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Advertising Editor, Journal of the Canadian Chiropractic Association
186 Spadina Avenue, Suite 6, Toronto, Ontario M5T 3B2
Tel: 416-585-7902 877-222-9303 Fax: 416-585-2970

Email: Dr. Kent Stuber <kstuber@jcca.ca>
Website: www.jcca-online.org

TYPESETTING

Thistle Printing
35 Mobile Drive, Toronto, Ontario M4A 2P6

JCCA

Journal of the Canadian Chiropractic Association

(Formerly the Canadian Chiropractic Association Journal)

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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 publication by the Canadian Chiropractic Association. The JCCA is published 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, Scopus, CINAHL (Cumulative Index to Nursing and Allied Health Literature), MANTIS (formerly CHIROLARS), AMED, PASCAL, Index to Chiropractic Literature, and selectively by SPORTDiscus.

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A retrospective analysis of pain changes and opioid use patterns temporally associated with a course of chiropractic care at a publicly funded inner-city facility

Steven Passmore, Hons BKin, MS, DC, PhD¹

Quinn Malone, BSc, MSc^{1,5}

Christian Manansala, BSc, DC, MSc¹

Spencer Ferbers, BSc²

E. Audrey Toth, DC³

Gerald M. Olin, BSc, DC, CDir⁴

Background: Non-pharmacologic treatment, including chiropractic care, is now recommended instead of opioid prescriptions as the initial management of chronic spine pain by clinical practice guidelines. Chiropractic care, commonly including spinal manipulation, has been temporally associated with reduced opioid prescription in veterans with spine pain.

Purpose: To determine if chiropractic management including spinal manipulation was associated

Analyse rétrospective de l'évolution de la douleur et des habitudes de consommation des opioïdes temporairement associées à des soins chiropratiques au sein d'un établissement du centre-ville financé par l'État
Contexte : Conformément aux directives de pratique clinique, un traitement non pharmacologique, notamment des soins chiropratiques, à la place de prescriptions d'opioïdes est désormais recommandé dans le traitement initial de la douleur chronique à la colonne vertébrale. Les soins chiropratiques, qui comprennent habituellement la manipulation vertébrale, ont été liés de manière provisoire à une consommation

¹ Faculty of Kinesiology and Recreation Management, University of Manitoba

² Rady Faculty of Health Sciences, University of Manitoba

³ Mount Carmel Clinic Chiropractic Program, Winnipeg, Canada

⁴ Canadian Chiropractic Protective Association

⁵ School of Health and Exercise Sciences, University of British Columbia – Okanagan

Corresponding author:

Steven Passmore, Faculty of Kinesiology and Recreation Management, University of Manitoba, 102- Frank Kennedy Centre, 420 University Crescent, Winnipeg, MB, R3T 2N2 Canada

e-mail: steven.passmore@umanitoba.ca

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The authors declare that they have no competing interests. Ethics approval for this study was granted by the University of Manitoba Health Research Ethics Board. This study was funded by the Canadian Chiropractic Association (CCA). The CCA had no influence over the reported results, data reduction, analysis, or statistical modelling. Statistical tests were performed by an individual who had no contact with the granting organization directly or indirectly throughout the process.

with decreased pain or opioid usage in financially disadvantaged individuals utilizing opioid medications and diagnosed with musculoskeletal conditions.

Methods: A retrospective analysis of quality assurance data from a publicly funded healthcare facility was conducted. Measures included numeric pain scores of spine and extremity regions across three time points, opioid utilization, demographics, and care modalities.

Results: Pain and opioid use significantly decreased concomitant with a course of chiropractic care.

Conclusions: A publicly funded course of chiropractic care temporally coincided with statistically and clinically significant decreases in pain and opioid usage in a financially disadvantaged inner-city population.

(JCCA. 2022;66(2):107-117)

KEY WORDS: analgesics, back pain, chiropractic, chronic pain, low-income population, musculoskeletal manipulations, musculoskeletal pain, opioid, single-payer system, spine

Introduction

Since 1994, there has been a 4-fold increase in opioid prescription in the United States and long-term opioid use has become a major public health concern.^{1,2} In recent years there has been a decrease in opioid prescription for chronic pain;³ however, opioid prescription for back pain remains high⁴⁻⁶, and prescription rates in the US and Canada are two or three times higher than in most European countries⁴. This is problematic because of the high incidence of addiction and overdose related deaths associated

réduite d'opioïdes sur ordonnance chez les vétérans souffrant de douleurs à la colonne vertébrale.

Objectif : Déterminer si un traitement chiropratique, y compris la manipulation vertébrale, était lié à une diminution de la douleur ou de la consommation d'opioïdes chez les personnes défavorisées sur le plan financier utilisant des médicaments à base d'opioïdes et souffrant de problèmes musculosquelettiques.

Méthodologie : Une analyse rétrospective des données sur l'assurance de la qualité provenant d'un établissement de soins de santé financé par l'État a été menée. Les mesures portaient sur des résultats numériques de la douleur à la colonne vertébrale et des extrémités des membres à trois moments différents, la consommation d'opioïdes, des données démographiques et les modes de soins.

Résultats : La douleur et la consommation d'opioïdes ont sensiblement diminué dans le cadre de soins chiropratiques.

Conclusions : Une diminution importante de la douleur et de la consommation d'opioïdes observée de façon statistique et clinique a coïncidé de manière provisoire avec des soins chiropratiques financés par l'État dans un groupe de personnes défavorisées sur le plan financier vivant au centre-ville.

(JCCA. 2022;66(2):107-117)

MOTS CLÉS : analgésiques, chiropratique, colonne vertébrale, douleur chronique, douleur dorsale, douleur musculosquelettique, manipulations musculosquelettiques, opioïde, population à faible revenu, système à payeur unique

with opioid use and the paucity of evidence that opioids actually aid those suffering from chronic musculoskeletal conditions, such as back pain.⁷⁻⁹ Opioid medications impair the ability to engage in activities of daily living⁵ and are no more effective than alternative treatments for pain-related dysfunction¹⁰, creating financial and quality of life challenges. While there may be situations where opioid medication prescription is clinically necessary; for those patients with chronic, non-cancer conditions such as those suffering from musculoskeletal conditions includ-

ing back and neck pain; there are other options that are recommended by clinical practice guidelines (CPGs).¹¹⁻¹⁴

Back pain has been cited as the leading cause of activity limitation and work disability worldwide and has become one of the most common reasons for seeking care.^{6,15-17} Most adults will experience back pain at some point in their life¹⁸ and total costs associated with back pain are estimated as high as \$100 billion per year in the United States^{11,19} and \$6-\$12 billion per year in Canada¹³. People afflicted with back pain tend to have significantly higher health care utilization and costs.^{6,20} Additionally, studies have provided evidence that more expensive therapies and diagnosis techniques do not result in better patient outcomes.²⁰⁻²² Given the ballooning costs of healthcare systems around the world, health policy stakeholders, such as governmental policy makers, clinicians, governing bodies of healthcare professions, insurance companies, workers' compensation groups, and the general public, should consider more affordable, cost-efficient, and effective approaches for the management back pain that are congruent with CPGs.

According to recent CPGs, a trial of non-pharmacologic care should be considered as a first line treatment for those suffering back pain. Spinal manipulative therapy (SMT) is one such recommended treatment option.^{11-14,23,24} Spinal manipulative therapy has been demonstrated to be a cost-effective treatment option for the management of back pain²⁵⁻²⁸ and results in high reported levels of patient satisfaction²⁹⁻³¹. Chiropractic care, which involves spinal manipulation and adjunctive therapies, is consistent with recent CPGs¹¹⁻¹⁴ and is a viable first line treatment option prior to the use of opioid prescription medication. Additionally, many individuals with chronic non-cancer pain (46%) seek chiropractic as a treatment option.³² Chiropractic care is congruent with recommendations from both the American College of Physicians¹¹ and Canadian Chiropractic Guideline Initiative¹³ because it has demonstrated positive outcomes for spinal pain and has been associated with safety, cost effectiveness, and reductions in opioid use^{12-14,33-35}. Unfortunately, low-income individuals may not have equitable access to chiropractic care as a treatment option. In the Canadian healthcare system, individuals with incomes below a certain point are compensated for any prescription drugs they purchase by provincial pharmaceutical programs, while full reimbursement for chiropractic care is not currently covered. While more

affluent individuals may access chiropractic care through third party insurance or out-of-pocket payments, low-income individuals may be unable to access such CPG recommended treatment options. Low-income individuals are therefore unable to access chiropractic care due to financial barriers even though it is a less expensive and less harmful form of treatment than prescription opioids. An investigation of whether a low-income demographic benefits from a course of chiropractic care would help to demonstrate if extending equitable access to this form of therapy is warranted. With the present opioid crisis, SMT should be considered as a possible treatment option for patients to transition from opioid prescriptions or illicit use towards more effective and less harmful pain management options such as chiropractic. The purpose of this study was to investigate opioid utilization and musculoskeletal pain rating among low-income patients receiving chiropractic care in a publicly funded healthcare system. It was our hypothesis that such individuals would decrease their opioid use concomitant with decreased pain intensity ratings associated with a course of chiropractic care.

Methods

Ethics approval for this study was granted by the University of Manitoba Health Research Ethics Board.

Study design

The study was a retrospective review of prospectively collected quality assurance data obtained from the chiropractic program database of a publicly funded clinic.

Setting

All information collected for this study was obtained from a publicly funded clinic in Winnipeg, Manitoba with integrated on-site chiropractic services. The data used for this study is securely maintained at the publicly funded clinic by the treating clinicians on site. Patient data was completely de-identified upon entry to an anonymized database prior to analysis and interpretation.

Patients and variables

The data was collected between January 2011 to December 2017. Inclusion criteria for database review included patients identified/indicated as having: (a) experienced pain >3 months duration, (b) a history of opioid utiliz-

Table 1.
Patient Characteristics

| Characteristic | N (%), or mean (SD) [range] |
|---|-----------------------------|
| Total Patients | 62 (100%) |
| Age (years) | 48.6 (13.6) [19-83] |
| BMI^a (kg/m ²) | 31.6 (8.46) [18.24-49.75] |
| Gender^b | |
| Men | 24 (38.7%) |
| Women | 38 (61.3%) |
| Ethnicity^b | |
| Caucasian | 30 (48.4%) |
| Metis | 15 (24.2%) |
| First Nations | 15 (24.2%) |
| African | 1 (1.61%) |
| Latino | 1 (1.61%) |
| Chronic Pain Region at Baseline | |
| Cervical | 23 (37.1%) |
| Thoracic | 40 (64.5%) |
| Lumbar | 50 (80.6%) |
| Sacral | 41 (66.1%) |
| Extremity | 34 (54.8%) |
| Referrals | |
| Referred by PCP ^c | 42 (67.7%) |
| Referred back to PCP post-treatment | 5 (8.1%) |
| No further referral needed post-treatment | 57 (91.9%) |

^aBody Mass Index. ^bSelf-identified by patients. ^cPrimary Care Provider.

ation at admission or during their care, and (c) received a course of chiropractic care. Eligibility for chiropractic treatment included: (a) residence in a pre-identified low-income neighbourhood, and (b) lack healthcare insurance coverage for chiropractic care. Immigrants and refugees to Canada living in pre-determined geographic locales for less than three years and individuals who did not have a standing claim involving an automobile injury claim or Workers Compensation Board funding who were referred by partner programs/organizations also received care and were included in this analysis. The eligibility for chiropractic treatment, and therefore the focus on low-income individuals, was determined by the treatment and data collection site, which is dedicated to providing healthcare services to economically disadvantaged individuals in Winnipeg, Manitoba. Sociodemographic infor-

mation derived from the eligible patient database entries is provided in Table 1. Independent variables included the pain site and time point. Pain sites were indicated according to their anatomical site as follows: cervical spine (CS), thoracic spine (TS), lumbar spine (LS), sacroiliac region (SI), and extremity (EXT). Time points included: baseline (BL) which was the time of first treatment, visit 5 (V5), and discharge (DIS). Dependent variables included pain level, opioid use at baseline/discharge, and the number of Tylenol 3 (T3) pills used per day. Pain level experienced at each symptomatic site was assessed by a numeric rating scale (NRS), an 11-point Likert scale with 0 representing “no pain” and 10 representing “worst pain imaginable.”³⁶ The minimally clinically important difference (MCID) was determined to be 2-points on the pain rating Likert scale.¹¹ The number of patients using opioids at BL, DIS, or neither was reported (Table 4). If the opioid being used at BL or DIS was T3, the number of T3 tablets utilized per day was reported (Figure 2).

Bias

This study was funded by the Canadian Chiropractic Association (CCA). However, the CCA had no influence over the reported results, data reduction, analysis, or statistical modelling. Statistical tests were performed by an individual who had no contact with the granting organization directly or indirectly throughout the process. Another source of bias may have occurred from patients refusing to disclose or misreporting their own opioid use.

Chiropractic treatment methods and frequency

Patients receiving chiropractic treatment underwent a history and physical examination followed by a course of pragmatic care as determined by the attending chiropractors. Follow up visits during a course of care consisted of; diversified spinal or extremity joint manipulation and/or mobilization, soft tissue therapy, acupuncture, and/or other modalities, including but not limited to ultrasound, electrical stimulation, thermal treatment, exercise, home advice, and Kinesiotaping, when clinically indicated. All aforementioned treatments were delivered by a licensed chiropractor. Re-evaluation visits were scheduled after every four to six treatment visits to assess response to care. New patient assessments were scheduled for 30 to 60 minutes, while treatment visits and re-evaluation visits were 15 to 30 minutes in duration.

Statistical analyses

Descriptive analyses included demographic and treatment modality means and standard deviations, as well as the number of patients and their percentage change in T3 tablets taken per day for the subset of patients with T3 prescriptions over the course of chiropractic care.

Analyses were conducted using jamovi (The jamovi project, v. 0.9). All analyzed outcomes were calculated as p-values and the level of significance was set to $\alpha=0.05$. One-way repeated measures analysis of variance (ANOVA) models (3 timepoints – baseline, visit 5, discharge) were used to establish main effects for time under care at each pain site, after which Tukey's honestly significant differences was used to determine the location of main effects. McNemar's test was used to analyze the difference in opioid utilization rates at baseline and discharge.

Results

Patients

Out of the 482 patients treated by the chiropractic program in the analyzed timeframe (January 2011 to December 2017) at the publicly funded clinic, 62 individuals met the inclusion criteria. Out of the eligible patients, 67.7% were referred by their Primary Care Provider (PCP) to the on-site chiropractic program. The majority of study participants were woman (61.3%), who self-identified as Caucasian (48.4%), with a mean age of 48.6, SD=13.6 years old, and a BMI of 31.6, SD=8.5 kg/m² (obese). The most commonly reported painful spinal complaints were in the lumbar (80.6%), sacral (66.1%) and thoracic (64.5%) regions. The overwhelming majority of patients had pain in multiple regions, specifically: 14 out of 62 patients had pain in two regions, 17 had pain in three regions, 14 had pain in four regions and 16 had pain in five regions. At the end of their course of chiropractic care, 8.1% of patients were referred back to their PCP for alternate treatment consideration. As a result, 91.9% of chiropractic patients using opioids were able to be discharged without further referral for their musculoskeletal spine pain following a course of chiropractic care (Table 1). Thirty-three of the opioid using patients utilized a singled course of chiropractic care, which allowed us to confirm specific start and end dates of the course of care. The average duration of that course of care was M=15.77 weeks, SD=17.40

weeks; with M =16.38 treatment visits, SD=16.70 treatment visits over that period of time. A limitation of the dataset is that the number of weeks in a course of care is not possible to determine when multiple courses of care are engaged in by a single patient. For all patients with opioid medication prescriptions, dosage, onset, and offset of medication was guided by the prescribing physician. A breakdown of care modalities employed is shown in Table 2.

Pain by region and time point

We observed a statistically and clinically significant decrease in pain level over a course of care from baseline compared to visit 5 and baseline compared to time of discharge for patients using opioid medications. Pain was reduced by amounts exceeding minimally clinically important differences (MCID) in all anatomical regions. The MCID was determined to be 2-points on the pain rating Likert scale.¹¹ Mean reported pain between BL and V5 pain changed by -2.50 (CS), -3.15 (TS), -2.72 (LS), -2.97 (SI), and -3.48 (EXT); between BL and DIS, pain changed by -2.63 (CS), -3.11 (TS), -3.56 (LS), -3.72 (SI), and -3.78 (EXT). Between V5 and DIS, further pain changes were no longer statistically significant, though trends toward further reductions were seen, with the exception of the thoracic region: -0.125 (CS), 0.037 (TS), -0.844

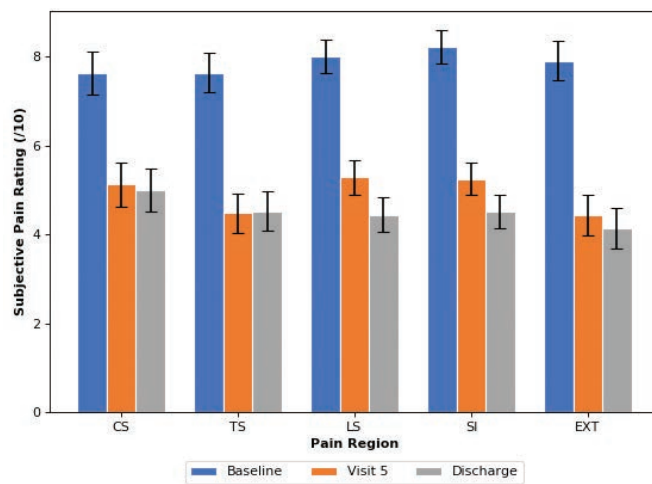


Figure 1.

