93.
11. Nussinovitch U, et al. The efficiency of 10-second resting heart rate for the evaluation of short-term heart rate variability indices. Pace. 2011; 34:1498-1502.
12. Carney RM, Rich MW, teVelde A, Saini J, Clark K, Freedland KR. The relationship between heart rate, heart rate variability and depression in patients with coronary artery disease. J Psychosom Res. 1988; 32(2):159-164.
13. Van Hoogenhuyze D, et al. Reproducibility and relation to mean heart rate of heart rate variability in normal subjects and in patients with congestive heart failure secondary to coronary artery disease. Am J Cardiol. 1991; 68(17): 1668-1576.
14. Ramaekers D, Ector H, Aubert AE, Rubens A, Van de Werf F. Heart rate variability and heart rate in healthy volunteers. Eur Heart J. 1998; 19: 1334-1341.
15. Soliman EZ, Elsala, MA, Li Y. The relationship between high resting heart rate and ventricular arrhythmogenesis in patients referred to ambulatory 24 h electrocardiographic recording. Europace. 2010; 12: 261-265.
16. Hsia J, et al. Resting heart rate as a low tech predictor of coronary events in women: prospective cohort study. BMJ. 2009; 338:b219.
17. Verrier RL, Tan A. Heart rate, autonomic markers, and cardiac mortality. Heart Rhythm. 2009; 6(11 Suppl): S68-S75.
18. Hart J. Association between heart rate variability and novel pulse rate variability methods. Ann Vert Sublux Res. 2012 (Jul 9): 65-71.
19. Erikssen J, Rodahl K. Resting heart rate in apparently healthy middle-aged men. Eur J Appl Physiol Occup Physiol. 1979; 42(1):61-69.
20. Runcie CJ, Reeve W, Reidy J, Dougall JR. A comparison of measurements of blood pressure, heart rate and oxygenation during inter-hospital transport of the critically ill. Intensive Care Med. 1990; 16 (5):317-322.
21. Hwu YJ, Coates VE, Lin FY. A study of the effectiveness of different measuring times and counting methods of human radial pulse rates. J Clin Nurs. 2000; 9: 146-152.
22. Healthy weight – it's not a diet, it's a lifestyle. Centers for Disease Control and Prevention. [Cited 2013 Mar 28]. Available from: http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#Interpreted
23. Umetani K, Singer DH, McCRaty R, Atkinson M. Twenty-four hour time domain heart rate variability and heart rate: Relations to age and gender over nine decades. J Am Coll Cardiol. 1998; 31:593-601.
24. Lowry R. VassarStats: Website for statistical computation. Vassar College. [Cited 2013 May 15-16]. Available from: http://vassarstats.net/
25. Zhang J, Effect of age and sex on heart rate variability in healthy subjects. J Manip Physiol Ther. 2007; 30(5): 374-379.
26. Baldi B, Moore DS. The practice of statistics in the life sciences. New York: Freeman. 2009: 721.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/251–259/$2.00/©JCCA 2013

Knowledge and management of Adolescent Idiopathic Scoliosis among family physicians, pediatricians, chiropractors and physiotherapists in Québec, Canada: An exploratory study

Jean Théroux, DC, MSc[1]
Guy Grimard, MD, MSc[1,2]
Marie Beauséjour, PhD[1,5]
Hubert Labelle, MD[1,3]
Debbie Ehrmann Feldman, PT, PhD[4,5]

Background: *Health professionals (HPs) are likely to encounter adolescent idiopathic scoliosis (AIS) patients. Best practice dictates that early detection leads to better decision making regarding optimal management. The aim of our study was to appraise the basic knowledge, evaluation and management skills concerning AIS care among family physicians, pediatricians, chiropractors, and physiotherapists.*

Methods: *A semi-structured questionnaire including 3 clinical scenarios was developed. Telephone interviews were conducted with 51 HPs to assess their knowledge of the clinical signs, risk factors, and management options of AIS and their preferences in clinical guidelines for AIS care.*

Results: *The majority of HPs (70-90%) would refer the patient who required prompt referral, but only 38-60% actually rated the case as requiring prompt referral. Forty percent of HPs (predominantly physiotherapists and family physicians) stated that they would not be comfortable providing AIS patient follow-up. Access to specialized care was considered a problem, and nearly all believed that establishment of clinical guidelines would be beneficial.*

Antécédents: *Les patients porteurs d'une scoliose idiopathique (SI) peuvent être évalués par différents professionnels de la santé. La bonne pratique nous dicte qu'une détection précoce mène à une prise en charge optimale. Le but de notre étude visait à évaluer les connaissances en lien avec l'évaluation clinique et la prise en charge des patients scoliotiques parmi les médecins de famille, les pédiatres, les chiropraticiens et les physiothérapeutes.*

Méthodologie : *Nous avons conçu un questionnaire semi-structuré incluant 3 scénarios cliniques. Des entrevues téléphoniques ont été effectuées auprès de 51 professionnels de la santé. En plus d'évaluer leurs connaissances en lien avec les signes cliniques, les facteurs de risques et la prise en charge des patients, nous avons voulu mesurer leurs préférences dans l'élaboration éventuelle d'un guide de bonnes pratiques.*

Résultats : *En présence d'un patient nécessitant une évaluation en soin spécialisé, 70 à 90 % des professionnels sont en accord avec l'importance de la référence. Néanmoins, seulement 38 à 60 % de ceux-ci ont bien identifié le cas nécessitant une référence. Les professionnels (40 %), particulièrement les médecins*

[1] Research Center, Sainte-Justine University Hospital Center, Montréal, Québec, Canada;
[2] Department of Surgery, Université de Montréal, Montréal, Québec, Canada
[3] Faculté de médecine, Université de Montréal, Montréal, Canada
[4] École de réadaptation, Université de Montréal, Montréal, Canada
[5] Institut de recherche en santé publique, Université de Montréal, Montréal, Canada
Correspondence: Jean Théroux, CHU Sainte-Justine, Unité de recherche clinique en orthopédie URCO, 3175 Côte-Ste-Catherine, local 1102A, Montréal, Québec, Canada H3T 1C5 Tél : 514-345-4931 extension 5870 Fax : 514-345-4783 jean.theroux@gmail.com

This study was funded by a grant from the Canadian Institutes of Health Research (operating grant 86491, 2008-2011). Dr. Feldman holds a senior career award from the Fonds de recherche du Québec en santé.

Conclusions: *Considerable gaps exist regarding the knowledge of the clinical signs and risk factors of AIS. The importance of a patient in need of a prompt referral is recognized by the majority of the HPs, but they believe that there are problems regarding accessibility to a specialist. Interprofessional collaboration is discussed as a promising approach to improve the management of AIS.*

généralistes et les physiothérapeutes, ne semblent pas à l'aise à effectuer le suivi clinique. L'accessibilité aux soins spécialisés est perçue comme un problème. L'élaboration d'un guide de pratique serait bénéfique.

Conclusion : *Il existe des lacunes considérables à l'égard des connaissances des signes cliniques et des facteurs de risque en lien à la scoliose idiopathique de l'adolescent. La majorité des professionnels reconnaissent l'importance de référer un cas urgent mais notent les difficultés d'accessibilité des spécialistes. La collaboration interprofessionnelle apparait comme une avenue prometteuse pour améliorer la prise en charge de ces patients.*

KEY WORDS: adolescent idiopathic scoliosis, education, musculoskeletal system, health professionals, clinical signs, risk factors

MOTS CLÉS: scoliose idiopathique adolescente, éducation, système musculosquelettique, signes cliniques, facteurs de risques, professionnels de la santé

Introduction

Musculoskeletal conditions account for approximately 20% of visits in primary-care settings and emergency rooms.[1,2] The health care professionals (HPs) most likely to see these patients are chiropractors, family physicians, and physiotherapists.[3] Musculoskeletal related conditions including scoliosis compose between 10 and 37%[4,5] of office visits to family physicians and account for approximately 85% of chiropractor visits. Children and adolescents seeking care for musculoskeletal conditions are likely to be seen by family physicians or pediatricians[5] but may be seen by chiropractors[6,7] or physiotherapists.[8] These HPs should have proficiency and clinical competence regarding the management and appropriate referral of scoliotic patients.[9]

A number of studies in different countries have assessed the knowledge HPs have of musculoskeletal conditions.[1,4,8,10-13] A basic competency examination was developed to evaluate medical students' fundamental musculoskeletal system knowledge[1] including knowledge of non-traumatic (low back pain, osteoarthritis, and arthralgia) and traumatic conditions (sprains of the neck/back, wrist, hand, and fingers, and fractures). These studies suggest that medical students and recent medical graduates fail to demonstrate basic competency in musculoskeletal system medical care. While physiotherapy[8] and osteopathy students[11] performed better than medical students on the identical exam, most did not achieve a passing grade. The chiropractic students were the most successful group in attaining the passing grade of 73%.[12]

This study assesses the knowledge and management of adolescent idiopathic scoliosis (AIS), a three-dimensional deviation of the spine of unknown cause with a prevalence that varies with age and sex. It is much more common in girls, with a peak prevalence of approximately 1.2% at age 12.[14] The severity of the curvature of the spine is commonly described using the Cobb angle measure. The prevalence of severe scoliosis, defined as a Cobb angle >40°, is estimated at 0.1%.[14] Undiagnosed AIS could lead to serious morbidity and, in extreme cases, mortality.[14] The important clinical signs to consider upon the initial and follow-up evaluations of a patient with AIS include shoulder and pelvis obliquity, the presence of a rib hump (assessed by the Adams forward bending test), waistline (flanks) symmetries, and apparent asymmetries of the thoracic and thoracolumbar spine.[15] Depending on the severity and potential for progression, the recommended treatments for AIS are conservative (observation, exercises, and bracing) or surgical. The important factors in a decision on treatment strategy include gender, the curve magnitude at presentation, the skeletal maturity and, in females, the menarchal status.[15-17] Current best practice dictates that early detection of AIS leads to better deci-

Table 1.
Socio-demographic aspects of health professionals

	Gender (female %)	Age ≤ 40 (%)	Mean years of practice (sd)	Specialisation (%)	Rural practice (%)	Group practice (%)	# treatment > 75
Chiropractors (10)	4 [40]	6 [60]	15.60 [10.64]	2 [20]	6 [60]	5 [50]	3 [30]
Pediatricians (10)	5 [50]	2 [20]	25.80 [11.37]	N/A	6 [60]	10 [100]	5 [50]
PTs (10)	8 [80]	6 [60]	15.10 [10.46]	4 [40]	5 [50]	10 [100]	0 [0]
FPs (21)	13 [62]	8 [38]	22.43 [12.06]	6 [29]	10 [48]	21 [100]	11 [52]

PT: physiotherapists, FP: family physicians

sion making regarding the course of conservative treatment and whether surgery can be avoided.[18] Recognition of more than one clinical sign usually results in a more appropriate referral strategy.[19]

The objectives of our study were (1) to assess the level of knowledge about AIS among HPs; (2) to compare the level of knowledge across different groups of HPs; and (3) to determine how these HP evaluated patients with AIS and their course of management.