Self-reported spine pain across a course of chiropractic care (error bars represent standard error).

Table 2.
Treatment modalities utilized

| Treatment | N (% total patients) | Treatment | N (% total patients) |
|---|-------------------------|--|-------------------------|
| Total Patients | 62 (100%) | Electrical Stimulation^b | 13 (21.0%) |
| Spinal/Extremity Manipulative Therapy | 62 (100%) | Cervical | 2 (3.23%) |
| Cervical | 28 (45.2%) | Thoracic | 5 (8.06%) |
| Thoracic | 52 (83.9%) | Lumbar | 8 (12.9%) |
| Lumbar | 54 (87.1%) | Sacral | 7 (11.3%) |
| Sacral | 49 (79.0%) | Extremity | 2 (3.23%) |
| Extremity | 30 (48.4%) | Thermal Treatment^c | 49 (79.0%) |
| Spinal/Extremity Manipulative Therapy Method | 62 (100%) | Cervical | 11 (17.7%) |
| Manual adjustment with cavitation | 44 (71.0%) | Thoracic | 27 (43.5%) |
| Side posture with cavitation | 23 (37.1%) | Lumbar | 33 (53.2%) |
| Drop table | 46 (74.2%) | Sacral | 34 (54.8%) |
| Activator instrument 41 (66.1%) | | Extremity | 19 (30.6%) |
| Mobilization | 62 (100%) | Exercises | 43 (69.4%) |
| Cervical | 30 (48.4%) | Cervical | 19 (30.6%) |
| Thoracic | 53 (85.5%) | Thoracic | 32 (51.6%) |
| Lumbar | 58 (93.5%) | Lumbar | 36 (58.1%) |
| Sacral | 50 (80.6%) | Sacral | 29 (46.8%) |
| Extremity | 36 (58.1%) | Extremity | 25 (40.3%) |
| Soft Tissue Therapy^a | 62 (100%) | Kinesiotaping | 7 (11.3%) |
| Cervical | 31 (50%) | Cervical | 1 (1.61%) |
| Thoracic | 54 (87.1%) | Thoracic | 2 (3.23%) |
| Lumbar | 58 (93.5%) | Lumbar | 3 (4.84%) |
| Sacral | 50 (80.6%) | Sacral | 1 (1.61%) |
| Extremity | 36 (58.1%) | Extremity | 4 (6.45%) |
| Acupuncture | 31 (50%) | Other Modalities^d | 35 (56.5%) |
| Cervical | 10 (16.1%) | Cervical | 7 (11.3%) |
| Thoracic | 5 (8.06%) | Thoracic | 9 (14.5%) |
| Lumbar | 10 (16.1%) | Lumbar | 15 (24.2%) |
| Sacral | 14 (22.6%) | Sacral | 17 (27.4%) |
| Extremity | 26 (41.9%) | Extremity | 19 (30.6%) |
| Ultrasound | 1 (1.61%) | Reinforcement of other provider recommendations | 24 (38.7%) |
| Cervical | 0 (0%) | Prescriptions | 12 (19.4%) |
| Thoracic | 0 (0%) | Labwork ^e | 8 (12.9%) |
| Lumbar | 0 (0%) | Special Studies ^f | 16 (25.8%) |
| Sacral | 0 (0%) | Compliance ^g | 20 (32.3%) |
| Extremity | 1 (1.61%) | Other | 18 (29.0%) |
| | | Supportive Nutritional Encouragement | 22 (35.5%) |
| | | Supportive Emotional/Social Encouragement | 37 (60.0%) |

^aMechanical percussive therapy using a Thumper, Effleurage, Deep Tissue, Trigger Point Therapy, Transverse Friction Therapy, Soft Tissue Mobilization.

^bInterferential Current, Transcutaneous Electrical Nerve Stimulation (TENS), Russian Stim. ^cCryotherapy or heat application. ^dLinament application. ^eProviding labwork results to the patient in lieu of another provider. ^fExplanation and encouragement to go through with a procedure/imaging recommended by another provider. ^gEncouragement to adhere to a prescription from another provider.

Table 3.
ANOVAs for pain across a course of chiropractic care at different anatomical locations

| Descriptives | | | | ANOVA | | | | | Post-Hoc | | |
|--------------|-----------|------------|----------|--------------------|------------------------------|------------------------------|--------------------|-----------------------------|---|------------------------------|-----------------|
| Pain Region | Time | Mean (/10) | SE (/10) | F _{ANOVA} | df _B ^a | df _W ^b | p _{ANOVA} | η ² _p | BL ^c -V5 ^d (/10) | BL-DIS ^e (/10) | V5-DIS (/10) |
| Cervical | Baseline | 7.63 | 0.488 | 9.47 | 2 | 30 | <0.001* | 0.387 | 2.51* | -2.63* | -0.120 |
| | Visit 5 | 5.12 | | | | | | | | | |
| | Discharge | 5.00 | | | | | | | | | |
| Thoracic | Baseline | 7.63 | 0.445 | 33.0 | 2 | 52 | <0.001* | 0.559 | -3.15* | -3.11* | 0.040 |
| | Visit 5 | 4.48 | | | | | | | | | |
| | Discharge | 4.52 | | | | | | | | | |
| Lumbar | Baseline | 8.00 | 0.384 | 36.4 | 2 | 62 | <0.001* | 0.540 | -2.72* | -3.56* | -0.840 |
| | Visit 5 | 5.28 | | | | | | | | | |
| | Discharge | 4.44 | | | | | | | | | |
| Sacroiliac | Baseline | 8.22 | 0.375 | 40.9 | 2 | 62 | <0.001* | 0.569 | -2.97* | -3.72* | -0.750 |
| | Visit 5 | 5.25 | | | | | | | | | |
| | Discharge | 4.50 | | | | | | | | | |
| Extremities | Baseline | 7.91 | 0.455 | 44.9 | 2 | 44 | <0.001* | 0.671 | -3.48* | -3.78* | -0.300 |
| | Visit 5 | 4.43 | | | | | | | | | |
| | Discharge | 4.13 | | | | | | | | | |

^aDegrees of freedom between groups. ^bDegrees of freedom within groups. ^cBaseline. ^dVisit 5. ^eDischarge. *Significant difference (α=0.05)

(LS), -0.750 (SI), and -0.304 (EXT), respectively (Figure 1; Table 2).

Main effects for time were found in the ANOVA for each anatomical region. Post-hoc analysis revealed that the BL timepoint was different from V5 and DIS, while there were no significant differences between V5 and DIS in any comparison (Table 3).

Opioid usage by time point

A significant number of people who utilized opioids at BL no longer did at DIS (n=15). Although some people who did not use opioids at BL did at DIS (n=4), McNemar’s test revealed that the number of people who stopped using opioids during the study period was significantly greater than those who began (p=0.012) (Table 4). Therefore, there was a significant decrease in the number of people who used opioids at DIS compared to BL. This translated into a 59.0% reduction in the number of patients using

Table 4.
Results of McNemar’s test for differences between opioid utilization at baseline and discharge

| Baseline | Discharge | | Total |
|----------------|----------------|-------------|-------|
| | No Utilization | Utilization | |
| No Utilization | 19* | 4 | 23 |
| Utilization | 15 | 24 | 39 |
| Total | 34 | 28 | 62 |
| McNemar’s Test | | | |
| | Value | df | p |
| χ ² | 6.37 | 1 | 0.012 |
| N | 62 | | |

*Used opioids at some point during the course of care but did not at baseline or discharge.

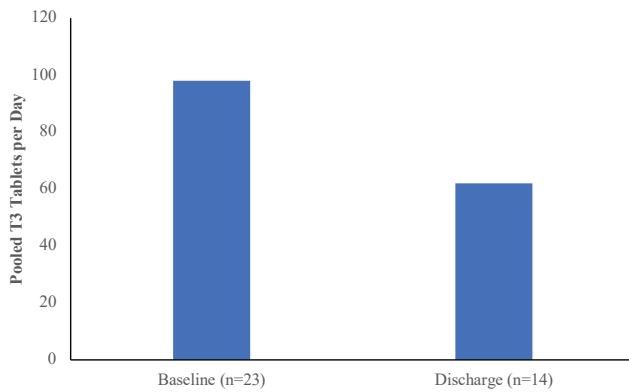


Figure 2.
Difference between baseline and discharge pooled Tylenol 3 usage per day

opioids after progressing through a course of chiropractic care (Table 4).

Tylenol 3 tablet usage per 24-hour period

Tylenol 3 tablets (T3 – 30mg of codeine phosphate) were the most commonly prescribed opioid for the chiropractic clinic patients between BL and DIS. At BL the pooled daily usage of T3 tablets was 98 tablets per day based on a sample size of 23 patients. At DIS the pooled daily usage of T3 tablets reduced to 62 tablets per day. There was a 36.7% reduction in usage (number of tablets per 24-hour period, excluding PRN [pro re nata, or “at will”] prescriptions) following a course of chiropractic care. Upon closer examination, the relationship is linked to the number of patients continuing to be on a T3 prescription. Individuals taking T3 were consuming about the same amount on average per person at the start and the end of care (98 tablets/23 people=4.26 tablets per person, 62 tablets/14 people=4.43 tablets per person), but overall fewer people 14/23 =60.9% (a 39.1% reduction) remained on T3 by the end of a course of care.

Discussion

The hypothesis of this study; that low-income individuals would experience decreased pain and a reduced rate of opioid utilization after a course of chiropractic care; is supported by the present results. Pain decreased over a course of care, with statistically and clinically significant

differences being observed after five visits for every anatomical pain region examined and treated. The sample considered in this study was more likely to have ceased their opioid usage at discharge than to have commenced opioid utilization over that course of care. Nearly 40% fewer individuals used Tylenol 3 at the end of their course of care compared to their baseline.

A population frequently exposed to opioid medications are those with spinal pain, specifically low back pain. Usual medical care for low back pain patients is not consistent with CPG recommendations. Studies report up to 30% of patients who see their family physician with low back pain receive opioid prescriptions and 60% of patients reporting to the Emergency Department with low back pain do as well.³⁷ This indicates the overuse of opioid prescription in these settings. The low-income population is a group that is inordinately at risk of opioid addiction and mortality following exposure through prescription.³⁸ A potential solution to consider for patients with chronic spinal pain is a course of chiropractic care, a non-pharmacological healthcare intervention. A recent review by Corcoran suggested that those utilizing chiropractic services had 64% lower odds of being prescribed opioid medications compared to people not utilizing chiropractic services.³⁵ The results of the present study and those referenced above suggest that enabling economically disenfranchised people to have access to chiropractic services may reduce pain and may reduce opioid use.

The present study was conducted in an environment that alleviated the financial barrier for access to chiropractic care through public funding from a provincial government in Canada. The results observed were that a course of chiropractic treatment for those who utilized opioids occurred concomitantly with a statistically and clinically significant decrease in patient reported chronic pain. Most cases (91.9%) did not require further referral to another healthcare provider upon discharge from chiropractic care, providing evidence that most musculoskeletal pain issues were resolved to a point where the patients no longer sought additional healthcare services for their musculoskeletal pain at the end of the course of care. A low rate of further referral to other healthcare disciplines following a course of chiropractic care is in agreement with previously published studies.³⁹ Chiropractic management has been shown to be a relatively cost-effective non-pharmacological treatment for back pain.^{26,28} Not requiring fur-

ther referral in most cases and a decrease in chronic pain intensity after a brief course of care provide evidence that chiropractic management is potentially a cost-efficient and effective treatment option to consider for integration into publicly funded health systems.³⁹

There are limitations to the current study. As this is a retrospective analysis and patients were not randomized to a chiropractic care or control group, causation is not possible to determine using this design. The lack of control over additional comorbidity and life circumstances of the sample population mean that unpredicted factors may have impacted patient outcomes. The population is somewhat heterogenous, in that while all patients utilized opioid medications, some patients were prescribed opioid medications, while others admitted self-medicating with opioids that were not attained through prescription or legal sources. A limitation of the dataset is that the number of weeks in a course of care is not possible to determine when multiple courses of care are engaged in by a single patient. Additionally, the use of a design that does not require a control group means that the effects of time or other interventions were not controlled for. This also includes not being able to control for the updated opioid prescribing guidelines for chronic pain in Canada that were introduced in 2011, and were updated in 2017.^{40,41} Given that chronic pain may fluctuate over time, but is not likely to spontaneously resolve, and the treatments offered were congruent with CPG recommendations,¹¹ the improvements observed are promising and should not be discounted; they can be a catalyst for further prospective study.

Conclusions

The results of the present study found a statistically and clinically significant pain reduction concomitant with publicly funded chiropractic management in a low-income population who utilized opioids. Additionally, a reduction in opioid use, compared to baseline, was found following a course chiropractic management at a multidisciplinary healthcare facility where the majority of patient referrals came from primary care physicians, and resulted in an endpoint of musculoskeletal care for the majority of individuals treated by the onsite chiropractors.

Acknowledgements

The authors would like to acknowledge the support of the Mount Carmel Clinic for providing the database records

used to perform this study and the Canadian Chiropractic Association for providing grant support for the project. The granting agency had no impact or input on the design, analysis methods selected, results, or interpretation.

Availability of data and materials

The data underlying this article were provided by the Mount Carmel Clinic with permission. Data will be shared on request by the corresponding author with the permission of the Mount Carmel Clinic.

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The utility of bioelectrical impedance analysis in the diagnosis of sarcopenia: a systematic review

Ben Csiernik, DC¹

Michael Edgar, BKin, DC^{1,2}

Chris DeGrauw, DC, FRCCSS(C)

Scott Howitt, DC, MSc, FRCCSS(C), FCCPOR¹

Sheilah Hogg-Johnson, MMath, PhD^{1,3,4}

Context: Sarcopenia is a prevalent syndrome that has seen increased awareness in the last twenty years.

Objective: To systematically assess and evaluate the utility of bioelectrical impedance analysis (BIA) in the diagnosis of sarcopenia in adults over the age of 60.

Methods: An electronic search strategy of databases was conducted, including Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, and SportDiscus. Included articles were evaluated using The Quality Appraisal for Reliability Studies (QAREL) checklist.

Results: Seven articles (1336 participants) met the inclusion criteria of evaluating the diagnostic ability of BIA. Results indicate that there is a high degree of heterogeneity in how BIA is used to diagnose sarcopenia.

Utilité d'une analyse d'impédance bioélectrique dans le diagnostic de la sarcopénie : examen systématique

Contexte : La sarcopénie est un syndrome répandu qui a suscité une attention accrue ces vingt dernières années.

Objectif : Examiner et évaluer systématiquement l'utilité d'une analyse d'impédance bioélectrique dans le diagnostic de la sarcopénie chez des adultes âgés de plus de 60 ans.

Méthodologie : Une stratégie de recherche électronique sur des bases de données a été appliquée, notamment le Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL et SportDiscus. Les articles en question ont été évalués grâce à la liste de vérification de l'instrument Quality Appraisal for Reliability Studies (QAREL).

Résultats : Sept articles (1 336 participants) remplissaient les critères d'inclusion de l'évaluation de la capacité diagnostique de l'analyse d'impédance bioélectrique. Les résultats montrent un degré

¹ Canadian Memorial Chiropractic College

² University of Illinois College of Medicine

³ Institute for Disability and Rehabilitation Research

⁴ Dalla Lana School of Public Health, University of Toronto

Corresponding Author:

Ben Csiernik, Canadian Memorial Chiropractic College, 6100 Leslie Street, North York, Ontario, M2H 3J1 Canada

Tel: 416 482 2340,

e-mail: bcsiernik@cmcc.ca

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The authors have no disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript.

While BIA is an affordable and easy to use measurement tool, it does not consistently demonstrate high levels of diagnostic sensitivity.

Conclusion: The current evidence does not consistently support the utility of BIA as an accurate diagnostic tool for sarcopenia in adults over 60. If utilizing BIA, clinicians should select a validated BIA equation for their patient's demographics. Clinicians should also consider the use of functional tests and validated screening questionnaires.

This systematic review was registered at https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=211586

(JCCA. 2022;66(2):118-129)

KEY WORDS: aging, bioelectrical impedance, diagnosis, sarcopenia, screening, systematic review

Introduction

Sarcopenia, defined as poverty or deficiency of flesh, was first described by Rosenberg in 1989.¹ Sarcopenia is a degenerative muscular disease in which individuals have decreased muscle quantity, quality, and strength.^{2,3} Between the ages of 20 and 80 years old, the average adult experiences a reduction of roughly 30% of their muscle mass and a decline in cross-sectional area of approximately 20%.⁴ To better address the needs of individuals with sarcopenia, multiple international working groups targeting sarcopenia have been created, each with their own operational definition for the condition.^{2,5-7} While differences exist between these definitions, all acknowledge that sarcopenia is characterized by a decrease in muscle strength and function. Sarcopenia, in this regard, is viewed as the presence of both low muscle mass and low muscle function. Reported prevalence estimates for sarcopenia in community-dwelling older adults (>60

élevé d'hétérogénéité dans l'utilisation de l'analyse d'impédance bioélectrique pour diagnostiquer la sarcopénie. Si l'analyse d'impédance bioélectrique est un outil de mesure fiable et facile à utiliser, il ne démontre pas systématiquement de hauts niveaux de sensibilité diagnostique.