Methods

Design: We designed an exploratory cross-sectional study. Interviews were conducted with 51 health professionals.

Context: The participants were identified through respective professional regulatory boards from regions in the province of Québec. The main pediatric orthopedic referral centers in Québec are located in the major metropolitan areas of Montréal, Québec, and Sherbrooke. Patients who reside in the western part of the province may be referred to the pediatric hospital in Ottawa. We purposely selected professionals for the study who practiced near or distant from these centers to account for possible variation in the prevalence of scoliosis and in the ability of patients to access specialized orthopedic care. We hypothesized that patient access to specialized care might have an influence on the level of AIS knowledge and management of AIS by HPs. Written informed consent was obtained prior to the telephone interviews. The CHU Ste-Justine ethics committee approved the study.

Participants: We explored the AIS knowledge and management of licensed health care professionals in Quebec. Our aim was to recruit 20 family physicians, 10 pediatricians, 10 chiropractors, and 10 physiotherapists. To accomplish this objective, we randomly selected 60 family physicians, 30 pediatricians, 30 chiropractors, and 30 physiotherapists. The rationale for selecting more family physicians was that there are many more family physicians than pediatricians, chiropractors, and physiotherapists.

Material: We developed a semi-structured questionnaire in collaboration with an orthopedist who specializes in AIS, a physiotherapist and a chiropractor. We pretested the questionnaire with four HPs and adjusted the questionnaire accordingly prior to the study. The questionnaire included the following aspects: the demographics, knowledge about AIS (the clinical signs, risk factors, and treatment options), the referral process, inter-professional relationships and awareness of the usual clinical management of scoliosis. Three clinical vignettes were developed to assess the management options. The two vignettes that were considered manageable cases by the HPs were of a 14-year-old girl and a 17-year-old girl who had menstrual periods for at least 2 years; one had a 30° (with associated dorsal pain) thoracic scoliosis, and the other had 22° thoracic scoliosis, and they primarily required observation.[20,21] The third vignette was a "clear cut" case for referral and involved an 11-year-old girl who had not yet menstruated, with a 22° thoracic scoliosis, who required close follow-up to evaluate proper treatment.[22,23]

Procedure: All the telephone interviews were conducted by the principal investigator and lasted approximately 30 minutes. All the interviews were recorded and transcribed.

Analysis: Count and percentages were reported.

Results

Fifty-one health professionals were interviewed including 21 family physicians, 10 chiropractors, 10 pediatricians, and 10 physiotherapists (Table 1). Approximately

Table 2

Major clinical signs	Major risk factors
Shoulder levelling	Female gender
Pelvis levelling	Bigger curve magnitude at presentation
Rib hump (Adams test)	Lower skeletal maturity
Postural asymmetry	Menarchal status

one-half (47%) of the participants were from regions with a specialized pediatric center. More than one-half (59%) were female, and 43% were younger than 40 years. The mean number of years of practice was 20.3 with a range from 2–46 years. All except one pediatrician graduated from a Canadian university. Most HP belonged to a group practice (90%) averaging 31 to 40 hours/week, and 37.25% treat >75 patients/week. Vertebral problems are seen by the majority of the HP (80%), with low back pain being the most frequent complaint, and all HP except one had seen scoliotic patients.

Knowledge

We assessed the level of clinical knowledge by the ability to recognize the important clinical signs and risk factors of the progression of scoliosis (Table 2), the diagnostic evaluation and the management options.

When evaluating a patient with suspected scoliosis, using more than one clinical sign typically results in a lower referral rate.[19] Among all the professionals, 63% could mention a minimum of 2 clinical signs. The physiotherapists and family physicians appeared to be less knowledgeable compared with the pediatricians. The chiropractors had an overall better knowledge compared to the physiotherapists and family physicians, but not compared to the pediatricians. Only 43% of the interviewed professionals could mention 3 of the 4 aforementioned signs. Of all the interviewed professionals, only 5 (9.8%) could mention all four signs (Table 3).

The risk of progression is important to consider for treatment planning in AIS. Considering all the professionals, 72.6% were unaware of any risk factors that could affect scoliosis progression, and 27.5% could identify a minimum of one risk factor. There were differences between the professionals; the family physicians were the least knowledgeable concerning the risk factors, and only 5% could identify a minimum of one risk factor. The corresponding percentages were 70% among the pediatricians, 50% among the chiropractors, and 10% among the physiotherapists (Table 3).

We assessed whether knowledge differed between the professionals who practiced in areas that had specialized pediatric orthopedic services for scoliosis versus those who practiced in regions that did not have these services. There were no noticeable differences between the groups regarding knowledge of the clinical signs and risk factors. Among those practicing in areas where pediatric orthopedic services were available, 58.3% knew a minimum of 2 clinical signs, and 8.3% knew a minimum of 2 risk factors. In those who practiced in rural regions that did not have specialized orthopedic services, the corresponding percentages were 66.6 and 11.1.

Table 3.
Assessment of knowledge
HP knowledge of either 0, 1, 2, 3 or 4 clinical signs or risk factors

	Number of clinical signs					Number of risk factors				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
Chiropractors	2 [20]	8 [80]	5 [50]	5 [50]	2 [20]	5 [50]	4 [40]	1 [10]	0 [0]	0 [0]
Pediatricians	0 [0]	10 [100]	9 [90]	6 [60]	1 [10]	3 [30]	7 [70]	3 [30]	2 [20]	1 [10]
PTs	1 [10]	9 [90]	4 [40]	2 [20]	1 [10]	9 [90]	1 [10]	0 [0]	0 [0]	0 [0]
FPs	2 [9.52]	19 [90.48]	14 [66.66]	9 [42.86]	1 [4.46]	20 [95.24]	1 [4.76]	1 [4.46]	1 [4.76]	0 [0]
All HCP	5 [9.80]	46 [90.2]	32 [62.75]	22 [43.13]	5 [9.80]	37 [72.56]	13 [25.49]	5 [9.80]	3 [5.88]	1 [1.96]

HCP: health care professionals; PT: physiotherapists; FP: family physicians

Table 4.
Management options regarding adolescent idiopathic scoliosis

	Would they follow this patient themselves [%]	Would this patient be referred out [%]	Possibility of Progression [%]	Urgency [%]
Vignette 1: 14 year old girl who had her menarche 2 years ago and a right thoracic scoliosis of 30° with dorsal pain				
Chiropractors (n=10)	7 [70]	5 [50]	7 [70]	0
Pediatricians (n=10)	1 [10]	8 [80]	4 [40]	3 [30]
PTs (n=10)	4 [40]	5 [50]	4 [40]	1 [10]
FPs (n=21)	2 [9.5]	21 [100]	6 [28.60]	1 [4.8]
Vignette 2: 11 year old girl not menstruated yet with a 22° thoracic scoliosis				
Chiropractors	6 [60]	7 [70]	5 [50]	5 [50]
Pediatricians	1 [10]	9 [90]	5 [50]	6 [60]
PTs	1 [10]	7 [70]	4 [40]	6 [60]
FPs	1 [4.8]	17[81]	9 [43]	8 [38]
Vignette 3: 17 year old girl who started her menses five years ago with a 22° thoracic scoliosis				
Chiropractors	9 [90]	1 [10]	0	0
Pediatricians	4 [40]	5 [50]	0	0
PTs	7 [70]	5 [50]	0	0
FPs	13 [62]	8 [38]	0	1 [4.8]

PT: physiotherapists; FP: family physicians

In terms of the diagnostic evaluation, standing simple radiographic examination is considered the usual diagnostic evaluation to establish the initial diagnosis[24], and most HPs realized its importance.

We evaluated the management options via the presentation of three clinical vignettes (Table 4). Vignettes 1 and 3 were cases that are considered to be manageable by the professional.[20,21] Pediatricians, chiropractors, and physiotherapists were more inclined to provide the follow up with the 17-year-old girl (vignette 3) with a painless scoliosis of 22° than to follow the case of the 14-year-old girl (vignette 1) with a 30° scoliosis associated with dorsal pain. The family physicians had a similar course of action towards both patients but were more likely to refer them to an orthopedist. Vignette 2 – the 11-year-old girl with a 22° curve – would require referral to an orthopedist[22,23] and is a more urgent case for possible intervention. Only 38% of the family physicians felt that it was important to refer this patient, and the percentages were higher for the chiropractors (50%), pediatricians (60%), and physiotherapists (60%).

The majority of the professionals (86.3%) in the study were aware of the available treatments for scoliosis, with bracing and surgery being the most commonly mentioned treatments. Nonetheless, 19% of the family physicians failed to list any current treatment strategy.