Conclusion : Les données probantes actuelles ne justifient pas systématiquement l'utilité d'une analyse d'impédance bioélectrique comme outil diagnostic précis de la sarcopénie chez des adultes âgés de plus de 60 ans. S'ils utilisent l'analyse d'impédance bioélectrique, les cliniciens doivent choisir une équation de l'analyse validée pour les données démographiques de leurs patients. Les cliniciens doivent également envisager de recourir à des examens fonctionnels et à des questionnaires de dépistage validés.

L'examen systématique a été consigné sur le site https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=211586

(JCCA. 2022;66(2):118-129)

MOTS CLÉS : dépistage, diagnostic, examen systématique, impédance bioélectrique, sarcopénie, vieillissement

years) vary between 1% and 52% based on the definition and measurements used.⁸

Multiple methods exist to measure muscle mass or function for the diagnosis of sarcopenia.⁸ Although magnetic resonance imaging (MRI) is considered the reference standard for measuring lean body mass, it is costly and not readily available.^{8,9} Several clinically based measures have also been used to detect sarcopenia. These include tests such as bioelectrical impedance analysis (BIA), grip strength via handheld dynamometry, gait speed, the short physical performance battery, SARC-F functional test, the sarcopenia – Quality of Life (SarQoL) questionnaire, and the Short Portable Sarcopenia Measure (SPSM).^{2,9-11} Given the aging population and complications related to sarcopenia, it is critically important to find practical and affordable measures to diagnose the condition.

Bioelectrical impedance analysis was originally designed as a tool to measure total body water and fat free

mass.¹⁰ BIA offers a fast, affordable, easy-to-use method for the estimation of lean body mass by clinicians, including sports medicine physicians, physiotherapists, and chiropractors.¹¹ With BIA, lean body mass is measured using electrical conductance to determine the resistance to flow as the current passes through the body, without the use of radiation. This provides estimates of body composition using specific equations programmed into the device, which can assist in the detection of low muscle mass.¹¹⁻¹³ BIA has been studied in a variety of populations, demonstrating its popularity as a measure of lean body mass worldwide. However, previous reviews have not explicitly evaluated the diagnostic utility of BIA in adults over the age of 60 years old.

The purpose of this systematic review was to identify and critically appraise the utility of bioelectrical impedance analysis to measure lean body mass in order to detect sarcopenia, and to determine its diagnostic validity in a clinical setting. In this study, we present findings related to the diagnostic utility of BIA for sarcopenia in adults over 60 years old.

Methods

Search strategy

A search strategy was developed in consultation with a health sciences librarian with the search performed on 28 April 2020.¹⁴ The basic search strategy was developed using key search terms such as, “Sarcopenia” OR “lean body mass” AND “bioelectrical impedance analysis” AND “DXA” AND “Validity” OR “Reliability.” Search terms consisted of subject headings specific to each database (e.g., MeSH in MEDLINE) and free text words relevant to sarcopenia measures, validity, and reliability (Appendix I).

The following electronic databases were systematically searched from database inception to April 2020: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, and SportDiscus. The systematic review search strategy was similar to the strategy used previously by Shafiee *et al.*¹⁵ on a similar topic to confirm that relevant studies were found.

Selection of studies

To be included in the systematic review, studies had to fulfill the following inclusion criteria: 1) English lan-

guage; 2) published in a peer-reviewed journal; 3) study designs included observational studies including cohort studies, cross-sectional studies, case series and randomized controlled trials if they met other inclusion criteria; 4) study population adults 60 or older (study could report on other ages, but the ability to extract data for participants 60+ years old had to be available for inclusion); 5) measures included bioelectrical impedance analysis (BIA) compared to ultrasound sonography (USS), dual-energy x-ray absorptiometry (DXA), computerized tomography (CT) or magnetic resonance imaging (MRI) 6) measuring lean muscle mass or diagnosing sarcopenia; 7) statistical measures included at least one of the following: sensitivity, specificity, positive and negative predictive values, reliability, validity, limits of agreement, mean difference, standard error of estimates and responsiveness of BIA as measure of lean muscle mass or sarcopenia. For the synthesis presented in this manuscript, only studies that utilized BIA to diagnose sarcopenia were included.

Studies fulfilling any of the following criteria were excluded: 1) publication types including: guidelines, letters, editorials, commentaries, unpublished manuscripts, dissertations, government reports, books and book chapters, conference proceedings, meeting abstracts, lectures and addresses, consensus development statements; 2) study designs including: pilot studies, case reports, qualitative studies, non-systematic and systematic reviews, clinical practice guidelines, biomechanical studies, laboratory studies, studies not reporting on methodology; 3) cadaveric or animal studies; 4) tests or measures which do not include a measure of BIA; 5) sarcopenia muscle mass tests which did not compare to bioelectrical impedance analysis.

Screening of titles and abstracts

All potentially relevant citations identified by the search strategy were exported into EndNote X6 for reference management, study screening, and removal of duplicates. Rotating pairs of trained reviewers independently screened articles in two phases using a standardized pre-piloted Excel spreadsheet. The first phase involved screening titles and abstracts for relevance based on criteria described above, with potential ratings of relevant, possibly relevant, and irrelevant. At the end of phase one screening, disagreements between reviewers were resolved by discussion to reach consensus. In the second phase, a single pair of reviewers screened the full text arti-

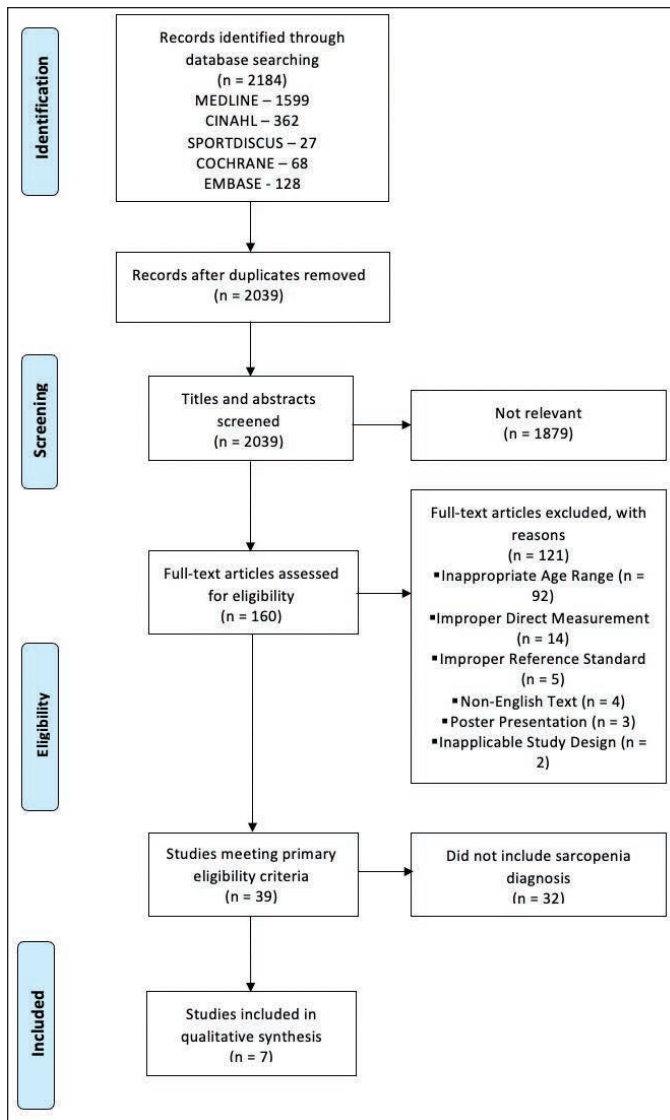


Figure 1.
PRISMA flow diagram

cles of the possibly relevant citations to determine whether they were relevant to be included.

Critical appraisal and data extraction

All relevant studies were critically appraised by a pair of reviewers. The Quality Appraisal for Reliability Studies (QAREL) checklist was used to critically appraise the quality of the studies included.¹⁶ Consensus between reviewers was reached through discussion. The single pair

of reviewers extracted data from eligible studies to build evidence tables and a second review was done to confirm the study results. Data extracted from each study included author, publication year, study design, setting and participants (age, sex, number), assessment tool, reference standard used, outcome measured, sensitivity and specificity, negative and positive predictive value, negative and positive likelihood ratio, and inter-rater and intra-rater reliability. The QAREL checklist allowed for methodological quality to be assessed but did not lead to the exclusion of any studies.

Statistical analyses

We computed the inter-rater reliability for the screening of titles and abstracts using percent agreement and kappa coefficients (κ) with 95% confidence intervals (CI) for phase 1. We used data provided in the studies and computed the 95% CI where information was available. We reported sensitivity, specificity, positive and negative predictive values with 95% CI.

Results

Figure 1 displays the flow of articles identified through the search strategy through the screening phases. The initial search yielded 2184 potentially relevant titles and abstracts from five different databases, with 2039 remaining after duplicates were removed. Upon phase one of title and abstract screening, 1879 were found not relevant. Full-text articles (160) were reviewed with 121 being excluded as not relevant. Thirty-nine studies were further assessed for statistical analysis and purpose, with 32 excluded from the synthesis presented here as they did not assess the ability to diagnose sarcopenia. Finally, seven studies reporting on BIA as part of a diagnostic tool for sarcopenia were included in this review.

Screening

For phase 1 title and abstract screening, screeners 1 and 2 screened 691 titles and abstracts with % agreement 87.0 (95%CI 84.5-89.5) and kappa 0.30 (95%CI 0.20-0.40), screeners 1 and 3 screened 669 title and abstracts with % agreement 93.6 (95%CI 91.7-95.4) and kappa 0.63 (95%CI 0.53-0.73), and screeners 1 and 4 screened 672 titles and abstracts with % agreement 96.9 (95%CI 95.6-98.2) and kappa 0.62 (95%CI 0.47-0.77). Phase 2 involved a single person assessing the full text with a

second individual reviewing afterward to verify. The majority of studies were excluded as participants were in the inappropriate age range.

Study characteristics

Seven studies assessed BIA as a tool alone or in combination with other measurements for the diagnosis of sarcopenia, of which two also assessed the test-retest of BIA.¹⁷⁻²³ Six studies used Dual-energy X-ray Absorptiometry (DXA), and one study used ultrasound sonography (USS) as reference standard comparators. A total of four different body composition measurements were described, with appendicular skeletal muscle mass (ASMM) being used five times^{18,20-23}, and appendicular muscle mass¹⁷ and fat-free mass¹⁹ being used once each.

The number of participants included in the studies ranged from 60 to 438, with a total of 1336 participants

(472 males and 870 females). The participants ranged in age from 65 to 98 years old. The studies included community-dwelling or free-living individuals, and in-patients. The geographic location varied among studies as they took place in six different countries with two occurring in Austria^{21,23}, and one study occurring in the United States²⁰, Japan¹⁷, Indonesia¹⁸, Taipei¹⁹, and Norway²².

Methodological critical appraisal of included studies

All seven studies demonstrated acceptable methodological quality based on appropriate study design for the assessment of muscle mass in older adults. However, studies did not consistently include information regarding the individuals performing the measures, or pre-measurement factors such as fasting or fed state of the participants (Table 1). Studies were not excluded due to sample size at any point during this systematic review.

Table 1. Modified QAREL critical appraisal tool study assessment

| Modified QAREL Critical Appraisal Tool | | | | | | | | | | | | | | | |
|--|-------------------------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|--------------------------|---|
| Number | Author, Year | Section 1 | | | | | | | | | | | | Overall Study Assessment | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| 1 | Yamada et al., 2017 ¹⁷ | Y | Y | U | U | U | U | U | U | U | Y | Y | Y | A | Y |
| 2 | Laksmi et al., 2018 ¹⁸ | Y | Y | U | U | U | U | U | U | U | Y | Y | Y | A | Y |
| 3 | Fang et al., 2020 ¹⁹ | Y | Y | U | U | U | U | U | U | N | Y | Y | Y | A | Y |
| 4 | Deer et al., 2020 ²⁰ | Y | Y | U | U | U | U | U | U | U | U | Y | Y | A | Y |
| 5 | Reiter et al., 2019 ²¹ | Y | Y | U | U | U | U | U | U | U | Y | Y | Y | A | Y |
| 6 | Steihaug et al., 2016 ²² | Y | Y | Y | Y | Y | Y | Y | U | U | Y | Y | Y | A | Y |
| 7 | Reiss et al., 2016 ²³ | Y | Y | U | U | U | U | U | U | U | Y | Y | Y | A | Y |

| Legend | |
|--------|------------|
| Green | Yes |
| Red | No |
| Yellow | Unclear |
| Blue | N/A |
| Orange | Acceptable |

Footnote: The modified QAREL checklist is a tool for studies of diagnostic reliability where raters can discuss the interpretation of each item. Section 1 items revolve around study objective, representative sample and testers, blinding, examination order and timing, interpretation and statistical measures used. Section 2 focuses on the overall assessment of the paper, such as methodological quality and generalizability. A description of the 14 items evaluated is provided below.

| Section 1 | |
|-----------|--|
| 1. | Study objective clarity |
| 2. | Sample representative of intended population |
| 3. | Test rater's representative of intended raters |
| 4. | Inter-rater blinding |
| 5. | Intra-rater blinding |
| 6. | Rater blinding to reference standard |
| 7. | Rater blinding to clinical information |
| 8. | Rater blinding to additional cues |
| 9. | Order of tests |
| 10. | Interval between tests |
| 11. | Test application and interpretation |
| 12. | Statistical measures |

| Overall Study Assessment | |
|--------------------------|-----------------------------------|
| 1. | Overall assessment of methodology |
| 2. | Results applicability |

Fasting protocol

Only one study described the fasting protocol used for participants while the other six studies did not state if a fasting versus non-fasting protocol was used. Fang *et al.*¹⁹ stated that all subjects did not consume alcohol for at least 48 hours, perform vigorous exercise for at least 12 hours, or consume a meal or drink for at least 12 hours prior to the examination. No study compared fasting versus non-fasting in this population to determine its importance in BIA measurement utility. No conclusion can be made at this time regarding the utility of fasting or fasting protocols for accuracy of BIA measure as part of the diagnosis of sarcopenia.

Types of BIA measures

Four studies used single-frequency BIA (SF-BIA)²⁰⁻²³ and three studies used multi-frequency BIA (MF-BIA).¹⁷⁻¹⁹ One study used the InBody 720 which has its own proprietary formula.¹⁹ The type of BIA used as part of the diagnosis of sarcopenia may be significant, as measurements made by different frequency devices have shown different levels of accuracy in specific populations.¹⁰ However, no conclusions on the superiority of one type of BIA measurement can be made in this review as no studies compared MF-BIA to SF-BIA for the detection of sarcopenia.

Sarcopenia definitions

Several definitions for sarcopenia were utilized. The European Working Group on Sarcopenia in Older People (EWGSOP), the Janssen cut-off, and the Chien cut-offs were each used in one study, while the Asian Working Group for Sarcopenia (AWGS) definition, the Foundation for the National Institutes of Health (FNIH) definition, and Baumgartner's definition was used in two studies. Each definition had a differing cut-off point for the diagnosis of sarcopenia. It is relevant to note that no global consensus definition exists for muscle mass cut offs as the diagnosis of sarcopenia varies based on population characteristics, including anthropometric and lifestyle differences.⁷

Diagnostic ability of sarcopenia

Seven studies using a total of 13 predictive equations (10 unique) assessed the ability of BIA alone, or in combination with other variables, to diagnose sarcopenia (Table 2). As some studies used multiple cut points and equations, a total of 23 unique combinations of patient, equa-

tion, and cut points were extracted. Inconsistent findings were seen in the various studies when BIA was used in the diagnosis of sarcopenia. The majority of the formulas that included BIA to diagnose sarcopenia also incorporated factors such as age, weight, and height, in addition to impedance as measured by BIA. Therefore, BIA is often used in combination with other variables in formulas to predict muscle mass for the diagnosis of sarcopenia, rather than being used as a stand alone determinant.

The diagnostic properties of the BIA based equations for diagnosing sarcopenia are reported in Table 2. Four samples, using three equations^{17,18,23} demonstrated that using BIA had a specificity of less than 0.72, while 19 samples using eight equations¹⁹⁻²³ demonstrated that BIA had a specificity greater than 0.89. Similarly, four samples using four equations^{18,20,22,23} found a sensitivity greater than 0.76 while 19 samples using eight equations^{17,19,21-23} found that BIA had a sensitivity less than 0.67. Collectively, the specificity of BIA across the 10 unique equations ranged from 0.57 – 1, while the sensitivity ranged from 0.275 – 0.84.

Discussion

This systematic review identified seven studies that assessed the utility of BIA, alone or in combination with other variables, as a method of diagnosing sarcopenia in older adults. While criteria and protocols varied greatly, these studies found inconsistent sensitivity and specificity for equations that used BIA as a means to diagnose sarcopenia. This indicates that a wide degree of heterogeneity exists in the methods between studies that use BIA as a measurement tool when evaluating older adults. High degrees of heterogeneity were observed in whether a fasting protocol was described, patient demographics, and predictive equations used. This review identified 10 unique predictive equations that have been used in adults over the age of 60. The large number of predictive equations that have been developed highlights the variability involved in BIA as a diagnostic tool for sarcopenia, as it is significantly impacted by demographic factors such as race, age, and sex. A recently published systematic review by Beaudart *et al.*²⁴ identified similar issues with BIA predictive equations across all age groups, identifying the need for BIA equations to be validated in their intended population prior to clinical implementation. Similarly, Gonzalez *et al.*²⁵ identified that using BIA as a diagnostic

Table 2.
Data extraction from seven studies including description of studies and the diagnostic properties of BIA based diagnostic tools for diagnosis of sarcopenia

| Study author, year | Setting, Population | BIA Device | Equation | Sarcopenia Muscle Mass Cut-Offs | Subgroup | Sample Size | Sensitivity (95% CI) | Specificity (95% CI) | Positive Predictive Value (95% CI) | Negative Predictive Value (95% CI) | + Likelihood Ratio | - Likelihood Ratio |
|-----------------------------|--|---|---|---|--|--|----------------------|----------------------|------------------------------------|------------------------------------|--------------------|--------------------|
| Yamada 2017 ¹⁷ | Community dwelling older adults 65yr +, Tokyo Japan | MSd-100 (Tanita Corp., Tokyo, Japan) | Tanita device proprietary equation – unspecified | Post Hoc Cutoffs < 7.18 kg/m ² < 5.89 kg/m ² | men | N=100 | 0.66 (0.55, 0.79) | 0.57 (0.42, 0.73) | 0.70 (0.58, 0.82) | 0.53 (0.39, 0.68) | 1.53 | 0.60 |
| | | | | | women | N=247 | 0.62 (0.53, 0.70) | 0.60 (0.51, 0.68) | 0.60 (0.52, 0.69) | 0.61 (0.52, 0.70) | 1.55 | 0.63 |
| Laksmi 2018 ¹⁸ | Consecutive patients 60yr + Geriatric Clinic Jakarta Indonesia | BIA Tanita MC-780MA (Tokyo, Jepang) | Tanita device proprietary equation – unspecified | AWGS:* Men: < 7.0 kg/m ² Women: < 5.7kg/m ² | all | N=120 | 0.79 | 0.67 | 0.37 | 0.93 | 2.38 | 0.31 |
| Fang 2020 ¹⁹ | Elderly patients undergoing health examination, Taipei, Taiwan | InBody 720; Biospace | InBody proprietary equation – unspecified | AWGS:* Men: < 7.0 kg/m ² Women: < 5.4kg/m ² | Validation sample n=84 for sensitivity & specificity | N=438 (N=84 for sensitivity & specificity) | 0.66 | 1.00 | | | ∞ | 0.34 |
| Deer 2020 ²⁰ | Inpatients University of Texas hospital age 65yr + , able to stand upright | Tanita; BF-350 | ASMM _{BIA} = 7.1 + (-2.8 x gender) + (0.5 x BMI) + (0.1 x Max Grip Strength) + (-0.1 x FM _{BIA}) gender: male = 0 female = 1 FM _{BIA} , fat mass from BIA (%) | FNIH:* Male < 19.75 kg Female: < 16 kg EWGSOP2:* Male: < 7 kg/m ² Female: < 6 kg/m ² Two criteria led to same classification | all | N=125 | 0.80 (0.66, 0.94) | 0.91 (0.85, 0.96) | 0.73 (0.58, 0.88) | 0.93 (0.88, 0.99) | 8.89 | 0.22 |
| Reiter 2019 ²¹ | Geriatric inpatients 70yrs+, university hospital Salzburg Austria, able to walk a few metres and lie still for five minutes | AKERN BIA 101, Florence, Italy | 1.Kyle 2.Sergi 3.Scafoglieri 4.Rangel | Baumgartner: Men: < 7.26 kg/m ² Women: < 5.5 kg/m ² FNIH (muscle weakness): Men: <0.789 Women: < 0.512 | Baumgartner + Kyle | N=144 | 0.37 | 0.98 | 0.90 | 0.75 | 18.50 | 0.64 |
| | | | | | Baumgartner + Sergi | N=144 | 0.55 | 0.97 | 0.90 | 0.81 | 18.33 | 0.46 |
| | | | | | Baumgartner + Scafoglieri | N=144 | 0.63 | 0.94 | 0.84 | 0.83 | 10.50 | 0.39 |
| | | | | | Baumgartner + Rangel | N=144 | 0.61 | 0.90 | 0.75 | 0.82 | 6.10 | 0.43 |
| | | | | | FNIH + Kyle | N=144 | 0.28 | 0.98 | 0.85 | 0.78 | 14.00 | 0.73 |
| | | | | | FNIH + Sergi | N=144 | 0.38 | 0.98 | 0.88 | 0.80 | 19.00 | 0.63 |
| | | | | | FNIH + Scafoglieri | N=144 | 0.55 | 0.95 | 0.82 | 0.85 | 11.00 | 0.47 |
| | | | | | FNIH + Rangel | N=144 | 0.52 | 0.95 | 0.81 | 0.84 | 10.40 | 0.51 |
| Steihaug 2016 ²² | Inpatients 65yrs+, university hospital, admitted for surgical repair of hip fracture, Bergen, Norway | Single frequency tetrapolar BIA (RIL, III systems quantum R USA) and Body impedance analyzer (BIA 1010 ASE, Akern Srl, Italy) | 1.Kyle 2.Tengvall 3.Janssen 4.Sergi | Baumgartner: Men: < 7.26 kg/m ² Women: < 5.67 kg/m ² | Kyle Men | N=42 | 0.60 (0.41, 0.79) | 1.00 (1.00, 1.00) | | | ∞ | 0.40 |
| | | | | | Kyle Women | N=116 | 0.65 (0.52, 0.78) | 0.95 (0.90, 1.00) | | | 13.9 | 0.36 |
| | | | | | Tengval Men | N=42 | 0.56 (0.37, 0.75) | 1.00 (1.00, 1.00) | | | ∞ | 0.44 |
| | | | | | Tengvall Women | N=116 | 0.62 (0.48, 0.75) | 0.94 (0.88, 1.00) | | | 9.8 | 0.40 |
| | | | | | Janssen Men | N=42 | 0.32 (0.14, 0.50) | 1.00 (1.00, 1.00) | | | ∞ | 0.68 |
| | | | | | Janssen Women | N=116 | 0.42 (0.29, 0.56) | 0.97 (0.93, 1.00) | | | 13.1 | 0.60 |
| | | | | | Sergi Men | N=42 | 0.84 (0.70, 0.98) | 0.94 (0.83, 1.00) | | | 14.3 | 0.17 |
| | | | | | Sergi Women | N=116 | 0.66 (0.52, 0.78) | 0.90 (0.83, 0.98) | | | 6.9 | 0.38 |
| Reiss 2016 ²³ | Geriatric inpatients 70yrs+, university hospital Salzburg Austria, able to walk a few metres and lie still for five minutes (subset of n=144 ²¹) | BIA single-frequency device (AKERN Florence, Italy) | Janssen equation sex=1 for men and 0 for women Ht in cm R total body resistance | Janssen cutoffs: Men: < 8.5 kg/m ² Women: < 5.75 kg/m ² Chien cutoffs: Men: < 8.87 kg/m ² Women: < 6.42 kg/m ² | Janssen cutoffs | N=60 | 0.77 (0.59, 0.79) | 0.71 (0.58, 0.85) | 0.54 (0.35, 0.73) | 0.88 (0.77, 0.99) | 2.66 | 0.32 |
| | | | | | Chien cutoffs | N=60 | 0.55 (0.33, 0.79) | 0.90 (0.82, 0.99) | 0.71 (0.48, 0.95) | 0.83 (0.72, 0.94) | 5.50 | 0.50 |

tool for sarcopenia requires clear and specific conditions in order to be applicable in an older population. As such, it is imperative to standardize protocols and equations to the population of focus in a research setting before clinical recommendations can be made.

BIA as a diagnostic tool for sarcopenia

A primary issue in the diagnosis of sarcopenia using BIA was the lack of standardization for how sarcopenia was defined, and the lean body mass cut-offs associated. Several studies used BIA predictive equations with different estimates for low muscle mass. While different cut-offs for sarcopenia have been created by different working groups, the studies in this review did not consistently follow the suggested cut-off points. These differences in the definition of low lean body mass may have contributed to the variability in the prevalence of sarcopenia diagnosed in these studies. Due to inconsistencies across measurement protocols and lean body mass cut-off values, results of studies using BIA to determine the prevalence of sarcopenia may not reflect prevalence rates as determined by another form of lean mass measurement.

The majority of the studies used DXA as a reference standard for BIA. While DXA potentially offers the best surrogate measure for skeletal muscle mass in large clinical trials, it is by definition not a true evaluation of lean muscle mass.^{26,27} Known limitations currently exist when using DXA as part of the diagnosis of sarcopenia, including inconsistencies relating to its ability as a predictor of outcomes such as functional decline.²⁷ Therefore, DXA may serve as the best reference standard in the measurement of lean mass, but issues may arise when the creation of predictive equations using BIA are built with DXA as the reference standard itself.

From a pragmatic standpoint, lean body mass measurement devices such as BIA may offer a better means of detecting sarcopenia in a hospital setting instead of a clinical setting, as low lean body mass is associated with hospital stays and surgical outcomes.^{20,21,23} However, functional measures for sarcopenia such as hand grip strength and gait speed may offer a more feasible option for outcomes considered more prevalent in a clinical setting, such as fall risk.²⁸

BIA was found to have high specificity and low sensitivity when used to diagnose sarcopenia. This demonstrates similar utility to the SARC-F questionnaire and therefore,

may not offer additional benefit.²⁹ In the clinical setting, avoiding false negatives should be given priority in order to avoid missing people with sarcopenia. Therefore, implementing the SARC-F combined with a calf circumference measurement (SARC-Calf) is recommended, as it demonstrates greater sensitivity than using the SARC-F alone.³⁰ This means that BIA equations used in the diagnosis of sarcopenia may not add benefit to pre-existing, more affordable, and more accessible tools. Given BIA's inconsistencies in diagnosing sarcopenia, it may act as more of a barrier than an aid for patients who would benefit from conservative interventions for sarcopenia, such as nutritional intervention and exercise prescription.

Feasibility

BIA offers a feasible option for a home and clinical setting due to the portability, ease of use and financial costs associated. However, based on the findings of this review, significant challenges in BIA's diagnostic ability still exist due to both the variability in predictive equations and the BIA device used. Furthermore, if measurement protocols (time of measurement, patient in fasting or fed state) are not repeatable, the results and utility of BIA is likely to be inconsistent and skewed.²⁶

Limitations

There were several methodological differences between studies that offer potential barriers to interpretation on an individual level. Some of this heterogeneity was due to protocols for measurement, such as the device used, equation used, electrode placement, fasting protocol, sex, and geography. Studies used different definitions of sarcopenia and muscle mass cut-offs, which changes the interpretation for sarcopenia diagnostic studies. Several devices also had proprietary predictive formulas which presented a limitation for reviewers to reproduce the data. Studies also tended to avoid re-test which minimized the ability to determine overall reliability of BIA.

The use of the QAREL checklist to determine the quality of included studies appeared to have some challenges. This was related to the irrelevance of some items included and determining that the majority of studies lacked assessor blinding when using measurement techniques. No study was deemed ineligible based on the inherent limitations of the critical appraisal tool for this subject.

Conclusion

BIA offers a portable, easy-to-use, and affordable means to assess lean body mass. However, due to the high heterogeneity in methodology between studies, BIA cannot be confidently recommended for use to diagnose sarcopenia. At the present time, if BIA is to be used on an individual level for diagnostic purposes, it should be used cautiously and with an equation that has been validated in a study population that best represents the patient it is being used for. For clinicians seeking to screen patients for sarcopenia, more clinically feasible functional tests and validated screening questionnaires should be considered.

Future research should aim to standardize, explicitly state, and reproduce methodology related to factors such as, sarcopenia cut-off definition, fasting or fed state, type of device, equation used, and patient demographics. As the number of older adults continues to rise, it becomes paramount to develop clinically useful and reliable means of measuring muscle mass and strength to diagnose sarcopenia.

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Appendix 1.

Electronic search strategy and results

Database(s): Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® 1946-Present

Search Strategy:

| # | Searches | Results |
|----|---|---------|
| 1 | Sarcopenia/ | 4060 |
| 2 | Muscular Atrophy/ | 10822 |
| 3 | Body Composition/ | 41750 |
| 4 | body mass index/ | 124823 |
| 5 | Muscle, Skeletal/ | 140138 |
| 6 | sarcopen*.ti,ab. | 7499 |
| 7 | ((muscle* or muscular) adj3 atroph*).ti,ab. | 18293 |
| 8 | ((muscle* or muscular*) adj3 degener*).ti,ab. | 3714 |
| 9 | ((muscle* or muscular*) adj3 wast*).ti,ab. | 5579 |
| 10 | (body adj3 composition*).ti,ab. | 36968 |
| 11 | (body adj2 mass).ti,ab. | 214319 |
| 12 | (muscle adj2 mass).ti,ab. | 18219 |
| 13 | (lean adj2 mass).ti,ab. | 13194 |
| 14 | (fat-free adj2 mass).ti,ab. | 7733 |
| 15 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 | 466592 |
| 16 | Aged/ | 3040981 |
| 17 | Aging/ | 226638 |
| 18 | “Aged, 80 and over”/ | 899385 |
| 19 | centenarian*.ti,ab. | 1966 |
| 20 | (elderly or elders or elder).ti,ab. | 252187 |
| 21 | geriatric*.ti,ab. | 46483 |
| 22 | (nonagenarian* or octogenarian*).ti,ab. | 4267 |
| 23 | old age home*.ti,ab. | 294 |
| 24 | (old adj2 (women or men or adult* or people* or population* or person or persons)).ti,ab. | 23524 |
| 25 | (older adj2 (women or men or adult* or people* or population* or person or persons)).ti,ab. | 144408 |
| 26 | (old-age* or older patient*).ti,ab. | 66501 |
| 27 | (post-menopaus* or postmenopaus*).ti,ab. | 60664 |
| 28 | 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 | 3398937 |
| 29 | Electric Impedance/ | 16888 |
| 30 | Electric Conductivity/ | 32445 |
| 31 | (electric* adj2 imped*).ti,ab. | 4752 |
| 32 | (bioelectric* adj2 imped*).ti,ab. | 5809 |
| 33 | 29 or 30 or 31 or 32 | 53698 |
| 34 | exp “Sensitivity and Specificity”/ | 578257 |

| # | Searches | Results |
|----|--|---------|
| 35 | exp “reproducibility of results”/ | 396902 |
| 36 | “Predictive Value of Tests”/ | 200383 |
| 37 | likelihood functions/ | 21864 |
| 38 | False Positive Reactions/ | 27581 |
| 39 | false negative reactions/ | 17639 |
| 40 | roc curve/ | 56971 |
| 41 | Odds Ratio/ | 89678 |
| 42 | exp Statistics as Topic/ | 2698000 |
| 43 | statistics, nonparametric/ | 72479 |
| 44 | exp Regression Analysis/ | 420312 |
| 45 | (accura* or correlat* or co-relat* or corelat* or cross-valid*).ti,ab. | 2532540 |
| 46 | (false* adj2 negative*).ti,ab. | 33666 |
| 47 | (false* adj2 positiv*).ti,ab. | 59721 |
| 48 | (internal* adj2 consistenc*).ti,ab. | 29530 |
| 49 | (intra-rater* or inter-rater* or interrater* or intrarater* or rater* or intra-examiner* or inter-examiner* or intraexaminer* or interexaminer*).ti,ab. | 30013 |
| 50 | kappa coefficient*.ti,ab. | 5904 |
| 51 | (likelihood* adj2 (function* or ratio*)).ti,ab. | 16756 |
| 52 | (linear adj2 (model* or regression*)).ti,ab. | 152503 |
| 53 | (mean adj2 differen*).ti,ab. | 75448 |
| 54 | (multivariate adj2 analy*).ti,ab. | 208844 |
| 55 | (odds adj2 ratio*).ti,ab. | 268667 |
| 56 | (predictive* adj2 value*).ti,ab. | 107752 |
| 57 | (r-coefficient* or “r coefficient”).ti,ab. | 247 |
| 58 | reference value.ti,ab. | 3583 |
| 59 | reliab*.ti,ab. | 475255 |
| 60 | reproducibility.ti,ab. | 75212 |
| 61 | responsiveness*.ti,ab. | 100533 |
| 62 | (roc curve* or received operating characteristic*).ti,ab. | 32679 |
| 63 | sensitivity*.ti,ab. | 786967 |
| 64 | specificity*.ti,ab. | 456410 |
| 65 | test-retest*.ti,ab. | 25702 |
| 66 | (pearson* or spearman*).ti,ab. | 82763 |
| 67 | (utility* adj2 test*).ti,ab. | |
| 68 | valid*.ti,ab. | 721043 |
| 69 | 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 | 6457990 |
| 70 | 15 and 28 and 33 and 69 (comment or editorial or letter or clinical conference or review or guideline or | 1645 |
| 71 | 6221554 practice guideline or case reports).pt. | |
| 72 | 70 not 71 | 1596 |

Development of a low resource exercise rehabilitation application for musculoskeletal disorders to help underserved patients in a primary care setting

Michael C. Edgar, DC^{1,2}

Cameron Lambert³

Anser Abbas, DC^{1,2}

James J. Young, DC, PhD, FCCS^{2,4}

Willem McIsaac, MScPT, MScCH⁵

Rhea Monteiro, MScPT⁵

Rajesh Girdhari, MD, MBA, CCFP (AM)^{6,7}

Lee Schofield, MD CCFP (SEM) Dip Sport Med^{6,7}

Lisa Miller⁶

Deborah Kopansky-Giles, DC, FCCS, MSc^{1,2,5}

Objective: We set out to create a Family Medicine EHR (electronic health record) embedded exercise application. This was done to evaluate the utility of the exercise app for providers and to understand the usefulness of the exercise app from the perspective of patients.