Management

We asked the clinicians whether they felt comfortable managing patients with scoliosis, whether they perceived problems with access to specialized care, and their opinion regarding development of guidelines for managing scoliotic patients.

Approximately 40% of the professionals states that they would be comfortable providing the clinical follow-up for a patient with a scoliosis. There were differences between the professional groups, with 40% of the pediatricians, 90% of the chiropractors, 24% of the family physicians and 20% of the physiotherapists being comfortable in assuming the clinical follow-up for these patients.

In terms of accessibility to specialized care, a majority of the professionals (88.2%) realized the importance of

referring patients to an orthopedic surgeon who specialized in scoliosis care. Except for the pediatricians, most felt that this action was problematic in terms of delays in obtaining an appointment with a specialist. The chiropractors and physiotherapists felt that access to a specialist was complicated because the majority of orthopedists only accept referrals from physicians, implying that they would be required to recommend that their patients contact a FP for referral to an orthopedic specialist.

When considering the awareness of the clinical signs, risk factors, effective treatment strategies and personal comfort in managing scoliosis patients, no noticeable differences were noted between the HPs who were near or distant from a major referral center. Ninety-eight percent of the professionals agreed that the development of clinical guidelines was essential and would be beneficial for clinical decision making. One-quarter of the respondents felt that the professional regulatory boards should publish these clinical guidelines, while 73% suggested that they be formulated by a multidisciplinary panel headed by orthopedists specializing in pediatric care. Over one-half favored publication of the guidelines in a booklet format that includes a decisional algorithm.

Discussion

The professionals who are most likely to encounter patients with AIS should have basic knowledge of the condition and the ability to recognize those who require urgent referral to orthopedic specialists. Our study indicated that there were considerable gaps in this knowledge, especially with respect to the clinical signs and risk factors for curve progression. The physiotherapists and family physicians were less aware of the important risk factors, compared with the chiropractors and pediatricians. Although the majority of the professionals interviewed recognized the need to refer an urgent case, they felt that there were problems with respect to access to a pediatric orthopedic specialist.

The family physicians and pediatricians comprise an important port of entry into the health care system for children and adolescents.[25] In the United States, family physicians care for 16-26% of children under 18 years of age.[26] A number of studies acknowledge a lack of confidence in their own musculoskeletal knowledge expressed by family physicians and pediatricians.[5,27] We found that only 66% of the family physicians could mention 2 of the 4 clinical signs of AIS. This percentage was higher with pediatricians (90%). Knowledge of the risk factors was considerably lower, and only 5% of the family physicians and 70% of the pediatricians could mention at least one risk factor. Being less aware of the clinical signs and less able to follow manageable patients could increase unnecessary referrals to the specialized services that are overwhelmed with patients.[28,29] We found that approximately 75% of the professionals would have referred the "borderline" patient (vignette 1) and that 37% would have referred the "clear-cut manageable" patient (vignette 3), although they agreed that progression was improbable.

Regarding the referral of the "clear-cut" case (vignette 2), the majority of professionals would refer this type of patient, although less than one-half felt that there was a possibility of curve progression in such patients. Considering this percentage, it is difficult to explain the reasons for this type of referral.

The professionals in the study were uncomfortable with providing patient follow-up, and less than 50% would be inclined to see these patients on a regular basis. The chiropractors appeared to be most comfortable providing AIS follow-up, and the reasons for this finding might be that chiropractic education focuses on spinal disorders and that chiropractors have access to radiology. Inappropriate referral of spinal problems contributes to congestion in the health care system. Access to specialized care was a major issue for the professionals, especially for the physiotherapists and chiropractors. They usually are required to refer their patients to family physicians although they may be less proficient at managing these patients, which increases the indirect costs and causes delays in specialized care that may have detrimental effects on the patient.[30]

When health professionals treat adolescents, they should be able to perform a routine back evaluation to screen for common back problems such as scoliosis, kyphosis or other spinal conditions.[31] This evaluation requires basic knowledge of the clinical signs and risk factors of spinal conditions. If scoliosis is suspected, the most prevalent clinical signs and risk factors should guide the decision as to whether the patient is manageable by the clinician or requires referral because of a high risk of curve progression.[16]

All the professionals, especially the family physicians (100%), had a greater tendency to refer the patient in

vignette 1 compared to the patient in vignette 3. Even though the patient in vignette 1 had associated back pain, both patients (vignettes 1 and 3) are considered manageable by the health care professionals.[20,21] Back pain is a common occurrence in AIS, but it is rarely associated with spinal pathology[32] and does not influence the risk of progression[33]; it should not account for systematic referral.[32]

Knowledge is important, as is the willingness to provide care of "manageable" patients with scoliosis. Adolescents with AIS should be seen on a regular basis and evaluated to ensure that the condition is stable. They frequently need reassurance and counseling throughout the follow-up period.[34]

One way to improve the knowledge of professionals who are likely to encounter patients with musculoskeletal conditions is to provide better training at the university level. Over the last decade, many studies have investigated the curriculum of the professional schools for a better understanding of the material that is being taught and ways in which education on musculoskeletal conditions can be improved.[1,2,4,35]

Pinney[36] evaluated the musculoskeletal curriculum of sixteen Canadian medical schools and concluded that approximately 2.26% of the curriculum was devoted to musculoskeletal education. Much of the teaching is dispensed by non-musculoskeletal specialists, which may be problematic.[37]

Sandefur[38] and Humphrey[12] determined that chiropractic students surpass medical students in musculoskeletal competencies. Physiotherapy students and osteopathy students performed better than medical students, but 66% and 67% of them, respectively, failed to achieve a passing grade.[8,11] In our study, we found deficits in knowledge in the chiropractors and physiotherapists, but the chiropractors were more knowledgeable than the physiotherapists with respect to the clinical signs and risk factors of scoliosis.

In addition to improving knowledge, interprofessional collaboration may be a method for enhancing healthcare delivery problems for persons with AIS. Chiropractors and physiotherapists can constitute a port of entry into the healthcare system, particularly when musculoskeletal complaints are involved. The use of other professionals who have proficiency in the musculoskeletal area might be an efficient way to manage scoliosis and other musculoskeletal conditions and help relieve some of the significant systemic problems of healthcare access.[39] Allowing specialists to accept referrals from other HCPs may improve efficiency.

Limitations

The goal of this study was to explore the knowledge and approaches of various professional groups regarding AIS. The small sample size may limit generalization, but it did permit more in-depth examination of these issues. We randomly selected professionals from distinct Québec regions where accessibility to specialized care varies to explore the differences dependent on resource availability. However, this process does not ensure representativeness of all HPs. The use of a semi-structured questionnaire with closed and open-ended questions enabled a broader understanding of the thinking process of the participants. Although our questionnaire was developed by a team of HP and researchers and pre-tested, it has not undergone a rigorous validation process. The inclusion of vignettes provided the participant with the opportunity to elaborate on decision making and is especially useful in situations in which low prevalence cases are involved[40]. We cannot be certain if the responses to these vignettes reflect the actual behavior of professionals.

The professionals who agreed to participate may be those who have a greater interest in improving individual practice and knowledge, and they may be more knowledgeable about musculoskeletal conditions. Being aware of the key theme of the research, the participants would have been able to prepare for the interview. In such a case, an alarming hypothesis is that our results may actually underestimate the deficits in knowledge regarding AIS care.

Clinical implications

Certain clinical implications can be drawn from our study. Considering that adolescent population, in Canada, is approximately 6 million with an AIS prevalence of 2 – 3 %, between 120 000 – 180 000 adolescents will suffer from this condition. In Québec, it amounts to 28 000 – 42 000 adolescents. Fortunately, the majority of them will not require surgery but primarily clinical follow-up. The improvement of musculoskeletal knowledge for those professionals, mainly family physicians and physiotherapists is vital. Evidence points to a better information

program and to the development, of clinical guidelines to help these HPs in dealing with these patients.

The association between acquiring knowledge and the willingness of using that knowledge is not self-evident. Chiropractors and physiotherapists' implications should be reassessed especially chiropractors who have radiological training.

Clearly, there appears to be problems with respect to Interprofessional collaboration. Barriers exist with respect to willingness and acceptability of referral. Both attitudes and established procedures need to be revisited.

Conclusion

Our study indicated that there were considerable deficits among the study participants in knowledge of the clinical signs and risk factors for curve progression in AIS. Although the majority of the professionals interviewed recognized the need to refer an urgent case, they felt that there were problems with respect to access to a pediatric orthopedic specialist. Interprofessional collaboration may be a promising approach to improve the management of these patients. We would suggest improved clinical training in the musculoskeletal field and development of continuing education in AIS for primary care practitioners. Future research should assess the impact on the population regarding delays in referral and costs to the system with respect to surgeries that may have been preventable. A possible solution that should be investigated is having primary care follow-up of patients with AIS done by chiropractors who are well-versed in musculoskeletal conditions and who know how to deal with AIS and when to refer to orthopedists. Finally, clinical research in AIS, such as management of such problems as back pain is an area that we are currently exploring.

The author acknowledges the support of Marjolaine Roy-Beaudry and Isabelle Turgeon from the CHU Sainte-Justine.

This study was funded by a grant from the Canadian Institutes of Health Research (operating grant 86491, 2008-2011). Dr. Feldman holds a senior career award from the Fonds de recherche du Québec en santé.

References

1. Freedman KB, Bernstein J. The adequacy of medical school education in musculoskeletal medicine. J Bone Jt Surg Am. 1998; 80(10): 1421-7.
2. Freedman KB, Bernstein J. Educational deficiencies in musculoskeletal medicine. J Bone Jt Surg Am. 2002; 84-A(4): 604-8.
3. Chevan J, Riddle D. Factors associated with care seeking from physicians, physical therapists, or chiropractors by persons with spinal pain: a population-based study. J Ortho Sports Physical Ther. 2011; 41(7): 467-76.
4. Lynch JR, Schmale GA, Schaad DC, Leopold SS. Important demographic variables impact the musculoskeletal knowledge and confidence of academic primary care physicians. J Bone Jt Surg Am. 2006; 88(7): 1589-95.
5. Jandial S, Myers A, Wise E, Foster HE. Doctors likely to encounter children with musculoskeletal complaints have low confidence in their clinical skills. J Pediatrics. 2009; 154(2): 267-71.
6. Marchand AM. Chiropractic care of children from birth to adolescence and classification of reported conditions: an internet cross-sectional survey of 956 European chiropractors. J Manip Physiol Ther. 2012; 35(5): 372-80.
7. Ndetan H, Evans M, Hawk C, Walker C. Chiropractic or osteopathic manipulation for children in the United States: an analysis of data from the 2007 National Health Interview Survey. J Altern Complement Med. 2012; 18(4): 347-53.
8. Childs JD, Whitman JM, Sizer PS, Pugia ML, Flynn TW, Delitto A. A description of physical therapists' knowledge in managing musculoskeletal conditions. BMC Musculoskeletal Disorders. 2005; 6: 32-.
9. Cherkin DC, Deyo RA, Sherman KJ, et al. Characteristics of visits to licensed acupuncturists, chiropractors, massage therapists, and naturopathic physicians. J Am Board Fam Pract. 2002; 15(6): 463-72.
10. Day CS, Yeh AC. Evidence of educational inadequacies in region-specific musculoskeletal medicine. Clinical Ortho Rel Res. 2008; 466(10): 2542-7.
11. Stockard AR, Allen TW. Competence levels in musculoskeletal medicine: comparison of osteopathic and allopathic medical graduates. J Am Osteo Assoc. 2006; 106(6): 350-5.
12. Humphreys BK, Sulkowski A, McIntyre K, Kasiban M, Patrick AN. An examination of musculoskeletal cognitive competency in chiropractic interns. J Manip Physiol Thera. 2007; 30(1): 44-9.
13. Jandial S, Rapley T, Foster H. Current teaching of paediatric musculoskeletal medicine within UK medical schools – a need for change. Rheumatology. 2009; 48(5): 587-90.

14. Wong H-K, Tan K-J. The natural history of adolescent idiopathic scoliosis. Indian J Orthopaedics. 2010; 44(1): 9-13.
15. Trobisch P, Suess O, Schwab F. Idiopathic scoliosis. Dtsch Arztebl Int. 2010; 107(49): 875-83; quiz 84.
16. Busscher I, Wapstra FH, Veldhuizen AG. Predicting growth and curve progression in the individual patient with adolescent idiopathic scoliosis: design of a prospective longitudinal cohort study. BMC Musculoskeletal Disorders. 2010; 11: 93.
17. Ylikoski M. Growth and progression of adolescent idiopathic scoliosis in girls. J Pediatr Orthop B. 2005; 14(5): 320-4.
18. Canavese F, Kaelin A. Adolescent idiopathic scoliosis: Indications and efficacy of nonoperative treatment. Indian J Orthopaedics. 2011; 45(1): 7-14.
19 Fong DY, Lee CF, Cheung KM, et al. A meta-analysis of the clinical effectiveness of school scoliosis screening. Spine. 2010; 35(10): 1061-71.
20. Bunnell WP. The natural history of idiopathic scoliosis before skeletal maturity. Spine. 1986; 11(8): 773-6.
21. Lonstein JE, Carlson JM. The prediction of curve progression in untreated idiopathic scoliosis during growth. J Bone Jt Surg Am. 1984; 66(7): 1061-71.
22. Sanders JO, Browne RH, Cooney TE, Finegold DN, McConnell SJ, Margraf SA. Correlates of the peak height velocity in girls with idiopathic scoliosis. Spine. 2006; 31(20): 2289-95.
23. Sanders JO, Browne RH, McConnell SJ, Margraf SA, Cooney TE, Finegold DN. Maturity assessment and curve progression in girls with idiopathic scoliosis. J Bone Jt Surg Am. 2007; 89(1): 64-73.
24. Cassar-Pullicino VN, Eisenstein SM. Imaging in scoliosis: what, why and how? Clinical Radiology. 2002; 57(7): 543-62.
25. Fortuna R, Ting D, Kaelber D, Simon S. Characteristics of medicine-pediatrics practices: results from the national ambulatory medical care survey. Academic Medicine. 2009; 84(3): 396-401.
26. Phillips RL, Bazemore AW, Dodoo MS, Shipman SA, Green LA. Family Physicians in the Child Health Care Workforce: Opportunities for Collaboration in Improving the Health of Children. Pediatrics. 2006; 118(3): 1200-6.
27. Abou-Raya A, Abou-Raya S. The inadequacies of musculoskeletal education. Clinical Rheumatology. 2010; 29(10): 1121-6.
28. Fortin M, Maltais D, Hudon C, Lapointe L, Ntetu AL. [Access to health care: perceptions of patients with multiple chronic conditions]. Canadian Family Physician. 2005; 51(11): 1502-3.
29. Leddin D, Armstrong D, Barkun AN, et al. Access to specialist gastroenterology care in Canada: comparison of wait times and consensus targets. Can J Gastroenterology. 2008; 22(2): 161-7.
30. Ahn H, Kreder H, Mahomed N, Beaton D, Wright JG. Empirically derived maximal acceptable wait time for surgery to treat adolescent idiopathic scoliosis. CMAJ. 2011; 183(9): E565-E70.
31. Angevine PDMDMPH, Deutsch HMD. Idiopathic scoliosis: Neurosurgery September 2008;63(3) Supplement:A86-A93; 2008.
32. Davids JR, Chamberlin E, Blackhurst DW. Indications for magnetic resonance imaging in presumed adolescent idiopathic scoliosis. J Bone Joint Surg Am. 2004; 86-A(10): 2187-95.
33. Sato T, Hirano T, Ito T, et al. Back pain in adolescents with idiopathic scoliosis: epidemiological study for 43,630 pupils in Niigata City, Japan. European Spine J. 2011; 20(2): 274-9.
34. Vasiliadis E, Grivas TB. Quality of life after conservative treatment of adolescent idiopathic scoliosis. Studies Health Tech Informatics. 2008; 135: 409-13.
35. Williams SC, Gulihar A, Dias JJ, Harper WM. A new musculoskeletal curriculum: has it made a difference? J Bone Jt Surg Br. 2010; 92(1): 7-11.
36. Pinney SJ, Regan WD. Educating medical students about musculoskeletal problems. Are community needs reflected in the curricula of Canadian medical schools? J Bone Jt Surg Am. 2001; 83-A(9): 1317-20.
37. Coady DA, Walker DJ, Kay LJ. Teaching medical students musculoskeletal examination skills: identifying barriers to learning and ways of overcoming them. Scandinavian J Rheumatology. 2004; 33(1): 47-51.
38. Sandefur R, Febbo TA, Rupert RL. Assessment of knowledge of primary care activities in a sample of medical and chiropractic students. J Manip Physiol Thera. 2005; 28(5): 336-44.
39. Morris J, Grimmer-Somers K, Murphy K, et al. Effectiveness of a physiotherapy-initiated telephone triage of orthopedic waitlist patients. Patient related outcome measures. 2011; 2: 9.
40. Veloski J, Tai S, Evans AS, Nash DB. Clinical vignette-based surveys: a tool for assessing physician practice variation. Am J Med Qual. 2005; 20(3): 151-7.

ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2013/260–270/$2.00/©JCCA 2013

Non-pharmacological interventions for sleep quality and insomnia during pregnancy: A systematic review

Dana Hollenbach, DC
Riley Broker, BSc, DC
Stacia Herlehy, BA Hons, DC
Kent Stuber, BSc, DC, MSc*

Objective: *To systematically review the literature regarding non-pharmacological inteventions for improving sleep quality and insomnia during pregnancy.*

Methods: *An electronic search strategy was conducted using several online databases (CINAHL, PubMed, Medline, Index to Chiropractic Literature) from inception to March 2013. Inclusion criteria consisted of studies evaluating non-pharmacological interventions, published in English in a peer reviewed journal, and assessed sleep quality or insomnia. The full text of suitable articles was reviewed by the authors, and scored using a risk of bias assessment.*

Results: *160 articles were screened and seven studies met the inclusion criteria in the form of three prospective RCTs, one prospective longitudinal trial, one experimental pilot study, and two prospective quasi-randomized trials. Quality scores ranged from five to eight out of twelve on the risk of bias scoring criteria.*

Conclusions: *Exercise, massage, and acupuncture may be associated with improved sleep quality during pregnancy, however, due to the low quality and heterogeneity of the studies yielded, a definitive recommendation cannot be made. Further higher quality research is indicated.*

KEY WORDS: sleep, quality, insomnia, interventions

Objectif : *Examiner systématiquement la documentation portant sur les interventions non pharmacologiques pour l'amélioration de la qualité du sommeil et pour le traitement de l'insomnie pendant la grossesse.*

Méthodologie : *Une stratégie de recherche électronique a été mise en œuvre utilisant plusieurs bases de données en ligne (CINAHL, PubMed, Medline, Index to Chiropractic Literature) depuis la création jusqu'en mars 2013. Les critères d'inclusion consistaient en études évaluant les interventions non pharmacologiques traitant de l'insomnie ou de la qualité du sommeil, et publiées en anglais dans une revue évaluée par des pairs. Les textes intégraux des articles utiles ont été examinés par les auteurs, qui ont accordé une note à chacun selon une évaluation de risque d'impartialité.*

Résultats : *160 articles ont été analysés, et 7 études ont satisfait les critères d'inclusion, dont trois qui sont des ECR prospectifs, un essai longitudinal prospectif, une étude pilote expérimentale et deux essais prospectifs quasi randomisés. Les scores de qualité se situaient entre cinq et huit sur une base de douze, selon les critères de notation des risques d'impartialité.*

Conclusions : *Durant la grossesse, les exercices, le massage et l'acupuncture semblent avoir une relation avec l'amélioration de la qualité du sommeil; cependant, le faible niveau de qualité et l'hétérogénéité obtenus des études ne permettent pas de formuler une recommandation claire. D'autres recherches de meilleure qualité sont recommandées.*

MOTS CLÉS : sommeil, qualité, insomnie, interventions

*corresponding author
19-8 Weston Drive SW, Calgary, AB T3H 5P2, 403-685-5252
Institution: Canadian Memorial Chiropractic College, Division of Graduate Education & Research
Disclaimers: The authors declare that they have nothing to disclaim in the preparation of this manuscript
Sources of support: The authors did not receive any financial support in the preparation of this manuscript.