Conception d'une application de réadaptation en cas de troubles musculosquelettiques avec exercices destinée aux personnes à faible revenu pour aider les patients dans des régions mal desservies, dans un cadre de soins primaires

Objectif : Concevoir une application d'exercices intégrés au DES (dossier de santé électronique) de la

¹ Department of Family and Community Medicine, St. Michael's Hospital, Unity Health Toronto

² Canadian Memorial Chiropractic College

³ Lambda Physique Concepts

⁴ Centre for Muscle and Joint Health, University of Southern Denmark

⁵ Department of Family and Community Medicine, University of Toronto

⁶ Unity Health- St. Michael's Hospital Academic Family Health Team

⁷ University of Toronto Department of Family & Community Medicine

Corresponding author:

Michael Edgar, Canadian Memorial Chiropractic College, 6100 Leslie Street, Toronto, ON M2H 3J1 Canada

e-mail: mikecedgar@gmail.com

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The authors have no disclaimers or competing interests to report in the preparation of this manuscript. The principal author would like to thank the foundation for the Royal College of Chiropractic Sports Sciences (Canada) for their funding support.

Methods: *This exercise application was developed through an iterative process with repeated pre-testing and feedback from an interprofessional team and embedded into the EHR at an academic family medicine clinic. Anecdotal feedback from patients was used to inform pre-testing adaptations.*

Results: *The application required six iterations prior to clinical utility. It had several features that clinicians and patients felt were beneficial. These features involved a customizable exercise directory with pre-made templated plans which could be further modified. To overcome accessibility barriers, the application was developed to include digital and printable copies with an integrated direct email option for ease of remote sharing with patients.*

Conclusion: *A customizable, open-source exercise application was developed to facilitate provider exercise prescription and support patient self-management. This project may be useful for other providers interested in developing similar programs to address musculoskeletal conditions in their patients. Next steps are to undertake pilot testing of the app with broader provider and patient feedback.*

(JCCA. 2022;66(2):130-145)

KEY WORDS: app, application, digital, ehealth, rehabilitation, technology, chiropractic

Introduction

Musculoskeletal disorders (MSDs) are considered the second most common cause of disability globally, with low back pain being the most common.¹ The burden of disability for MSDs has continued to increase with over 1.7 billion people currently in need of rehabilitation for MSDs.^{1,2} The large majority of MSDs are managed by primary care alongside conditions of obesity, sedentary

médecine familiale. Cela visait à évaluer l'utilité de l'application d'exercices pour les prestataires et à en comprendre l'utilité du point de vue des patients.

Méthodologie : *Cette application d'exercices a été élaborée au moyen d'un processus itératif mettant en œuvre une mise à l'essai répétée et une rétroaction d'une équipe interprofessionnelle et intégrée dans le DES d'une clinique universitaire de médecine familiale. Une rétroaction secondaire de patients a contribué aux adaptations de mise à l'essai.*

Résultats : *L'application a dû être répétée six fois avant l'utilité clinique. Selon les cliniciens et les patients, plusieurs fonctions ont présenté un avantage. Il s'agissait notamment d'un répertoire d'exercices personnalisable assorti de modèles de plans préconçus et modifiables par la suite. Afin de surmonter les obstacles d'accessibilité, l'application était conçue pour comprendre des versions numériques et imprimables dotées d'une option de courriel direct intégré pour faciliter le partage à distance avec les patients.*

Conclusion : *Une application d'exercices personnalisable et ouverte visait à faciliter la prescription d'exercices par les prestataires et à soutenir le traitement autonome des patients. Ce projet peut être utile à d'autres prestataires souhaitant élaborer des programmes semblables pour traiter les problèmes musculosquelettiques de leurs patients. Les étapes suivantes consistent à entreprendre des mises à l'essai de l'application avec un retour d'information plus large de la part des prestataires et des patients.*

(JCCA. 2022;66(2):130-145)

MOTS CLÉS : appli, application, numérique, cybersanté, réadaptation, technologie, chiropratique

behaviour, and aging.^{1,3} Exercise is currently a first-line treatment, although significant barriers exist to formal exercise participation, such as, financial constraints, work schedules and caregiver responsibilities.⁴⁻⁶ These barriers are disproportionately higher within low socioeconomic status (SES) populations.⁷ Self-directed exercise plans offer a low-cost and effective alternative to frequent or supervised care.^{8,9} The use of a written prescription for

exercise and a personal activity journal has also shown to improve adherence with home-based exercise programs among patients.¹⁰ Additionally, digital technology interventions such as mobile health applications (mHealth) have been shown to be an efficient way to support a patients' self-management.¹¹⁻¹⁵ As no specific modality of exercise has shown to be superior in the management of musculoskeletal pain, improved individualisation of exercise prescription, such as through mHealth, offers the potential for improved outcome in relation to pain.¹⁶⁻¹⁸

When developing a new technology, two important factors must be considered: usability and acceptability. Usability involves designing app technologies that a person can use for its intended purpose in a real-world setting.¹⁹⁻²¹ Acceptability is a multifaceted construct aimed at both the people delivering or receiving a healthcare intervention, and the degree they consider it appropriate.¹⁹⁻²¹ A large factor determining the degree an app is deemed acceptable for use is the extent that healthcare professionals (HCPs) feel involved in the development of it. Based on previous literature, both a human-centred design (HCD) and technology acceptance model (TAM) should be used.¹⁹⁻²¹ HCD allows for the needs of the healthcare professionals to be considered through the entire design process.¹⁹⁻²¹ App development usually involves a multi-stage (iterative) process with multiple versions of the app to ensure it meets the needs of the healthcare professionals and patients.¹⁹⁻²¹ The TAM focuses on the app's perceived usefulness and its ease of use.¹⁹⁻²¹ By involving key stakeholders, such as the HCPs and patients who will use the app, developers can enhance its pragmatic utility.

In the current practice setting, patients received both verbal and written recommendations for exercise, however there was no department-wide specific process or protocol for the prescription of exercise. This involved non-modifiable printed exercise templates or creating individualised plans from scratch. This approach was considered cumbersome, which limited the ability to provide appropriate individualization of exercise. Providers also did not have a standardised way to record patient progress or adherence. It was felt that the addition of an automated written exercise prescription program (inclusive of educational material on the benefits of exercise) would improve ease of prescription, reduce time to develop an individualised program, increase adherence rates and im-

prove exercise related outcomes, ultimately improving efficacy and efficiency of MSD treatment.

To help improve the care offered for people presenting with MSDs in an inner-city family medicine clinic, an interprofessional team worked to develop and test an exercise prescription application which could be embedded into the clinic's electronic health record (Practice Solutions Suite©). An open source, low-resource application (app) was iteratively designed, modelled on a quality improvement approach, by the team to facilitate the prescription of individualised exercise programs for patients attending for musculoskeletal treatment. The exercise prescription app also builds from previous exercise handouts created for the family practice unit. This app aimed to improve the individualization of the handouts, inefficiencies in clinician-time allocation, and poor adherence amplified due to COVID-19, requiring more use of telehealth visits. No prior EHR embedded exercise prescription software had been available for use in the department, and significant barriers prevented patients from participating in an in-person program, which were exacerbated by the COVID-19 pandemic.

Methods

Setting

The site for the project was an academic family medicine clinic located in Toronto, Canada, affiliated with the University of Toronto, and staffed by individuals and students from multiple health professions working in an integrated care model. Patients in the facility come from diverse backgrounds with the majority coming from low income, underserved and marginalised communities. The characteristics of the clinic and demographic characteristics of patients have been described previously.^{22,23} This highlights the unique barriers and complexities these individuals face when seeking care for pain.¹⁶

Participant characteristics

In the current practice, patients with MSDs are first evaluated in the clinic by physicians or nurse practitioners for complaints such as pain or functional deficits, and basic management techniques, like exercise, may be offered. Patients are then often referred to the clinic physiotherapists or chiropractors for further assessment and a plan of management. It was considered paramount to optimise

an individuals' abilities to self-manage through conservative measures such as exercise, especially due to decreased in-person sessions from COVID-19.

Project practitioners included primary care clinicians (chiropractors, physiotherapists, family physicians, sports medicine physicians, software development specialists and information technology specialists) who collaborated to develop the exercise prescription app and interface it with the electronic health record (EHR). This was iteratively developed through repeated pre-testing by clinical team members to troubleshoot for any challenges prior to undertaking formal pilot testing and ultimately integration of the exercise app on a department-wide scale. The iteration process was modelled after a QI approach using a modified 'Plan-Do-Study-Act' cycle. Each evolution of the app was tested by study team members who solicited informal feedback from patients as each iterative was evolved during development. The anecdotal feedback was conducted in person during a follow up visit or during a virtual appointment where patients were asked to provide feedback about ease of accessing the electronic exercise prescription, ability to follow the instructions and their compliance with performing the prescribed exercises.

Environmental Scan

A review of the current databases available for exercise rehabilitation plans was conducted to determine relevant utility of software. Previous methods of exercise prescription involved photocopied exercise pamphlets on various musculoskeletal conditions or the use of an online exer-

cise platform that offered a limited, free service or paid version. After review, a meeting was held with project team members with a secondary consultation with other department clinicians to determine interest in the idea and identification of needs. Approval from department leadership was given to proceed with development of the application. During design, the app was focused on the use of features presented in home-based exercise apps and strength and conditioning literature to establish important components for the exercise app.

Specifically, discussions involved what necessary features the app should have available to improve the quality of care for patients and efficiency for clinicians. It was determined that an open-source exercise rehabilitation app would suit the needs of the clinic due to financial constraints and the flexibility it would offer.

Several desired features were noted in development team discussions: a comprehensive exercise directory that allowed for customizability through exercise addition, a tracking log for adherence, pre-templated exercise plans based on region of the body or diagnosis, basic educational information regarding exercise parameters physical activity guidelines, automated exercise plan follow-up emails, and a PDF generator to offer printed copies. From a systems perspective, several specific factors that were discussed included app integration with the current EHR program, auditing for quality assurance as adaptations were made, and ensuring hospital confidentiality and security policies were followed surrounding contacting patients through email for exercise plan purposes. These features are summarised in Figure 1.

| HCP perspective | Systems Perspective |
|----------------------------------|---|
| Comprehensive exercise directory | Integration within EHR |
| Customizability | Integration with confidentiality procedures |
| Pre-templated plans | Auditing for quality assurance |
| Tracking ability | |
| Automated email follow-up | |
| Physical activity education | |
| PDF generation | |

Figure 1.
Desired features within exercise app

Subsequently, development team members had informal consultations with patients receiving musculoskeletal exercise rehabilitation during pre-testing. The discussion involved their opinions on using exercise plans generated from an app to prescribe home exercises, tracking logs and how they would potentially feel about receiving emails regarding adherence. Patients appeared to be receptive to the idea and appreciated their input being sought. The interest expressed by these patients and clinicians resulted in the creation of a development team composed of clinicians, administrators, technology specialists and researchers.

Results

A total of six iterations were completed with only minor changes made to the app on the final two iterations. Feedback from the providers testing and the patients who received exercise prescription through the app over the last two iterations indicated that it was ready for pilot testing. After each cycle of feedback was received, a decision made by consensus from the study team regarding the recommended amendments directed the changes.

Based on the parameters identified in Figure 1, the app evolved based on iterative input then developed using an active folder from which to extract photos and designed using the macro functions on Microsoft Excel (<https://www.microsoft.com/en-us/microsoft-365/excel>). A macro function is a piece of programming code that runs in Excel to record and playback functions to save time and minimize human error.²⁴ Further details of the revisions are outlined in Appendix 1. The application was integrated into the internal hospital system, although personal computer use is possible.

To ensure that the exercise app was personalised to the individual, each component of the exercise plan was made customizable. This allowed for the HCP to tailor the pre-made exercise templates to the personal needs of the patient. The app includes pre-made exercise templates (according to body location and clinical diagnosis) and a template generator (Appendix 2) that could generate new customizable plans to change exercise or parameters such as rest time, repetitions, and sets based on clinician preference.

The app also included a customizable exercise prescription form that is presented at the beginning of each generated plan (Appendix 3). This allowed for education

on the importance and benefits of exercise, such as the Canadian physical activity guidelines, in addition to other resources than an HCP felt may be necessary for an individual's care.²⁵

The built-in customizable exercise database allowed providers to add exercises as needed (Appendix 4). Exercise examples were extracted from an open-source exercise directory website.²⁶ Instructional exercise pictures and video hyperlinks previously identified and accessed by the family health team were integrated on an individual clinician basis prior to implementation of the app. The prescribed exercise programs are logged in the patients' EHR and transferable to an automated email or printable PDF. The email includes an automatically generated exercise prescription and educational form, customized exercise parameters and hyperlinks to instructional photos and videos, and a personalized tracking log in Excel spreadsheet and PDF format (Appendices 5 to 8). The PDF copy (Appendix 8) includes the exercise prescription and educational form, exercise parameters and photos, and an eight-week tracking log.

Based on pre-testing feedback, a secondary PDF option was developed, enabling printing of the prescription, to minimize technical constraints for some patients. The tracking log allows for self-reporting of exercise for the patient's own record or for the HCP to review and use to modify the exercise plan. This information provides an indication of the patient's progress and adherence.

Discussion

Introducing technology to HCPs is challenging, let alone during a pandemic requiring changes to intervention implementation. Although barriers to the use of the app were identified within this paper, solutions were offered by team members. By having users involved in the development of the technology, revisions could be made more efficiently, with a primary focus on usability and acceptability.

This app was developed by HCPs through a user-led design approach. This project involved input by key users regarding their needs at pivotal design points, with less formal input throughout the entire development process. The project team consulted with different HCP prescribers, such as physicians, chiropractors, physiotherapists, and nurse practitioners through the stages of development to allow for a diversity of inputs. Overall, the benefits

of the exercise app centred around its low resource and low-cost requirements, simplicity, efficiency, and tailored utility. This helped make it more acceptable to clinicians and alleviated barriers related to technology integration. HCP familiarity with the app through the design and testing stage, integration with EHR software, and cost- and time-efficiency are factors that have been identified as facilitators for uptake of mHealth technology.²⁷ Our approach and early findings are consistent with previous literature that using digital technology in this way offers an innovative means to reduce the barriers to accessing care in a musculoskeletal primary care setting.^{10-11,15}

App development barriers and limitations

Hospital policies for contact

Due to policies related to confidentiality and consent to email, several changes and adaptations were made to the app. The EHR system uses a confidential email service to prevent patients from gaining access to HCP email addresses. Due to the exercise app's automated email function working through Microsoft Outlook, this led to a barrier in ability to email patients their exercise plans. As such, a work-around was developed, in which the email body would be generated on the exercise app. The clinician would then 'copy and paste' the dialogue box into the email body and attach the patient's Excel exercise tracking log manually. Although the ease of use was diminished slightly, it allowed for a pragmatic workaround without diminishing the quality of care for the patient.

A second issue which arose due to policies surrounding emailing was related to the automated adherence email feature. This was related to the app's ability to build active and past patient rosters which automatically sent adherence emails to patients. Due to the fundamental software limitations of Microsoft Excel and department policies related to privacy concerns it was decided that it would not be a feature that could be used in this way in the final version.

The department also requires written consent from patients to email, posing a potential barrier to receiving an exercise program by email. An additional dialogue box was added to acknowledge if consent to email was given. If consent was not given, clinicians would write, 'no' in the box and the app would not send any emails.

Finally, a minimal sample of patients were asked for feedback regarding the exercise rehabilitation app. Our aim is to further engage patients for their perspectives on ease of use and applicability in the upcoming pilot testing phase. This will allow for integration of features that better suit the needs of patients and clinicians. Once the pilot-testing is completed, the project team will present the results to the department's Patient and Family Advisory Committee for input into future iterations of the app.

Computer software

Due to the design of the exercise app being formatted for Microsoft Excel on PC computers, it is not compatible for Apple devices. This limitation was discussed during design but was considered a non-issue during the pre-testing phase as the hospital uses only PC computers and the Microsoft Windows operating system.