Introduction

There are a wide variety of symptoms and concerns that a pregnant woman may encounter. Insomnia and poor sleep quality are among those that can have a substantial effect on a pregnant woman's quality of life. Roughly two-thirds of pregnant woman believe their sleep to be abnormal and associate it with the ongoing physical changes and changes in their overall size.[1] Many pregnant women experience frequent night waking, insomnia, difficulty falling and staying asleep, and restless sleep by the end of their pregnancy.[2] Disorders such as insomnia, sleep apnea, restless leg syndrome, parasomnias and narcolepsy can begin or be exacerbated throughout pregnancy.[1-7] Lying down to sleep can often exacerbate heartburn symptoms in pregnant women and adversely affect their sleep quality, and heartburn is estimated to occur in 30% to 50% of pregnancies, while some populations have reported an occurrence of up to 80%.[8]

Physiological changes such as increased progesterone and prolactin levels, increase in maternal size, fetal movement, and bladder distention can potentially explain some of the disturbances of a pregnant woman's sleep.[7] Pain can also lead to poor sleep quality.[9] The prevalence of low back pain (LBP, described as pain between the 12th rib and the gluteal fold) in pregnant women is high, with studies indicating that it can range in prevalence from 24% to 90% of pregnant women.[10] Furthermore, approximately 20% of woman experience pelvic girdle pain during pregnancy (defined as pain between the posterior iliac crest and the gluteal fold).[11,12] Providing evidence-based pain relieving treatments to pregnant women with poor sleep quality due to pain could decrease pain intensity and frequency, and could potentially improve their sleep quality as well.[2,5-7]

The treatment of poor sleep quality or sleep disorders during pregnancy is complicated, particularly as the Food and Drug Administration (FDA) recommends pregnant women not be exposed to category X drugs.[13] Box 1 depicts the different categories of drugs during pregnancy as classified by the FDA.[14] Category X drugs include sleep medications such as Mefloquine, Flurazepam, and Temazepam, all of which are contraindicated for pregnant and lactacting women.[13] Hardy et al determined that at least 0.6% of pregnancies may have been exposed to medications in early pregnancy whose FDA category implies contraindication in pregnancy or risk to fetal development.[15] One study showed that Benzodiazepines, a category X drug, accounted for the greatest number (85%) of psychotropic agents used during pregnancy.[16] Zolpidem is frequently prescribed by doctors for pregnant women with insomnia.[17] Zolpidem crosses the human placental rapidly and is a category C drug. Zolpidem does not appear to be a major tetratogenic agent in humans, although it is associated with an increased risk of low birth weight, preterm deliveries, caesarean deliveries

Box 1:
FDA Pregnancy Medication Categories:
The FDA-assigned pregnancy categories as used in the Drug Formulary14

Category A
Adequate and well-controlled studies have failed to demonstrate a risk to the fetus in the first trimester of pregnancy (and there is no evidence of risk in later trimesters).

Category B
Animal reproduction studies have failed to demonstrate a risk to the fetus and there are no adequate and well-controlled studies in pregnant women.

Category C
Animal reproduction studies have shown an adverse effect on the fetus and there are no adequate and well-controlled studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.

Category D
There is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience or studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.

Category X
Studies in animals or humans have demonstrated fetal abnormalities and/or there is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience, and the risks involved in use of the drug in pregnant women clearly outweigh potential benefits.

and delivery of small for gestational age infants compared to women who have not received Zolpidem.[18] For this reason, the prescription and use of sleep medications for pregnant patients should be carefully considered by both the patient and their attending medical doctor.

Research indicates that increasingly more pregnant woman are turning to non-pharmacological and natural forms of health care for treatment of pain during pregnancy and sleep issues such as poor sleep quality and insomnia.[3-5,18-22] Wang et al[18] found that massage therapy was the non-pharmacological intervention most commonly recommended to pregnant women with back pain by prenatal health care providers, followed by recommendations for acupuncture, relaxation, exercise, yoga, and chiropractic. Pregnant women may see numerous different health care professionals throughout pregnancy. A pregnant woman's health care team may include an obstetrician, family medical doctor, chiropractor, midwife, massage therapist, acupuncturist, or naturopath, among others.[4,8,16,19,20] These different professionals can each play a role in improving a pregnant woman's quality of sleep and quality of life by providing evidence-based recommendations and information regarding the risk and benefit profiles of different treatments during pregnancy. The aim of this study was to systematically identify and assess the evidence for the use of different non-pharmacological interventions to aid sleep quality and insomnia during pregnancy.

Methods

Objective: The objective of this literature review was to determine what evidence exists and the quality of the evidence for non-pharmacological interventions for improving sleep quality and insomnia during pregnancy.

Search Strategy: A literature search was performed in all languages through EBSCO to access various databases, specifically AMED, MEDLINE, and CINAHL and a separate search was conducted in The Index to Chiropractic Literature (the search strategy may be obtained from the authors). MeSH terms of Pregnancy (exploded) and Pregnancy complications were used, in addition to the text word pregnan*. When searching articles relating to sleep the MeSH terms sleep, sleep deprivation, and sleep initiation were employed, as well as the text terms sleep, and insomnia. Finally, with respect to non-pharmacological interventions MeSH terms of exercise and dietary supplements were both exploded and searched as well as complementary therapy, exercise therapy, diet, mind-body therapies, and acupuncture. Text words massage, and chiropract* were also used. Finally the terms Pregnancy, Sleep, Low Back Pain and CAM were searched with the boolean character AND. The literature search period was from the start date of each database up to and including March 2013. Hand searching of the reference lists of relevant articles retrieved from the electronic literature search was also performed.

Inclusion Criteria

The specific inclusion criteria employed in this review were:

Study Design: Articles had to be published in a peer-reviewed journal, utilizing intervention-based study designs. Articles were excluded if they were published in conference proceedings, or if they were case reports, cross-sectional and other descriptive designs, or narrative reviews.

Population: Pregnant female patients with uncomplicated pregnancies.

Language: Articles published in English only.

Interventions: Any studies that used some form of non-pharmacological intervention or had at least one study arm that did not involve the use of medication were considered for inclusion.

Outcome Measures: Studies had to include a measure of sleep quality or insomnia.

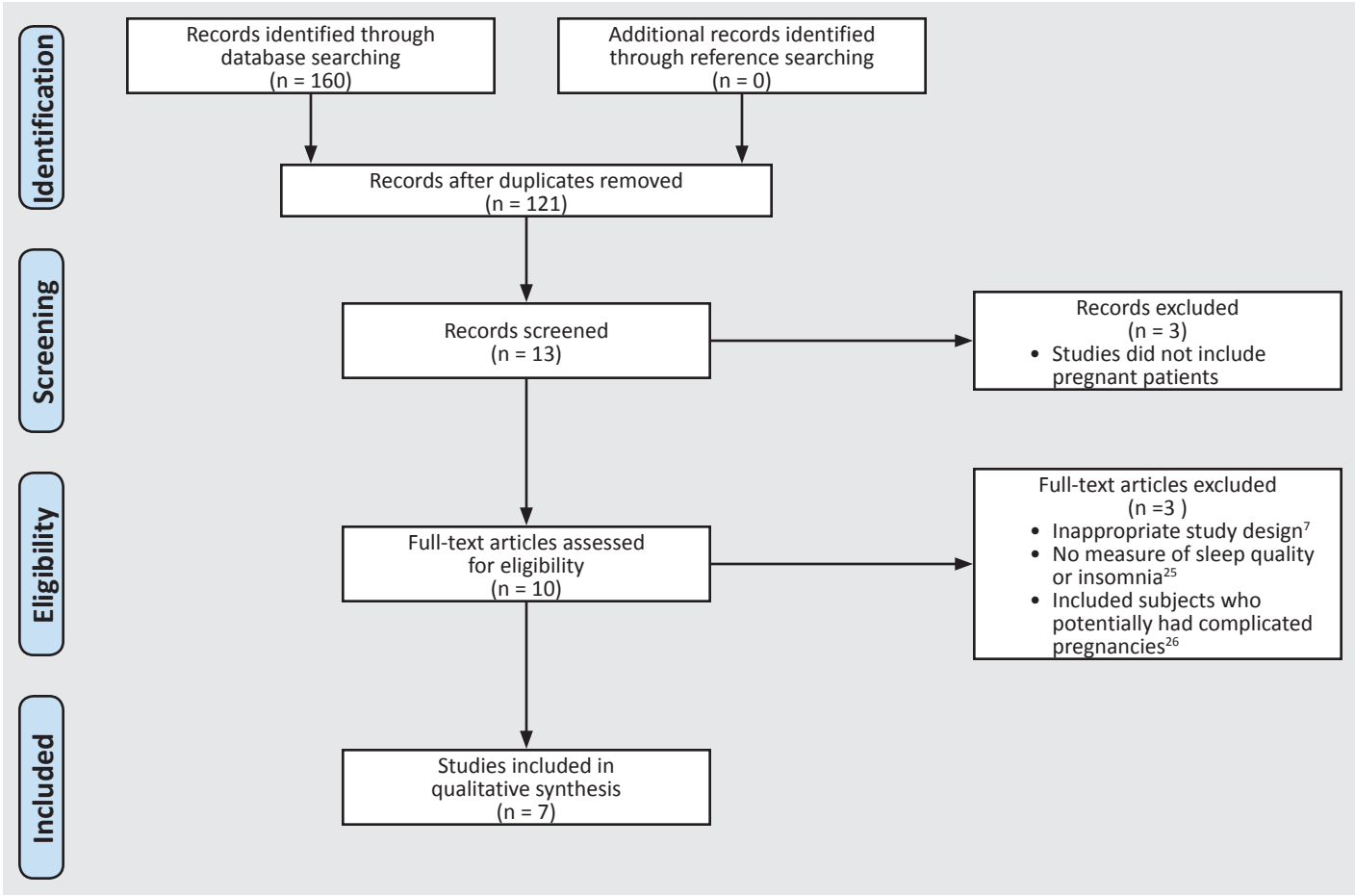
Study Selection

Four reviewers each independently reviewed the titles and abstracts from electronic searches for any articles that appeared to match the inclusion criteria. Each reviewer independently maintained a list of possible articles for inclusion. These lists were reviewed by the group and the full text of potentially suitable articles were evaluated using the inclusion criteria described above. Articles were included based on adherence to the inclusion criteria and any disagreements were resolved by consensus.

Risk of Bias Assessment

The risk of bias scoring criteria[23,24] was used to evaluate the included articles (please see Table 8.5a in Higgins and Green[24] for a complete description of the criteria). This particular scoring criteria was employed as it was recommended for use as part of student research projects (litera-

Figure 1.
PRISMA Flow Chart



ture reviews or syntheses focuing on interventions in particular) at the Canadian Memorial Chiropractic College. Using the risk of bias scoring criteria,[23,24] included articles were individually scored based on the following criteria: assignment of patients, similarity of baseline characteristics, use of prognostic stratification, relevance of clinical outcomes/significance, blinding strategies, statistical significance, co-interventions, compliance of subjects to the study procedures and follow-up levels. Each article was independently reviewed by three assessors. Any discrepancies found between the quality assessments were discussed in a group setting. Ambiguity was resolved and conclusive scores were finalized by group discussion. If applicable, meta-analyis would be conducted on included studies.

Results

Search Results and Study Designs

Figure 1 shows the flow of studies through this review. A total of 160 studies were screened from the literature search, ten of which were assessed for eligibility, three studies were excluded due to either inappropriate study design[7], not including a measure of sleep quality or insomnia[25], or involving subjects who potentially had complicated pregnancies.[26] As such, seven articles met the inclusion criteria of the review, all of which were identified by the electronic database searches. Of the seven included articles, three were prospective randomized control trials, one was a prospective longitudinal study, one was an experimental pilot study, and two were prospective quasi-

Table 1:
Summary of Included Articles

Study Authors; quality score	Study Design	Sample	Interventions	Outcome measures	Main sleep quality results/conclusions
Guerreiro da Silva et al[4] 2005 8/12	Prospective, quasi-randomized control study	30 patients between 15 and 39 years old between 15 and 30 weeks pregnant	Traditional acupuncture, or no acupuncture performed once per week (twice if severe) over 8 weeks	Numerical rating scale of quality of life at 14 day intervals which included sleep quality	Average insomnia score decreased by over 50% in more than 75% of the patients compared to 30% in the control.
Guerreiro da Silva et al[3] 2009 8/12	Prospective randomized control study	42 pregnant women 15-39 years old, 15 to 30 weeks pregnant.	Traditional acupuncture or no treatment over 8 weeks.	Interviewed by a research assistant, and a numerical rating scale of quality of life which included sleep quality	A statistically significant ($p<0.01$) greater proportion of the study group (14 out of 20) reported improvements of at least 50% compared with the control group (four of out 16).
Guerreiro da Silva[28] 2007 8/12	Prospective, quasi-randomized control	51 pregnant women 15-39 years old, 15 to 30 weeks pregnant	Traditional acupuncture plus conventional treatment over 8 weeks versus conventional treatment only (physician and nurse counseling and possibly two different phytotherapeutic agents: *Passiflora edulis* for anxiety symptoms, and *Hypericum performatum* for depression symptoms)	Numerical rating scale of emotional distress, and numerical rating scale of five different areas of life including sleep quality.	A statistically significant ($p<0.01$) greater proportion of the study group (48%) reported improvements of at least 50% compared with the conventional treatment group (5%).
Goodwin et al[21] 2010 5/12	Prospective longitudinal study	65 nulliparous women aged 23-39.	Exercise in pre-natal classes	Sleep quality and duration was collected in a self administered questionnaire given to women at 24 and 29 weeks, general health questionnaire with a variable for sleep	A weak association of physical activity (PA) with sleep duration and quality in late pregnancy. PA is recommended for health benefits but more research is needed if it should be recommended to improve sleep.
Beddoe et al[5] 6/12	Experimental pilot study	15 nulliparous women in 2nd or 3rd trimester	Weekly community based mindfulness meditation and prenatal hatha yoga for 7 weeks	General sleep disturbance scale (GSDS)	Woman who began the yoga in the 2nd trimester has significantly fewer awakenings, less wake time during the night, and less sleep disturbances as compared to those who started in their 3rd trimester.
Field et al[19] 1999 7/12	Prospective randomized control trial	26 pregnant woman between ages 23 and 35 in their 2nd trimester.	Massage or relaxation therapy for 5 weeks.	State anxiety inventory, profile of mood states depression scale, 15 item VAS sleep scale	Only the massage group reported reduced anxiety, improved mood, better sleep, less back pain, and had a decrease in urinary stress hormones.
Tella et al[27] 2011 5/12	Prospective randomized controlled trial	30 pregnant women, between the ages of 18 and 45 years in all three trimesters	Aerobic exercise group (six minute walk exercises, five minutes of stair climbing, four minutes of jogging, five minutes of throwing a ball) over six weeks along with education on sleep hygiene versus an education only control group	Insomnia Severity Index (ISI) and Quality of Life Questionnaire (QoL)	At six weeks, both groups demonstrated statistically significant within group improvements in insomnia levels, and a statistically significant reduction in insomnia levels between groups favouring the aerobic exercise group was observed.

randomized studies.[3-5,19,21,27,28] None of the included studies employed a priori sample size estimations.[3-5,19,21,27,28] Table 1 provides information on the included studies with respect to the study design, sample, interventions, outcome measures, results, and conclusions in addition to the quality score of each article.

Participants

A total of 259 pregnant women participated in the seven included studies. Study sizes varied from 15 to 65 participants. In two studies, the participants were specifically indicated as being nulliparous.[5,21] Beddoe's[5] sample was comprised of 15 women aged 25 to 37 between 12 and 32 weeks gestation. Three studies by Guerreiro da Silva et al [3,4,28] were included, one examined 36 women aged 15 to 39 who were 15 to 30 weeks pregnant,[3] another other looked at looked at 22 women aged 15-39 who were 15-30 weeks pregnant,[4] and the final study looked at 51 women aged 15-39 who were 15 to 30 weeks pregnant.[28] Goodwin et al[21] examined 65 women aged 20 to 40 who were 14 to 20 weeks pregnant. Field et al examined 26 pregnant women aged 23 to 35 where all subjects were between 14 and 30 weeks pregnant.[19] Tella et al[27] looked at 30 women aged 18 to 45 years old whose gestational age spanned all three trimesters, with 20 subjects in their second trimester, and five each in their first and third trimesters respectively.

Outcome Measures Employed

One study employed a ten point numerical rating scale for sleep quality over seven domains of sleep disturbance, which included delayed sleep onset, frequent awakenings, early awakenings, waking tired, disrupted sleep, day napping and nightmares.[4] In another study, aside from the primary outcome measure of dyspepsia, secondary efficacy variables were also considered including sleep quality, which was quantified by means of a ten-point numerical rating scale (NRS).[3] Another study evaluated the primary outcome measure of emotional distress, while sleep quality was assessed as a secondary variable.[28] Field et al[19] used a 15-item visual analog sleep scale over three subcategories including sleep disturbance, sleep effectiveness and supplementary sleep; the subjects placed a mark across an answer line that ranged from 'did not awaken' to 'was awake ten hours'. The General Health Questionnaire (GHQ-28), which consists of four subsets of questions including somatic symptoms, social dysfunction, depression, and anxiety and insomnia was employed by Goodwin et al.[21] In the study by Beddoe et al[5], subjective sleep disturbance was measured with the General Sleep Disturbance Scale (GSDS), a 7-point scale that asks questions regarding the past week's poor sleep experiences. Tella et al[27] used the Insomnia Severity Index to assess their level of insomnia, as well as the Quality of Life Questionnaire to assess levels of fatigue.

Intervention Type

Three studies evaluated acupuncture on pregnant women. One study focused on the treatment of dyspepsia[3], another focused on the treatment of insomnia,[4] and the last looked at the treatment of mild to moderate emotional complaints.[28] All three of the studies employed eight week acupuncture programs with a minimum of eight and to a maximum of twelve sessions.[3,4,28] Exercise intervention was examined in three studies consisting of two studies that evaluated the effects of aerobic exercise[21,27], and one study that looked at the effect of a seven week mindfulness yoga intervention.[5] Another study examined massage therapy and relaxation therapy interventions[19], which included ten twenty-minute massages or ten twenty-minute relaxation therapy sessions over a five-week period. One employed sleep hygiene education in both groups.[4]

Primary Outcome Measure: Sleep Quality and Insomnia

Guerreiro da Silva[3] found in their prospective randomized controlled trial (RCT) comparing acupuncture with a control group, that with regards to sleep measures, a statistically significant ($p<0.01$) greater proportion of the study group (14 out of 20) reported improvements of at least 50% compared with the control group (four of out 16).