Patient engagement

Although care has been taken to make this app accessible to HCPs and patients, the characteristics of this patient population may pose unique challenges. Self-tracking of exercise adherence is the most cost-effective way of measuring patient progress. However, self-tracking can be cumbersome for patients and self-tracked data can be ascribed moral or emotional value which can be detrimental to progress and the patient-provider relationship.²⁷ This is particularly true of patients with multiple chronic conditions, elderly patients, and less affluent patients, all of whom make up a significant proportion of this patient population.^{22,23,28} To mitigate these effects, a patient-centred model of care is essential where patients are involved in personal goal-setting, leading to individualized and goal-specific exercise prescription which can improve motivation and compliance. To address issues of technology access, patients are able to receive emailed or printed copies of the exercise prescription. This retains the accessibility for HCPs who are able to access the app from within the EHR, while providing access options for patients with varying levels of technological proficiency. The patient population is also unique in its high proportion of recent immigrants and individuals who may otherwise have low fluency in English.²³ Communication regarding the importance of physical activity, and instructions for specific exercises can often be difficult. Integration of photo- and video-based exercise instructions is

included in the prescription, which may help mitigate this challenge. Finally, although mHealth technology has seen a significant increase in usage in recent years, evidence supporting significant positive impacts on patient health outcomes remains weak.²⁹ Rigorous methodological approaches are required to effectively track outcomes and determine the value of this exercise prescription app as well as other mHealth tools.

Conclusion

As technology development and utilization continues to increase within healthcare settings, it becomes imperative to understand the strengths, limitations, and integration procedures of different technological innovations that may be applied in primary care.

Recognizing the burden of musculoskeletal conditions seen in our primary care setting, the department undertook to develop an exercise application which could be integrated into the department electronic health record for use by interprofessional health providers and their patients. This paper describes the preliminary work undertaken by our family medicine department and the approach used to develop the application and its successful integration into the EHR based on iterative feedback from providers and patients during the app's development process. Next steps are to formally pilot test the app with a broader range of HCPs and with patients evaluate its utility and applicability. Upon completion of pilot testing, the app will become available for others to freely use, enabling its transferability, and scaling with the hope of improving rehabilitation for people with MSDs.

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Appendix 1.
Timeline and revisions

| | | |
|--------------------------|---------------------|---|
| Access Exercise App V1. | September 1st, 2020 | Initial concept and discussion <ul style="list-style-type: none"> Initial programming and design instructions in word document |
| Access Exercise App V1.1 | September 3rd, 2020 | Hospital consent addition |
| Access Exercise App V2.0 | September 16, 2020 | <ul style="list-style-type: none"> Modified to only show patient first name for generated exercise plans 'Remove duplicates' feature in exercise directory Added drop-down menu for exercise templates for specific body parts Finalizing emailing system Automated expired patients to 'Past Patients' tab from active patients tab |
| Access Exercise App V2.1 | October 23, 2020 | <ul style="list-style-type: none"> Added auto-populate PDF exercise plan Added auto-populate excel exercise tracking sheet Added auto-add excel exercise tracking sheet to email template |
| Access Exercise App V3.0 | January 15, 2021 | <ul style="list-style-type: none"> Added additional drop-down programs for specific musculoskeletal conditions Added exercise prescription and education tab for PDFs and emails Multiple small bugs worked out over this time frame from previous versions |
| Access Exercise App V4.0 | July 7, 2021 | <ul style="list-style-type: none"> Added template generator to allow individuals to make their own customized exercise plans Revised email function to include Excel exercise tracking log and PDF exercise tracking log Simplified tabs to include the following: <ul style="list-style-type: none"> Main (<i>email, print, populate</i>) Prescription Exercise Directory Template Generator All other previous tabs hidden (option to make visible available) <ul style="list-style-type: none"> 'Patient' and 'Past Patient' tabs Multiple small bugs worked out over this time frame from previous versions |

Appendix 2.
Pre-made templates and modifiable exercise parameters

| Pre Made Templates | | Tennis and Golfers Elbow | | | < Drop Down Menu | | | |
|--------------------|-----------------------------|--------------------------|------------------|------------------|------------------|---|---|----------------------|
| | Enter Exercise Below | Region | Enter Sets Below | Enter Reps Below | Enter TUT Below | Video URL | Picture URL | Picture File Name |
| Exercise-1 | Wrist Extension Stretch | Wrist | 1 | 5 | 15 | https://play | https://www.he | Wrist Extension Stre |
| Exercise-2 | Wrist Flexion Stretch | Wrist | 1 | 5 | 15 | https://play | https://www.he | Wrist Flexor Stretch |
| Exercise-3 | Free Weight - Wrist Extensi | Wrist | 3 | 15-20 | | https://play | https://www.he | Free Weight - Wrist |
| Exercise-4 | Free Weight - Wrist Flexion | Wrist | 3 | 15-20 | | https://play | https://www.he | Free Weight - Wrist |
| Exercise-5 | Hammer Pronation-Supinat | Wrist | 3 | 12-15 | | https://play | https://www.he | Hammer Pronation- |
| Exercise-6 | Stress Ball Squeeze | Hand | 1 | 10 | | https://www.he | | Stress Ball Squeeze |
| Exercise-7 | Finger Stretch | Hand | 1 | 10 | | https://www.he | | Finger Stretch.jpg |
| Exercise-8 | | | | | | | | |
| Exercise-9 | | | | | | | | |
| Exercise-10 | | | | | | | | |
| Exercise-11 | | | | | | | | |
| Exercise-12 | | | | | | | | |
| Exercise-13 | | | | | | | | |
| Exercise-14 | | | | | | | | |
| Exercise-15 | | | | | | | | |

| Pre Made Templates | | Tennis and Golfers Elbow | | | < Drop Down Menu | | | |
|--------------------|-----------------------------|--------------------------|------------------|------------------|------------------|---|---|----------------------|
| | Enter Exercise Below | Region | Enter Sets Below | Enter Reps Below | Enter TUT Below | Video URL | Picture URL | Picture File Name |
| Exercise-1 | Wrist Extension Stretch | Wrist | 1 | 5 | 15 | https://play | https://www.he | Wrist Extension Stre |
| Exercise-2 | Wrist Flexion Stretch | Wrist | 1 | 5 | 15 | https://play | https://www.he | Wrist Flexor Stretch |
| Exercise-3 | Free Weight - Wrist Extensi | Wrist | 3 | 15-20 | | https://play | https://www.he | Free Weight - Wrist |
| Exercise-4 | Free Weight - Wrist Flexion | Wrist | 3 | 15-20 | | https://play | https://www.he | Free Weight - Wrist |
| Exercise-5 | Hammer Pronation-Supinat | Wrist | 3 | 12-15 | | https://play | https://www.he | Hammer Pronation- |
| Exercise-6 | Stress Ball Squeeze | Hand | 1 | 10 | | https://www.he | | Stress Ball Squeeze |
| Exercise-7 | Finger Stretch | Hand | 1 | 10 | | https://www.he | | Finger Stretch.jpg |
| Exercise-8 | | | | | | | | |
| Exercise-9 | | | | | | | | |
| Exercise-10 | | | | | | | | |

| Enter Template Name Below | | | | | | Populate |
|------------------------------|----------|------|----------|---------|---|-----------------|
| Frozen Shoulder | | | | | | |
| # Exercise | Category | Sets | Reps | Seconds | Video URL | |
| # Shoulder AAROM (abduction) | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com | |
| # Shoulder AAROM (ER) | Shoulder | 3 | 12 to 15 | | https://www.youtube.co | |
| # Shoulder AAROM (flexion) | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com | |
| # Shoulder AAROM (HBB) | Shoulder | 3 | | 30 | https://media.physitrack | |
| # Shoulder AROM (scaption) | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com | |
| # | | | | | | |

Appendix 3.
Exercise prescription and guideline tab



This exercise plan has been prescribed to you by your health care professional for physical rehabilitation purposes.

Perform this rehabilitative exercise plan once daily unless specified otherwise.

FITT Principle

- * Frequency - How often you exercise
- * Intensity - How hard you exercise
- * Time - How long you exercise
- * Type - What kind of exercise you do

Exercise Parameters

- * Reps - the number of times you perform a specific exercise
- * Sets - the number of cycles of reps that you complete
- * Rest - the amount of time between sets

Exercise Intensity Based on Maximum Heart Rate

Calculate Maximum Heart Rate = (220 - Age)

1. Low Intensity - Less than 70% (you can carry a conversation while exercising)
2. Moderate Intensity - 70 to 85% (you can talk in short bursts between breaths)
3. High Intensity - Greater than 85% (you are unable to talk during exercise)

Types of Exercise

- * Aerobic Exercise - tends to be longer duration with greater improvements in cardiorespiratory fitness
- * Resistance Exercise - tends to involve an external load and effects muscular strength

Benefits of Exercise - Canadian 24-Hour Movement Guidelines

- * A lower risk of mortality, cardiovascular disease, hypertension, type 2 diabetes, several cancers, anxiety, depression, dementia, weight gain, adverse blood lipid profile
- * Improved bone health, cognition, quality of life and physical function.

[Visit www.csepguidelines.ca for more information](http://www.csepguidelines.ca)

Please notify your health care professional if you experience worsening of symptoms.

Appendix 4. Exercise directory tab

Sort By Exercise

Sort By Category

Remove Dups

| # | Exercise | Category | Sets | Reps | Seconds | Video URL | Picture URL | Picture File Name |
|----|---|------------|------|----------|----------|---|---|--|
| 1 | Band Sidesteeps | Lower Body | 3 | 15 to 20 | | https://player.vimeo.com/video/411180150?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=92258&userRef=gclaaake | Band Sidesteeps.jpg |
| 2 | Banded Pull Aparts | Midback | 3 | 15 to 20 | | https://player.vimeo.com/video/26883195?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=82434&userRef=gclaaake | Banded Pull Aparts.jpg |
| 3 | Bicep Curls | Arms | 3 | 8 | | https://www.youtube.com/watch?v=FN43sqjCA | https://oralfitnessandvoga.com/wp-content/uploads/2018/08/blog_birdsog.jpg | bicep curl.jpg |
| 4 | Bird Dog | Core | 3 | 15 to 20 | | https://player.vimeo.com/video/61979281?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=144&userRef=gclaaake | Bird-dog.jpg |
| 5 | Calf Raises | Ankle | 3 | 12 to 15 | | https://www.hep2go.com/exercise_editor.php?exid=15840&userRef=gclaaake | https://www.hep2go.com/exercise_editor.php?exid=102&userRef=gclaaake | Calf Raises.jpg |
| 6 | Calf Stretch on a Stair | Ankle | 3 | 15 to 30 | | https://www.hep2go.com/exercise_editor.php?exid=327&userRef=gclaaake | https://www.hep2go.com/exercise_editor.php?exid=80748&userRef=gclaaake | Calf Stretch on a Stair.jpg |
| 7 | Calf Stretch With Towel | Ankle | 3 | 15 to 30 | | https://player.vimeo.com/video/422963851?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=69880&userRef=gclaaake | Calf Stretch With Towel.jpg |
| 8 | Cat Camels | Midback | 3 | 12 to 15 | | https://player.vimeo.com/video/366292892?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=85198&userRef=gclaaake | Cat Camels.jpg |
| 9 | Chair Stand | Lower Body | 3 | 12 to 15 | | https://player.vimeo.com/video/36630481?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=59308&userRef=gclaaake | Chair Stand.jpg |
| 10 | Chin Tuck with Towel | Neck | 3 | 12 to 15 | | https://player.vimeo.com/video/43015814?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=44426&userRef=gclaaake | Chin Tuck with Towel.jpg |
| 11 | Crossover Arm Stretch | Shoulder | 1 | 4 | 15 to 30 | | https://www.hep2go.com/exercise_editor.php?exid=3578&userRef=gclaaake | Crossover Arm Stretch.jpg |
| 12 | Diaphragmatic Breathing | Core | 3 | 60 | | https://player.vimeo.com/video/8123533?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=5258&userRef=gclaaake | Diaphragmatic Breathing.jpg |
| 13 | Elastic Band - Dorsiflexion | Ankle | 3 | 12 to 15 | | https://player.vimeo.com/video/5873581?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=1085&userRef=gclaaake | Elastic Band - Dorsiflexion.jpg |
| 14 | Elastic Band - Anti-Rotation | Midback | 3 | 15 to 20 | 30 | https://player.vimeo.com/video/63295488?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=80748&userRef=gclaaake | Elastic Band - Anti-Rotation.jpg |
| 15 | Elastic Band - Hamstring Curls | Knee | 3 | 15 to 20 | | https://player.vimeo.com/video/366292892?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=68668&userRef=gclaaake | Elastic Band - Hamstring Curls.jpg |
| 16 | Elastic Band - Hip Abduction | Hips | 3 | 15 to 20 | | https://player.vimeo.com/video/366292892?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=85198&userRef=gclaaake | Elastic Band - Hip Abduction.jpg |
| 17 | Elastic Band - Hip Extension | Hips | 3 | 15 to 20 | | https://player.vimeo.com/video/366292892?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=4198&userRef=gclaaake | Elastic Band - Hip Extension.jpg |
| 18 | Elastic Band - Knee Extension | Knee | 3 | 15 to 20 | | https://player.vimeo.com/video/62476634?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=69880&userRef=gclaaake | Elastic Band - Knee Extension.jpg |
| 19 | Elastic Band - Single Leg Press | Lower Body | 3 | 15 to 20 | | https://player.vimeo.com/video/31532723?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=64498&userRef=gclaaake | Elastic Band - Single Leg Press.jpg |
| 20 | Elastic Band - Straight Leg Raise | Hips | 3 | 15 to 20 | | https://player.vimeo.com/video/53194996?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=46868&userRef=gclaaake | Elastic Band - Straight Leg Raise.jpg |
| 21 | Elastic Band Pinch Grip - Index Finger | Wrist | 3 | 30 | | https://www.hep2go.com/exercise_editor.php?exid=68668&userRef=gclaaake | https://www.hep2go.com/exercise_editor.php?exid=78518&userRef=gclaaake | Elastic Band Pinch Grip - Index Finger.jpg |
| 22 | Elastic Band Pinch Grip - Pinky Finger | Wrist | 3 | 30 | | https://www.hep2go.com/exercise_editor.php?exid=68668&userRef=gclaaake | https://www.hep2go.com/exercise_editor.php?exid=68668&userRef=gclaaake | Elastic Band Pinch Grip - Pinky Finger.jpg |
| 23 | External Rotation With Arm Abducted 90° | Shoulder | 3 | 8 | | https://player.vimeo.com/video/54175956?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=39385&userRef=gclaaake | External Rotation With Arm Abducted 90.jpg |
| 24 | Farmers Walk | Full Body | 1 | 120 | | https://player.vimeo.com/video/294033838?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=63498&userRef=gclaaake | Farmers Walk.jpg |
| 25 | Finger Stretch | Hand | 1 | 10 | | https://www.hep2go.com/exercise_editor.php?exid=39385&userRef=gclaaake | https://www.hep2go.com/exercise_editor.php?exid=39385&userRef=gclaaake | Finger Stretch.jpg |
| 26 | Free Weight - Wrist Extension | Wrist | 3 | 15 to 20 | | https://player.vimeo.com/video/39674297?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=40&userRef=gclaaake | Free Weight - Wrist Extension.jpg |
| 27 | Free Weight - Wrist Flexion | Wrist | 3 | 15 to 20 | | https://player.vimeo.com/video/39673998?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=38&userRef=gclaaake | Free Weight - Wrist Flexion.jpg |
| 28 | Glute Bridge | Hips | 3 | 30 | | https://www.youtube.com/watch?v=PwM8icPu6H8 | https://www.hep2go.com/exercise_editor.php?exid=37843&userRef=gclaaake | Glute Bridge.jpg |
| 29 | Hammer Pronation-Supination | Wrist | 3 | 12 to 15 | | https://player.vimeo.com/video/59778631?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=4675&userRef=gclaaake | Hammer Pronation-Supination.jpg |
| 30 | Ham Adduction Pillow Squeeze | Hips | 3 | 15 to 20 | | https://www.youtube.com/watch?v=DiNtYxQ6vFk | https://www.hep2go.com/exercise_editor.php?exid=69301&userRef=gclaaake | Sit to stand with band.jpg |
| 31 | Inversion Isometric | Ankle | 3 | 30 | | https://player.vimeo.com/video/53191463?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=85178&userRef=gclaaake | Inversion Isometric.jpg |
| 32 | Modified Curl Up | Core | 3 | 12 to 15 | | https://www.youtube.com/watch?v=94ELae3dtig | https://www.hep2go.com/exercise_editor.php?exid=28149&userRef=gclaaake | Modified Curl Up.png |
| 33 | Pendulum | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/57256767?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=186&userRef=gclaaake | Pendulum.jpg |
| 34 | Plank | Core | 2 | 30 | | https://www.youtube.com/watch?v=1Wpbe9iRySc | https://hips.hearstapps.com/hmg-prod.s3.amazonaws.com/images/hdm119918mth13842-1345227096.png | Plank.jpg |
| 35 | Prone T | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/2989772?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=19782&userRef=gclaaake | Prone T.jpg |
| 36 | Prone W | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/72424948?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=14081&userRef=gclaaake | Prone W.jpg |
| 37 | Resisted bilateral shoulder ER | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/72254807?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=202&userRef=gclaaake | Resisted bilateral shoulder ER.jpg |
| 38 | Resisted ER (at side) | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/56793702?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=209&userRef=gclaaake | Resisted ER (at side).jpg |
| 39 | Resisted IR (at side) | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/56794645?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=213&userRef=gclaaake | Resisted IR (at side).jpg |
| 40 | Resisted row | Back | 3 | 12 to 15 | | https://player.vimeo.com/video/56794797?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=216&userRef=gclaaake | Resisted row.jpg |
| 41 | Resisted scaption | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/53940449?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=8094&userRef=gclaaake | Resisted scaption.jpg |
| 42 | Standing Calf Stretch | Ankle | 3 | 15 to 30 | | https://player.vimeo.com/video/220581654?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=1&userRef=gclaaake | STANDING CALF STRETCH - GASTROCNEMIUS.jpg |
| 43 | Serratus slide | Shoulder | 3 | 12 to 15 | | https://player.vimeo.com/video/53784593?title=1&byline=0&portrait=0 | https://www.hep2go.com/exercise_editor.php?exid=8253&userRef=gclaaake | Serratus slide.ico |