Guerreiro da Silva et al[4] conducted a subsequent prospective, quasi-randomized controlled study comparing acupuncture to no acupuncture for the treatment of insomnia. This study found a statistically significant ($p<0.01$) greater reduction in insomnia in the acupuncture group compared with the control group. Average insomnia scores were decreased by at least 50% over the course of the study in most members of the study group (9 out of 12 participants) versus fewer than half of the members of the control group (3 out of 10 participants).

Guerreiro da Silva[28] conducted another prospective,

Table 2:
Risk of Bias Scoring Criteria results.

Brief Item Description	Guerrerio da Silva et al[4]	Guerrerio da Silva et al[3]	Guerrerio de Silva[28]	Field et al[19]	Beddoe et al[5]	Goodwin et al[21]	Tella et al[27]
Was the method of randomization adequate?	1	1	1	1	0	0	0
Was the treatment allocation concealed?	0	0	0	0	0	0	0
Was the patient blinded to the intervention?	0	0	0	0	0	0	0
Was the care provider blinded to the intervention?	0	0	0	0	0	0	0
Was the outcome assessor blinded to the intervention?	1	1	1	0	0	0	0
Was the dropout rate described and acceptable?	1	1	1	0	1	1	0
Were all randomized participants analyzed to the group to which they were allocated?	0	0	1	1	1	1	1
Are reports of the study free of suggestion of selected outcome reporting?	1	1	1	1	1	1	1
Were the groups similar at baseline regarding the most important prognostic indicators?	1	1	1	1	1	0	1
Were co-interventions avoided or similar?	1	1	1	1	0	0	0
Was the compliance acceptable in all groups?	1	1	1	1	1	1	1
Was the timing of the outcome assessment in all groups?	1	1	1	1	1	1	1
Total Score (/12)	8	8	8	7	6	5	5

Legend. 0 = Item was not fulfilled, 1 = Item was fulfilled

quasi-randomized controlled study comparing acupuncture to conventional treatment (physician and nurse counseling and possibly two different phytotherapeutic agents: *Passiflora edulis* for anxiety symptoms, and *Hypericum performatum* for depression symptoms). They found that with respect to sleep measures, a statistically significant ($p<0.01$) greater proportion of the study group (48%) reported improvements of at least 50% compared with the control group (5%).

Field et al[19] found in their prospective randomized controlled trial of massage therapy versus relaxation therapy that only the massage therapy group reported reduced anxiety, improved mood and sleep, and less back pain compared to the non-massage group over the five week study period, which was statistically significant (MANOVA, $F(4.21) = 2.86$; $p < 0.05$).

In a prospective longitudinal study on the effect of exercise, Goodwin et al[21] found that there was a significant decrease on the GHQ-28 composite score for the exercise group as well as reduced frequency of somatic symptoms, anxiety and insomnia, as well as a higher level of psychological well-being. There was a weak association between physical activity and sleep duration and quality in later pregnancy. The authors recommended physical activity for pregnant woman for health benefits but indicated that more research was needed to recommend it for improving sleep.

Tella et al[27] conducted an RCT comparing aerobic exercise and sleep hygiene education intervention to a control of sleep hygiene education only over six weeks and found that there was a statistically significant difference in average insomnia levels between the groups favoring the exercise group ($p<0.01$). Although the exercise group showed greater improvement, it must be noted that both groups demonstrated statistically significant improvements in average insomnia levels within groups ($p<0.01$ in the control group and $p<0.001$ in the exercise group).

Beddoe et al[5] found in their pilot study of a mindfulness-based yoga intervention on sleep quality during

pregnancy that women who began the yoga program in their second trimester reported less wake-time and less perceived sleep disturbance versus women who began the intervention in their third trimester. At baseline measures for second trimester women, the GSDS mean score was 2.9. Those in the third trimester had a mean baseline score of 1.8. After a seven week mindfulness yoga intervention, women in the second trimester group demonstrated significantly improved sleep by total GSDS score and fewer nights of poorer sleep. There was a mean decrease of 2.03 from the GSDS for the women in their second trimester. The third trimester group reported worse sleep by a mean increase of 1.6 and more nights with poorer sleep.

Quality of Methods and Risk of Bias Determination

The quality of each included article was scored out of a possible 12 marks, as seen in Table 2. Scores ranged from five to eight out of twelve. Due to differences in outcome measure use and heterogeneity of populations and treatments employed, meta-analysis was not feasible. Four articles did not have or report sufficient randomization methods.[5,19,21,27] None of the reviewed articles had adequate blinding or employed a priori sample size estimations; four articles had no blinding of the patient, care-provider nor the assessor.[5,19,21,27] The studies by Guerrerio da Silva[3,4,28] had blinding of the outcome assessor, however they lacked blinding of patients and care-providers. Another flaw of all seven studies was that treatment allocation was not concealed. Control over co-interventions was not done in the Goodwin[21] or Tella[27] studies, other sources of bias including non-uniform base line characteristics were a flaw of both the Goodwin[21] and Beddoe[5] studies. There was also concern about the inappropriate application of the MANOVA in the study by Field et al[19], particularly as there were only 26 subjects total in their sample.

Discussion

To our knowledge, this is the first literature review of non-pharmacological interventions for sleep quality during pregnancy. The review identified three studies of acupuncture, one of yoga, two on aerobic exercise, and one massage therapy study.[3-5,19,21,27,28] No adverse effects were reported in any of the studies; however, studies on non-pharmacological interventions and sleep disturbances in the pregnant population were scarce, and those identified were generally of low quality.

Sleep changes in pregnancy contribute to perinatal mood disturbance and somatic complaints.[29] Furthermore; insomnia tends to worsen over the course of a pregnancy.[30] Common physical symptoms such as edema, muscle spasms, cramps and fatigue, may lead to difficulty sleeping due to discomfort and body pains.[29,30] Moreover, melatonin levels are usually lower in pregnant women with sleeping difficulties compared to those without sleep issues.[31]

Despite the knowledge that insomnia can cause a reduced quality of life, often patients with insomnia are not treated with medications for fear of adverse effects.[4] In a study by Auerbach et al[32], the newborns of mothers who received antipsychotic and anti-anxiety medications during pregnancy exhibited poor neonatal motor functioning, including tremulousness, hyper- tonicity, and poor motor maturity.

Acupuncture

In a subjective assessment by Becker-Carus et al[33] acupuncture was used as an effective treatment for insomnia, however this study did not include pregnant subjects. Guerreiro da Silva et al[4] used traditional acupuncture once or twice per week over eight weeks in 17 women, and results showed that over half of these women experienced statistically significant decreased insomnia when compared with controls. The authors opined that self-reported sleep quality does not provide high quality data; however, they evaluated the subjects this way to observe results under real life conditions. The authors did not suggest reasons why acupuncture treatment was effective, however they agreed that more research was needed.

Another study by Guerreiro da Silva et al[3] observed the effects of acupuncture in practice on the treatment of dyspepsia in pregnancy. They evaluated subjects using a numerical rating scale related to quality of life that included sleep quality, suggesting that dyspepsia may cause a reduced sleep quality in pregnant women. They concluded that after acupuncture treatment, the NRS differences in the treatment group were significantly higher in comparison to the control group. Based on Guerreiro da Silva's work[3,4,28], acupuncture may be an effective therapy for sleep difficulties and showed no adverse effects. To our knowledge, only Guerreiro da Silva and colleagues have conducted research on the effects of acupuncture for sleep improvements in a pregnant population, thus, addi-

tional research could further justify its use in this population.

Yoga

Although past intervention studies have looked at yoga's effect on sleep, the first and only controlled study demonstrating the effects of mindfulness-based interventions on sleep quality in the pregnant women was done by Beddoe et al.[5] Several studies have focused on prenatal yoga and its benefits, however this was the first to focus on sleep alone. For example, Narendran et al[34] conducted a prenatal yoga intervention study which used yoga postures, breathing practices, and meditation for pregnant women. The yoga group reported a significantly lower incidence of adverse perinatal outcomes in the treatment group compared to controls who did not practice yoga.[34] Beddoe et al[5] proposed a seven-week prenatal mindful Hatha style yoga as an approach to alter stress appraisal and thereby attenuate the stress response. They used a subjective and objective method of sleep evaluation to enhance the study design. Results found that no significant sleep improvements were shown with a yoga intervention, however, women who began the intervention in their second trimester had fewer awakenings and less wake time during the night compared to women who began a yoga intervention in their third trimester.

Beddoe et al's study contradicted past research suggesting that sleep gets worse as women progress through pregnancy[26,30] Beddoe et al[5] showed that baseline subjective sleep measurements were worse in the second trimester versus those in the third. Therefore, it is plausible that non-pharmacological interventions may be helpful in earlier stages of a pregnancy. More specifically, yoga may improve sleep quality when started in the second trimester of a pregnancy.

Aerobic Exercise

Sternfeld et al[35] found that aerobic exercise may be associated with fewer perceived pregnancy symptoms, but did not focus on sleep quality as an outcome measure. In a longitudinal study by Goodwin et al,[21] a subjective assessment of exercise in 72 nulliparous women in late pregnancy compared perceptions of body image and psychological well being. Goodwin et al used the General Health Questionnaire which includes items related to sleep. When the exercise group was compared to the non-exercise group in late pregnancy, a significant difference was found for overall psychological well being in the area of somatic symptoms, anxiety, and insomnia. Although this study's main focus was not on sleep, it suggests that exercise has beneficial effects on improving sleep quality in late pregnancy and may warrant further research.[21] Tella et al[27] found that insomnia improved following six weeks of aerobic exercise and sleep hygiene education to a statistically significant degree greater than a sleep hygiene education only control group, although both groups did see statistically significant within groups differences.