Appendix 5. Excel template e-mail

Email Body- Hello John,

Exercise-1 Wrist Exte Wrist
Sets- 1
Reps- 05-Jan
TUT- 15
Video- <https://player.vimeo.com/video/396813350?title=1&byline=0&portrait=0&autoplay=1&quality=4k&loop=1&controls=1&transparent=1&share=false>
Picture- https://www.hep2go.com/exercise_editor.php?exId=41&userRef=gciaake

Exercise-2 Wrist Flex Wrist
Sets- 1
Reps- 05-Jan
TUT- 15
Video- <https://player.vimeo.com/video/396812823?title=1&byline=0&portrait=0&autoplay=1&quality=4k&loop=1&controls=1&transparent=1&share=false>
Picture- https://www.hep2go.com/exercise_editor.php?exId=43&userRef=gciaake

Exercise-3 Free Weig Wrist
Sets- 3
Reps- 15-20
TUT-
Video- <https://player.vimeo.com/video/396742972?title=1&byline=0&portrait=0&autoplay=1&quality=4k&loop=1&controls=1&transparent=1&share=false>
Picture- https://www.hep2go.com/exercise_editor.php?exId=40&userRef=gciaake

Exercise-4 Free Weig Wrist
Sets- 3
Reps- 15-20
TUT-
Video- <https://player.vimeo.com/video/396739998?title=1&byline=0&portrait=0&autoplay=1&quality=4k&loop=1&controls=1&transparent=1&share=false>
Picture- https://www.hep2go.com/exercise_editor.php?exId=38&userRef=gciaake

Exercise-5 Hammer P Wrist
Sets- 3
Reps- 15-Dec
TUT-
Video- <https://player.vimeo.com/video/59778633?title=1&byline=0&portrait=0&autoplay=1&quality=4k&loop=1&controls=1&transparent=1&share=false>
Picture- https://www.hep2go.com/exercise_editor.php?exId=4675&userRef=gciaake

Exercise-6 Stress Ball Hand
Sets- 1
Reps- 10
TUT-
Video-
Picture- https://www.hep2go.com/exercise_editor.php?exId=94255&userRef=gciaake

Exercise-7 Finger Stret Hand
Sets- 1
Reps- 10
TUT-
Video-
Picture- https://www.hep2go.com/exercise_editor.php?exId=39385&userRef=gciaake

All the best,

Appendix 6.
Outlook template e-mail

Send

To

jsmith@outlook.com

Cc

Subject

Exercise Rehab

John Smith_01 23 21.xlsx ▼

11 KB

Exercise-1 Wrist Extension Stretch Wrist
Sets- 1
Reps- 1000-01-04
TUT- 15
Video- [Click Here](#)
Picture- [Click Here](#)

Exercise-2 Wrist Flexion Stretch Wrist
Sets- 1
Reps- 1000-01-04
TUT- 15
Video- [Click Here](#)
Picture- [Click Here](#)

Exercise-3 Free Weight - Wrist Extension Wrist
Sets- 3
Reps- 15-20
TUT-
Video- [Click Here](#)
Picture- [Click Here](#)

Exercise-4 Free Weight - Wrist Flexion Wrist
Sets- 3
Reps- 15-20
TUT-
Video- [Click Here](#)
Picture- [Click Here](#)

Exercise-5 Hammer Promotions Supination Wrist
Sets- 3
Reps- 2023-12-15
TUT-
Video- [Click Here](#)
Picture- [Click Here](#)

Exercise-6 Stress Ball Squeeze Hand
Sets- 1
Reps- 10
TUT-
Video-
Picture- [Click Here](#)

Exercise-7 Finger Stretch Hand
Sets- 1
Reps- 10
TUT-
Video-
Picture- [Click Here](#)

Hello John,

This exercise plan has been prescribed to you by your health care professional for physical rehabilitation purposes. Perform this rehabilitative exercise plan once daily unless specified otherwise.

FITT Principle

- * Frequency - How often you exercise
- * Intensity - How hard you exercise
- * Time - How long you exercise
- * Type - What kind of exercise you do

Exercise Parameters

- * Reps - the number of times you perform a specific exercise
- * Sets - the number of cycles of reps that you complete
- * Rest - the amount of time between sets

Exercise Intensity Based on Maximum Heart Rate
Calculate Maximum Heart Rate = (220 - Age)

1. Low Intensity - Less than 70% (you can carry a conversation while exercising)
2. Moderate Intensity - 70 to 85% (you can talk in short bursts between breaths)
3. High Intensity - Greater than 85% (you are unable to talk during exercise)

Types of Exercise

- * Aerobic Exercise - tends to be longer duration with greater improvements in cardiorespiratory fitness
- * Resistance Exercise - tends to involve an external load and effects muscular strength

Benefits of Exercise - Canadian 24-Hour Movement Guidelines

- * A lower risk of mortality, cardiovascular disease, hypertension, type 2 diabetes, several cancers, anxiety, depression, dementia, weight gain, adverse blood lipid profile
- * Improved bone health, cognition, quality of life and physical function.

Visit www.caspguidelines.ca for more information

Please notify your health care professional if you experience worsening of symptoms.

All the best,

UNITY HEALTH
TORONTO
Caring hearts. Leading minds.

Appendix 7.
Auto-generated Excel tracking log

| | Week 1 | | | Week 2 | | | Week 3 | | | Week 4 | | | Week 5 | | | Week 6 | | | Week 7 | | | Week 8 | | | | | |
|-------------------------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|---|--|-------|
| | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | Sets | Loads | Reps | | | |
| Exercise-1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wrist Extension Stretch | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 |
| Exercise-2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wrist Flexion Stretch | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 | 1 | | 5 |
| Exercise-3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Free Weight - Wrist Extension | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 |
| | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 |
| | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 |
| Exercise-4 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Free Weight - Wrist Flexion | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 | 1 | | 15-20 |
| | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 | 2 | | 15-20 |
| | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 | 3 | | 15-20 |
| Exercise-5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hammer Pronation-Supination | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 | 1 | | 12-15 |
| | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 | 2 | | 12-15 |
| | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 | 3 | | 12-15 |
| Exercise-6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stress Ball Squeeze | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 |
| Exercise-7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Finger Stretch | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 | 1 | | 10 |

Appendix 8.
Auto-generated PDF exercise plan and tracking log

Hello John,

Rx This exercise plan has been prescribed to you by your health care professional for physical rehabilitation purposes.

Perform this rehabilitative exercise plan once daily unless specified otherwise.

FITT Principle

- Frequency - How often you exercise
- Intensity - How hard you exercise
- Time - How long you exercise
- Type - What kind of exercise you do

Exercise Parameters

- Reps - the number of times you perform a specific exercise
- Sets - the number of cycles of reps that you complete
- Rest - the amount of time between sets

Exercise Intensity Based on Maximum Heart Rate
Calculate Maximum Heart Rate = (220 - Age)

1. Low Intensity - Less than 70% (you can carry a conversation while exercising)
2. Moderate Intensity - 70 to 85% (you can talk in short bursts between breaths)
3. High Intensity - Greater than 85% (you are unable to talk during exercise)

Types of Exercise

- Aerobic Exercise - tends to be longer duration with greater improvements in cardiorespiratory fitness
- Resistance Exercise - tends to involve an external load and effects muscular strength

Benefits of Exercise - Canadian 24-Hour Movement Guidelines

- A lower risk of mortality, cardiovascular disease, hypertension, type 2 diabetes, several cancers, anxiety, depression, dementia, weight gain, adverse blood lipid profile
- Improved bone health, cognition, quality of life and physical function.


[Visit www.csepguidelines.ca for more information](http://www.csepguidelines.ca)

Please notify your health care professional if you experience worsening of symptoms.

Exercise-1 Wrist Extension Stretch Wrist

Sets- 1
Reps- 1900-01-04
TUT- 15


| | | | | | | | | |
|------|---|---|---|---|---|---|---|---|
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Sets | | | | | | | | |
| Reps | | | | | | | | |



Exercise-2 Wrist Flexion Stretch Wrist

Sets- 1
Reps- 1900-01-04
TUT- 15

| | | | | | | | | |
|------|---|---|---|---|---|---|---|---|
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Sets | | | | | | | | |
| Reps | | | | | | | | |



Varied presentations of cervical spondylotic myelopathy presenting to a chiropractic clinic: a report of 3 cases

Chandler Bolles, DC¹
 Patrick Battaglia, DC, DACBR²
 Catherine Moore, DO³

Cervical spondylotic myelopathy (CSM) is the leading cause of acquired spinal cord dysfunction worldwide and may be expected to increase in prevalence due to an aging global population. Clinical features of CSM are highly variable, and chiropractors frequently manage patients with common signs and symptoms of CSM such as neck pain, extremity weakness, and gait imbalances. Early recognition of signs consistent with myelopathy may mitigate future disability and improve quality of life. Key predictors of patient outcome are the age of initial presentation, baseline CSM severity (as measured by mJOA score), and the presence of gait disturbances. This report describes three cases

Diverses descriptions de la myélopathie spondylotique cervicale présentées à une clinique de chiropratique : rapport de trois cas

La myélopathie spondylotique cervicale (MSC) est la principale cause d'un dysfonctionnement acquis de la moelle épinière dans le monde et sa prévalence devrait augmenter en raison d'une population mondiale vieillissante. Les caractéristiques cliniques de la MSC varient énormément et les chiropraticiens traitent souvent des patients présentant des signes et des symptômes courants de la MSC comme des douleurs cervicales, une faiblesse des extrémités et une démarche déséquilibrée. Une reconnaissance précoce des signes de la myélopathie peut permettre d'atténuer une incapacité future et d'améliorer la qualité de vie. Les principaux signes avant-coureurs des résultats pour le patient sont l'âge de la première manifestation, la gravité initiale de la MSC (mesurée par l'échelle mJOA) et des troubles dans la démarche. Le présent rapport décrit trois

¹ Edward Via College of Osteopathic Medicine, Spartanburg, SC

² Director of Health Policy and Interdisciplinary Care, Logan University

³ Family Practice Physician, Affinia Healthcare

Corresponding author:
 Chandler Bolles, 501 Howard St. 308, Spartanburg, SC 29303, USA
 e-mail: cbolles@vcom.edu

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The authors have no disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript. The involved patients provided consent for case publication.

of CSM presenting to a chiropractic clinic. Each case illustrates a unique manifestation of CSM, including myelopathy, myeloradiculopathy, and distal neuropathic pain (funicular referral). In addition, a review of CSM terminology, epidemiology, pathobiology, clinical features, imaging, and management is provided.

(JCCA. 2022;66(2):146-156)

KEY WORDS: cervical spondylotic myelopathy, degenerative cervical myelopathy, cervical myelopathy, spinal cord dysfunction, conservative management, chiropractic

cas de MSC soumis à une clinique de chiropratique. Chacun des cas illustre une manifestation unique de MSC, à savoir la myélopathie, la myéloradiculopathie et la douleur neuropathique distale (funiculaire). De plus, une étude de la terminologie, de l'épidémiologie, de la pathobiologie, des caractéristiques cliniques, de l'imagerie et du traitement de la MSC est fournie.

(JCCA. 2022;66(2):146-156)

MOTS CLÉS : chiropratique, dysfonctionnement de la moelle épinière, myélopathie cervicale, myélopathie cervicale dégénérative, myélopathie spondylotique cervicale, traitement conservateur

Introduction

Cervical spondylotic myelopathy (CSM) is the leading cause of spinal cord dysfunction and spastic paresis in adults aged 55 and older.¹⁻⁵ Patients with CSM often present with neck pain and stiffness, loss of manual dexterity, weakness and/or paresthesia in both the upper and lower extremities, gait imbalances, and urge incontinence.^{1,6}

Considering the prevalence of CSM is estimated at 605 per million¹ and the likelihood of concurrent neck pain and neurologic signs and symptoms, it is critical that chiropractors have a thorough understanding of this entity.

We present three contrasting cases of CSM presenting to chiropractic physicians working within a federally qualified health center (FQHC) as part of an academic affiliation with Logan university. We also provide discussion on the epidemiology, pathophysiology, clinical features, and treatment options.

Case presentations

Patients provided written informed consent between August and September 2019 as this work was originally constructed for submission to the 27th Association of Chiropractic Colleges Research Agenda Conference. All patients were referred to chiropractic integrated into a Federally Qualified Health Center in St. Louis, MO.

Case 1

49-year-old male referred from primary care for initial evaluation and management of chronic, atraumatic neck and right arm pain in May 2018. He noted the neck pain started insidiously approximately four years prior in an episodic manner, worsening two years prior with new onset right upper extremity pain. The pain was subjectively noted by the patient to be in the posterior neck, right lateral shoulder, and anterior arm. He also reported worsening right hand weakness and bilateral hand numbness and pain that started insidiously eight months prior to initial presentation and has been concerned lately because he “cannot make a muscle,” meaning he could not contract his biceps brachii. No patient reported outcome measures were obtained at initial consultation.

The neck and right upper extremity pain was constant, with dull, sharp, and burning characteristics, exacerbated by any neck or upper extremity movements. He was managing this pain with prescribed gabapentin (600 mg three times daily) and cyclobenzaprine (10 mg at night before bed) with minimal relief. In addition, he reported trying his own unsupervised upper extremity strengthening exercises for this complaint without benefit.

Functionally, he was driving less because of pain related to right upper extremity movements. He also noted paroxysms of severe pain when the “air-conditioning hits my arm”, suggesting a neuropathic origin. He was working as a painter and reported impaired work performance

related to inability to hold his tools and inability to “balance on a ladder.”

Review of systems revealed blurred vision (without diplopia or blindness), “balance issues” interpreted as unsteadiness with gait, and episodic urinary incontinence. Past surgical history included left sided carpal tunnel release three years prior, with residual numbness in the left hand (all five digits). The remaining past medical and surgical history was unremarkable.

At examination, his gait was grossly normal, including heel and toe walk. He could not tandem walk because of unsteadiness. Spinal inspection revealed upper thoracic kyphosis with forward head posture. He had full cervical range of motion, and full shoulder range of motion but increased pain at end ranges of all motions for both his cervical spine and shoulders. Inspection of the limbs was notable for right biceps atrophy with fasciculations, exacerbated with manual muscle testing. A small scar was noted on the left palm consistent with history of carpal tunnel release.

His neurologic examination was notable for 3/4 patellar and Achilles deep tendon reflexes bilaterally without clonus. Biceps, brachioradialis, and triceps deep tendon reflexes were 2/4 bilaterally. Upper extremity vibration sensation to a 128 Hz tuning fork was normal. There was approximately a five second delay to vibration cessation in the lower extremity. Allodynia to light touch was noted along the lateral right deltoid and lateral and anterior right arm. Manual muscle testing revealed 4/5 strength of the right biceps brachii and right hand. The remainder of his upper and lower body strength within the C5-T1 and L2-S1 myotomes was normal. He had a plantar flexor response and there was no Hoffman sign.

Maximal foraminal compression to the right reproduced the right upper extremity pain.

Radiographs dated April 2014 were available for review demonstrating straightening of the cervical spine and C5/6 discogenic spondylosis. Since the initial encounter raised concern for myelo-radiculopathy, a contemporaneous MRI was obtained in June 2018 demonstrating congenitally short pedicles with long segment central canal stenosis that was severe at C4/5 and C5/6. There was also severe bilateral neuroforaminal stenosis at these same levels. T2 hyperintensity was present in the spinal cord at the C4/5 level without cord expansion consistent with myelomalacia.

The MRI findings supported the clinical diagnosis of cervical spondylotic myelopathy with concomitant right C5 radiculopathy, and the patient was referred to neurosurgery where he underwent anterior decompression consisting of disc replacement at the C4/5 and C5/6 level. There was no posterior decompression performed.

Case 2

38-year-old female was referred from primary care in December 2017 for initial evaluation and management of acute neck pain post recent motor-vehicle accident and chronic upper and lower extremity paresthesia. The paresthesias started in 2008 after a motor-vehicle accident where she reported head trauma. She reported being told that she had “spinal cord impingement” at that time but was only offered physical therapy for her complaints which she completed without change in extremity complaints. Specifics about her physical therapy regime in 2008 were not available at the time of her chiropractic consultation in 2017. No imaging was available for review from 2008. She had neck pain at that time that mostly abated after physical therapy. However, she did have periods of episodic neck “discomfort” from 2008 until present, worsened in December 2018 with a reported low speed motor-vehicle accident. It is unknown if she sought care for this episodic pain complaint.