Massage/Relaxation Therapy:

Field and colleagues[36] found that although massage therapy had not been studied as a treatment for many symptoms associated with pregnancy, massage during labor has been shown to reduce labor time, hospital stay and to decrease postpartum. However, in a follow up study Field et al focused on just massage and relaxation, indicating that massage and relaxation interventions might have a positive impact on pregnant women by decreasing stress hormones and potential stressors, improved mood, and sleep.[19] After their treatment period there was less disruption of sleep for the massage therapy group and an increase in supplemental daytime sleep for the relaxation group as measured using a visual analog sleep scale.

Strengths and Weaknesses

Although this systematic review yielded few papers, a thorough literature search was performed to strengthen the findings. The authors searched multiple relevant electronic databases over all searchable years and employed reference searching. Furthermore numerous authors were involved in selecting articles and reviewing them for quality, using discussion to resolve differences. Furthermore, several non-pharmacological interventions were evaluated in this review, as articles assessing yoga, massage, exercise, and acupuncture were included.[3-5,19,21,27,28]

The main limitation of this review was the small number of studies included. However as mentioned above the methods of this review were robust, although the yield may have potentially been improved by including articles from languages other than English, by searching additional databases, and by inclusion of studies from the grey literature. Regardless, no articles were excluded from this review due to being published in a language other than

English or because they were found in the grey literature. Of the articles included in the review, some employed lower quality methods as exhibited by their risk of bias scores. Three of the included studies[5,21,27] had risk of bias scores at or below six out of twelve or 50%, and their findings in particular should be viewed with caution due to the inherently heightened risk of bias. The lack of sample size estimations in all studies and questionable use of MANOVA in one study[19] are cause for concern over study quality as well. Furthermore, sleep quality was measured subjectively in nearly all included studies. Such subjective outcome measures may be liable to subject-reporting errors and may adversely impact the results. The risk of bias scoring criteria that was employed in this review[23,24] is best suited for use on RCTs and several of the studies included in this review were not RCTs. As such, more valid scoring of quasi-randomized or observational studies may have been obtained through use of a difference risk of bias scoring method.

Despite the lack of evidence generated herein, the findings of this review may help direct the need for further research in the field of pregnancy and sleep disturbances or insomnia. Higher quality randomized controlled trials are needed to evaluate the possible role of non-pharmacological interventions in impacting sleep quality and insomnia in the pregnant population specifically. Such studies will need to have more consistent application of validated sleep quality outcome measures.

Conclusions

There were only seven articles included in this review, these suggest that exercise[5,21,27], acupuncture[3,4,28], and massage[19] each may be associated with improved sleep quality or insomnia levels in pregnant women. However, the quality of methods of included studies was generally low. Although no adverse effects of non-pharmacological interventions were reported, higher quality research is clearly needed to determine their effects on sleep.

References

1. Lopes E, Carvalho L, Seguro P, Mattar R, Silva A, Prado G, et al. Sleep disorders in pregnancy. Arquivos De Neuro-Psiquiatria. 2004; 62(2A): 217-221.
2. Mindell J, Jacobson B. Sleep disturbances during pregnancy. J Obstetric, Gynecologic, Neonatal Nursing. 2000; 29(6): 590-597.
3. Guerriero da Silva J, Nakamura M, Cordeiro J, Kulay L, Saidah R. Acupuncture for dyspepsia in pregnancy: a prospective, randomised, controlled study. Acupuncture in Medicine. 2009; 27(2): 50-53.
4. Guerreiro da Silva J, Nakamura M, Cordeiro J, Kulay L. Acupuncture for insomnia in pregnancy - a prospective, quasi-randomised, controlled study. Acupuncture in Medicine. 2005; 23(2): 47-51.
5. Beddoe A, Lee K, Weiss S, Kennedy H, Yang C. Effects of mindful yoga on sleep in pregnant women: a pilot study. Biological Research for Nursing. 2010; 11(4): 363-370.
6. Santiago J, Nolledo M, Kinzler W, Santiago T. Sleep and sleep disorders in pregnancy. Annals Internal Med. 2001; 134(5): 396-408.
7. Lee K, Zaffke M, Baratte-Beebe K. Restless leg syndrome and sleep disturbance during pregnancy: The role of folate and iron. J Women's Health Gender-based Medicine. 2001; 10(4): 335-341.
8. Richter J. Gastroesophageal reflux disease during pregnancy. Gastroenterology Clinics Of North America. 2003; 32(1): 235-261.
9. Sloan E. Sleep disruption during pregnancy. Sleep Medicine Clinics. 2008; 3(1): 73-80.
10. Mogren I, Pohjanen A. Low back pain and pelvic pain during pregnancy: prevalence and risk factors. Spine. 2005; 30(8): 983-991.
11. Maria C. Low back and pelvic girdle pain of pregnancy: Recommendations for diagnosis and clinical management. J Clinical Chiropractic Pediatrics. 2010; 11(2): 774-779.
12. Vleeming A, Albert H, Ostgaard H, Sturesson B, Stuge B. European guidelines for the diagnosis and treatment of pelvic girdle pain. European Spine J. 2008; 17(6): 794-819.
13. Cooper W, Hickson G, Ray W. Prescriptions for contraindicated category X drugs in pregnancy among women enrolled in TennCare. Paediatric Perinatal Epidemiology. 2004; 18(2): 106-111.
14. FDA classification of drugs for teratogenic risk. Teratology Society Public Affairs Committee. Teratology. 1994; 49(6): 446-447.
15. Hardy J, Leaderer B, Holford T, Hall G, Bracken M. Safety of medications prescribed before and during early pregnancy in a cohort of 81,975 mothers from the UK General Practice Research Database. Pharmacoepidemiology Drug Safety. 2006; 15(8): 555-564.
16. Marchetti F, Romero M, Bonati M, Tognoni G. Use of psychotropic drugs during pregnancy. A report of the international co-operative drug use in pregnancy (DUP) study. Collaborative Group on Drug Use in Pregnancy (CGDUP). European J Clinical Pharmacology. 1993; 45(6): 495-501.
17. Wang L, Lin H, Lin C, Chen Y, Lin H. Increased risk of adverse pregnancy outcomes in women receiving

zolpidem during pregnancy. Clinical Pharmacology and Therapeutics. 2010; 88(3): 369-374.
18. Wang S, Dezinno P, Maranets I, Berman M, Caldwell-Andrews A, Kain Z. Low back pain during pregnancy: prevalence, risk factors, and outcomes. Obstetrics and Gynecology. 2004; 104(1): 65-70.
19. Field T, Hernandez-Reif M, Hart S, Theakston H, Schanberg S, Kuhn C. Pregnant women benefit from massage therapy. J Psychosomatic Obstetrics and Gynaecology. 1999; 20(1): 31-38.
20. Stuber K, Smith D. Chiropractic treatment of pregnancy-related low back pain: a systematic review of the evidence. J Manip Physiol Thera. 2008; 31(6):447-454.
21. Goodwin A, Astbury J, McMeeken J. Body image and psychological well-being in pregnancy. A comparison of exercisers and non-exercisers. Australian & New Zealand J Obstetrics & Gynaecology. 2000; 40(4): 442-447.
22. Sadr S, Pourkiani-Allah-Abad N, Stuber K. The treatment experience of patients with low back pain during pregnancy and their chiropractors: a qualitative study. Chiropractic and Manual Therapies. 2012; 20(32): 1-8.
23. Chandler J, Clark M, Higgins, J. Cochrane Methods. Willey-Blackwell. 2012; ISSN: 2044-4702
24. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.
25. Borodulin K, Evenson K, Monda K, Wen F, Herring A, Dole N. Physical activity and sleep among pregnant women. Paediatric Perinatal Epidemiology. 2010; 24(1): 45-52.
26. Lee K, DeJoseph J. Sleep disturbances, vitality, and fatigue among a select group of employed childbearing women. Birth. 1992; 19(4): 208-213.
27. Tella BA, Sokunbi OG, Akinlami OF, Afolabi B. Effects of aerobic exercises on the level of insomnia and fatigue in pregnant women. Int J Gyn Obst. 2011; 15(1): DOI: 10.5580/549.
28. Guerreiro da Silva JB. Acupuncture for mild to moderate emotional complaints in pregnancy--a prospective, quasi-randomised, controlled study. Acupuncture in Medicine: J Br Med Acupuncture Society. 2007; 25(3): 65-71.
29. Smith R, Brinsmead M. Mood changes, obstetric experience and alterations in plasma cortisol, beta-endorphin and corticotropin releasing hormone during pregnancy and the puerperium. J Psychosomatic Research. 1990; 34(1): 53-69.
30. Hertz G, Fast A, Feinsilver SH, Albertario CL, Schulman H, Fein AM. Sleep in normal late pregnancy. Sleep. 1992; 15(3): 246-251.
31. Suzuki S, Dennerstein L, Greenwood K, Armstrong S, Sano T, Satoshita E. Melatonin and hormonal changes in disturbed sleep during late pregnancy. J Pineal Research. 1993; 15(4): 191-198.
32. Auerbach J, Hans S, Marcus J. Maternal psychotropic medication and neonatal behavior. Neurotoxicology and Teratology. 1992; 14(6): 399-406.
33. Becker-Carus C, Heyden T, Kelle A. Effectiveness of acupuncture and attitude – relaxation training in the treatment of primary sleep disorders. Zeitschrift fur Klinishche Psychologie, Psychopathologie und Psychotherapie. 1985; 33(2): 161-172.
34. Narendran, S., Nagarathna, R., Gunasheela, S., & Nagendra, H. R. Efficacy of yoga in pregnant women with abnormal Doppler study of umbilical and uterine arteries. J Indian Med Assoc. 2005; 103: 12-14, 16-17.
35. Sternfeld B, Quesenberry CP, Eskenazi B, Newman LA. Exercise during pregnancy and pregnancy outcome. Medicine and Science in Sports and Exercise. 1995; 27: 634-640.
36. Field T, Hernandex-Reif M, Taylor S, Quintino O, Burman I. Labor pain is reduced by massage therapy. J Psychosomatic Obstetrics and Gynecology. 1997; 18(4): 286-291.