Regarding the neck pain, it was subjectively noted to be in the posterior, midline and described as mild. The patient was more concerned with her worsening sensorimotor complaints which consisted of weakness in both hands, right greater than left, decreased general sensation in both hands, pain in the right hand traveling to the right elbow, a “shock-like” sensation traveling from her neck to her toes on occasion, especially with head and neck movement, and decreased sensation in the toes, right greater than left. These lower extremity sensory changes resulted in feelings of “unsteadiness” when walking.

She worked as a bartender at a country club and was becoming more fearful she would drop “the expensive bottles of liquor.” Additionally, she was avoiding going down her basement stairs at home for fear of falling. No patient reported outcome measures were applied at initial consultation. Her past medical and surgical history and her review of systems were otherwise unremarkable.

At examination, inspection and palpation of the cervical spine were unremarkable. Range of motion testing was

deferred considering the reported neurologic dysfunction. Her gait was unsteady, and she could not tandem walk. Her deep tendon reflexes were 3/4 upper and lower extremity, and Hoffman sign was present bilaterally. Three beats of clonus were noted in the right ankle, and one beat of clonus was present in the left ankle.

Gross motor testing as part of a neurologic screen revealed 4/5 intrinsic hand and finger flexor strength bilaterally, 4/5 right knee flexion and extension strength, and 4/5 right dorsiflexor strength. The remaining muscle groups of the upper and lower extremity were normal. No muscle atrophy or fasciculations were observed.

Radiographs were available for review dated July 2017 demonstrating straightening of the cervical spine with mild kyphosis at C5/6. Associated discogenic spondylosis and uncovertebral arthritis were present at the C5/6 level.

A working diagnosis of cervical myelopathy (degenerative or demyelinating) was made. An MRI was obtained five days after initial consultation demonstrating congenitally short pedicles at C4/5 and C5/6 with severe central canal stenosis. At C5/6 there was also a broad-based disc-osteophyte complex with spinal cord compression. T2 hyperintensity (i.e., brightness in the spinal cord likely representing myelomalacia) was present in the spinal cord at the C5/6 level. She consulted with neurosurgery in March 2018, and was lost to follow-up until September 2018, when she again consulted with neurosurgery and subsequently underwent anterior cervical discectomy with fusion for cervical myelopathy in October 2018.

Case 3

49-year-old male was referred from primary care in January 2019 for evaluation and management of left sided back and lower extremity pain, described as “sciatica”. His history was notable for an abrupt onset of neck pain with left sided upper and lower extremity numbness after a lifting accident at work as a mechanic in November 2013. At that time, an MRI of the brain and spinal cord was obtained demonstrating central canal stenosis at the C3/4 level secondary to a disc-bone complex, with a superimposed left paracentral disc extrusion. There was related spinal cord compression and T2 hyperintensities consistent with myelomalacia. The remainder of the brain and spine MRI was normal. The patient’s numbness persisted and was accompanied with episodic neck pain through 2016. Despite being offered neurosurgery

in 2013, due to insurance issues and psychosocial stressors, he did not see neurosurgery until end of year 2016. A contemporaneous cervical spine MRI was obtained in January 2017 demonstrating resorption of the cervical disc extrusion but persistence of spinal stenosis secondary to degenerative changes and unchanged myelomalacia at the C3/4 level. The patient consulted with neurosurgery in May 2018 and was told he was not a surgical candidate at that time. Approximately in 2017, the patient’s symptoms progressed to include not only numbness, but also worsening pain in the back and left lower extremity. His neck pain had resolved. His pain management from 2017 to 2019 consisted of 5 mg hydrocodone – 325 mg acetaminophen (Norco) three times daily with minimal benefit. In 2019, he was switched to buprenorphine and 300 mg gabapentin three times daily also without benefit.

At his chiropractic consultation in January 2019, his pain complaints were subjectively localized to the left-sided lower back, left gluteal, and entire left lower extremity, and rated as severe (i.e., 10/10 on a numeric rating scale). No patient reported outcome measures were obtained at initial consultation. His review of systems was notable for feeling “unsteady” with occasional falls. Otherwise, his review of systems was unremarkable. At examination, his gait was slow and unsteady but without any signs of spasticity. Inspection of the neck, back, and limbs was unremarkable without lesion or deformity. He had allodynia along the left hemithorax, left sided low back, and entire left lower extremity to light touch. All lumbar ranges of motion were limited due to pain (degrees not measured), but he had full passive hip range of motion. Upper and lower deep tendon reflexes were 2/4 throughout except 3/4 patellar reflexes. Bilateral Hoffman sign was noted. There was no ankle clonus, and he had a flexor plantar response. His straight leg raise was negative up to 90 degrees. The working diagnosis was CSM with funicular referral. There was low clinical concern for lumbosacral radiculopathy.

Conservative care emphasizing myofascial therapies as a means of desensitization was initiated for pain management, with subjective short-term benefit. A concurrent Physical Medicine and Rehabilitation (PM&R) referral was placed. At that appointment, it was agreed that the patient’s back and lower extremity symptoms were likely secondary to incomplete spinal cord injury (i.e., cervical stenosis with superimposed disc herniation) at C3/4 with

subsequent neuropathic pain (funicular referral). The patient was started on Cymbalta 30 mg twice daily for their pain and was recommended to follow-up with Pain Management for consideration of cervical epidural injection and/or spinal cord stimulator trial. The Cymbalta was not helpful for managing his pain, and he declined both interventions. Also, a lumbar MRI was obtained at the time of Physical Medicine and Rehabilitation to confirm there was not concurrent lumbar spine disease, and it showed mild multilevel degenerative changes without central canal or foraminal stenosis.

The patient was lost to follow up until 2021, when he re-presented with similar but worsening complaints. Most notably, his gait and balance had worsened. He continued to decline further Physical Medicine and Rehabilitation, Pain Management, or Neurosurgical referrals and was lost to follow-up after three therapy sessions.

Discussion

We present three unique cases of CSM that highlight the variable nature of the disease. A thorough understanding of this entity by chiropractors is important to optimize spine care.

History and terminology

Cervical spondylotic myelopathy (CSM) was first described by Bailey and Casamajor in 1911 and further characterized by Stookey in 1928 after describing seven patients believed to have extradural ventral chondromas in the cervical spine.^{7,8} In 1952, Brain, Northfield, and Wilkinson⁹ described compression of the spinal cord secondary to cervical spondylosis and the associated neurologic signs in 38 patients. In 1972, a landmark paper by Nurick¹⁰ investigated the degree of disability in 160 patients with CSM and corroborated the role of ischemia in long standing spinal cord compression.

CSM is characterized by spinal cord dysfunction secondary to acquired stenosis of the cervical spinal canal from vertebral degeneration (disc desiccation, osteophytic lesions, apophyseal joint hypertrophy). Degenerative cervical myelopathy (DCM) is an umbrella term, encompassing both CSM and acquired stenosis from ossification of the posterior longitudinal ligament (OPLL) or hypertrophy/ossification of the ligamentum flavum (OLF).¹ Congenital cervical spine stenosis (CSS), such as from short pedicles, is also a risk factor for developing CSM.^{1,6}

CSS has been defined as sagittal spinal canal diameter less than 13 mm, or a Torg-Pavlov measurement less than 0.82 (canal diameter/vertebral body diameter).¹¹

Epidemiology

The estimated incidence of CSM in North America is 41 per million per year with an estimated prevalence of 605 per million.¹ These numbers may underestimate the true burden of disease due to classifying CSM, OPLL, OLF, and non-traumatic spinal cord injury as separate clinical entities.^{1,5} A recent systematic review and meta-analysis assessed the prevalence of spinal cord compression in asymptomatic and symptomatic cohorts using magnetic resonance imaging (MRI) and proposed the point prevalence to be higher at 2.3%.¹²

While CSM is the leading cause of spinal cord dysfunction in individuals over the age of 55, it is interesting that all three cases presented here had symptomatic presentation before the age of 50, perhaps a result of degenerative changes superimposed on a congenitally narrowed spinal canal (cases 1 and 2), and an acute disc herniation superimposed on a region of degenerative stenosis (case 3).⁵ The patients described in cases 1 and 2 had confirmed congenital spinal stenosis at the affected levels. In case 3, the patient had degenerative stenosis at the C3/4 level with a superimposed disc extrusion. In this case, it is reasonable to conclude the disc herniation resulted in the described spinal cord injury (SCI) because it occurred on a background of spinal stenosis. Serial imaging of the cervical spine confirmed resorption of the disc herniation but persistence of the spinal stenosis and spinal cord changes. Other factors related to patient care seeking behaviors, such as severity of symptoms, could also explain the younger cohort of CSM patients in this series. Regardless, as spine treating clinicians, it is important that chiropractors not only appreciate the high prevalence of CSM above the age of 55, but also appreciate that patients may have congenital or developmental stenosis at younger ages predisposing to this condition.

Pathobiology

Structural degenerative changes that result in canal stenosis include osteophytic spurs and buckling of the ligamentum flavum secondary to micro-instability.¹¹ The long-term mechanical forces applied to the spinal cord results in impaired blood flow to the cord, which has long

Table 1.
Signs and symptoms of CSM^{1,15,16}

| Signs | Symptoms |
|---|---|
| Upper motor neuron (UMN) signs in the upper extremity/lower extremity (hyperreflexia, clonus, a positive Hoffman sign, a positive Tromner sign, a positive Babinski's sign, and spasticity) | Neck pain/stiffness |
| Corticospinal tract distribution motor deficits | Paraesthesias in the upper extremity and/or lower extremity |
| Atrophy of intrinsic hand muscles | Loss of manual dexterity |
| Dermatomal sensory loss | Gait imbalance/unsteadiness |
| Broad-based/unstable gait | Frequency and urgency of urination and/or defecation |

been heralded as a key pathophysiologic component of CSM. Chronic compression induced by degenerative changes in the cervical spine result in ischemia in both the extra- (i.e., vertebral) and intra-spinal (i.e., anterior spinal artery) blood vessels. Further, long-standing compression on extra-spinal vessels induces wall-thickening and hyalinization, further reducing regional perfusion. Additionally, chronic spinal cord compression causes stretching and flattening of penetrating vessels, reducing perfusion to axonal pathways, particularly the lateral corticospinal tract.¹ This feature may explain the distribution of motor deficits seen in CSM patients.

Emerging evidence points to the activation of an immune response in long-standing intraparenchymal ischemia.¹¹ This may be a key patient-specific factor explaining the highly variable nature of disease manifestation. Activation of microglia and the accumulation of macrophages at the site of compression are the main known components of this neuroinflammatory reaction. Triggering of the CX₃CR1–CX₃CL1 axis has been demonstrated to be a key component in the hypoxia – neuroinflammation cascade.³

The blood-spinal cord barrier (BSCB), an analogue to the blood brain barrier, has been implicated in acute spinal cord injury but is believed to play a central role in CSM.¹ Chronic spinal cord compression is believed to disrupt endothelial cells, permitting the entry of pro-inflammatory cells into the spinal cord paranechyma.¹

Ischemia and neuroinflammation are presumed to activate apoptotic pathways resulting in progressive neuronal and oligodendroglial death. The apoptotic pathway is mediated by signaling through Fas, Tumor Necrosis Fac-

tor (TNF), and mitogen-activated protein (MAP) kinase.¹ In fact, Karadimas *et al.*¹³ demonstrated neuronal and oligodendrocyte cells undergoing active apoptosis in a 5-mm area centered around the area of maximal compression in CSM patients.

Clinical features

The diagnosis of CSM is based on clinical features with imaging confirmation.^{1,12} Common signs and symptoms are presented in Table 1. Gait dysfunction is common among people over 60 years of age. For example, Mahlkecht *et al.*¹⁴ found a total of 24.0% of 60 to 97-year-old patients demonstrated neurological gait disorders, 17.4% non-neurological gait problems, and 9.2% who demonstrated a combination of both. In CSM, gait dysfunction and balance disturbances from proximal lower extremity weakness are common early manifestations of CSM but can incorrectly be attributed to old age and delay diagnosis by up to six years.⁶ Similarly, an average delay in diagnosis of 2.2 years was found by Behrbalk *et al.* in patients presenting with symptoms compatible with CSM in a community based setting.^{5,15} In a prospective, controlled trial in one single surgical practice, myelopathic signs such as an inverted brachial reflex, Babinski reflex, Hoffman sign, and sustained clonus were more common in CSM surgical candidates compared to controls.¹⁶ A positive Hoffman sign is suggestive of upper motor neuron pathology localized to cervical spinal cord. However, Annaswamy *et al.*¹⁷ found that a positive Hoffman sign was present in 22% of patients without cervical spinal cord compromise. Therefore, a Hoffman sign must always be considered in the context of the entire clinical picture and

may not indicate the presence of a cervical spinal cord lesion. The absence of sensory symptoms (such as upper and lower extremity paresthesia and neck pain) in cases of suspected CSM should prompt investigation of other motor neuron diseases such as ALS, neuromuscular junction diseases such as myasthenia gravis, or myopathies such as inclusion body myositis.¹

Funicular referral is an uncommon feature of spinal cord compression but awareness of its existence may prevent delayed diagnosis or mismanagement in CSM.¹⁸⁻²⁰ Highlighted in case 3, this phenomenon refers to dysfunction distant or remote from an expected anatomical locus of pathology.¹⁸ Larner¹⁸ suggested that mechanical compression of the ascending spinothalamic tract in the cervical spine might cause this false localizing sign remote from the level of compression. Ochiai and colleagues¹⁹ posited that a different mechanism, such as ischemia in the watershed zone of the anterior spinal artery, was a more likely explanation in CSM patients with mid-thoracic girdle sensation, a type of funicular referral. Our patient in case 3 presented with myelopathic symptoms after a previous injury, as well as neuropathic pain in the left thorax and left lower extremity. MRI revealed myelomalacia of the cervical spine and lumbar neurodynamic testing was negative, prompting a putative diagnosis of CSM with funicular referral. Chan *et al.*²⁰ described a similar presentation in two patients with CSM complaining of sciatica-like leg pain. In these two patients, early interventions were targeted at the lumbar spine. After limited improvement, both patients experienced symptom resolution after a cervical epidural steroid injection (CESI) and a selective nerve root block, respectively.

As a form of SCI, CSM can cause bladder voiding dysfunction, such as urge incontinence.¹ A lesion in the neuroaxis above S1 can lead to discoordination of micturition, resulting in reflex or spastic bladder. Voluntary inhibition of the micturition reflex may be lost in cases of SCI and can result in detrusor muscle overactivity or detrusor-sphincter dyssynergia. This discoordination can lead to high voiding pressure, residual urinary volume, and incontinence, leading to upper tract deterioration and renal failure.²¹

The natural history of CSM is variable, alternating between stepwise decline and rapid neurological deterioration.^{1,6} Clark and Robinson⁶ were the first to investigate the natural history of CSM in 1956 and categorized

three separate patterns: 75% of patients deteriorated in a stepwise fashion, 20% had slow, steady progression of disease, and 5% developed rapid onset of symptoms and signs and subsequently remained stable for years. A 2017 systematic review demonstrated that 20-62% of patients with CSM experienced neurologic deterioration during 3-6 year follow-up.²² This review highlighted that patients with circumferential spinal cord compression were at a greater risk of neurological deterioration than individuals with partial compression. In a multivariate analysis evaluating risk factors for patients converting to surgery after conservative care, Oshima *et al.*¹³ found that total cervical ROM (50°), segmental kyphosis in the maximum compression segment, or the presence of a local spondylolisthesis were independently associated with an increased risk of requiring surgery.

Diagnostic imaging

Radiography is valuable as a first-line imaging modality to assess cervical alignment and provide an estimation of spinal degeneration.¹ Computed Tomography (CT) is also a useful modality when operative treatment, such as spinal fusion, is being considered. In addition to providing superior detail of bony anatomy, CT is an invaluable resource when MRI is contraindicated, such as when a patient has a non-MRI-conditional pacemaker.¹ However, MRI is the imaging of choice for evaluation of the spinal cord and recent literature suggests that MRI is safe in patients with non-MRI-conditional cardiac devices.²³ Therefore, the benefits of obtaining the MRI to confirm SCI likely outweighs any perceived risks and this should be discussed with patients. Sectional imaging with CT and MRI is used to characterize both the nature of compression (spondylosis, OPLL, OLF) and the severity of compression in the cervical spine. MRI can also detect signal intensity changes within the spinal cord parenchyma.^{1,24,25} Uchida and colleagues²⁴ found that the signal intensity ratio on T1-weighted images but not T2-weighted images correlated with postoperative neurologic improvement in a cohort of patients undergoing surgery for CSM. In a retrospective study, Avadhani *et al.* also found that low signal intensity changes on T1-weighted images were associated with poor surgical outcomes.²⁵ Low intensity signal changes on T1-weighted images may represent myelomalacia, necrosis, and cystic cavitation, all of which are considered irreversible.^{1,25} Nouri *et al.*⁴ also demonstrated

that the presence of T1-weighted image signal hypointensity indicated more permanent injury and portended decreased functional recovery in patients with CSM.

The use of novel MRI techniques to diagnose CSM is an area of continued investigation as the prevalence of asymptomatic spinal cord compression in healthy populations is estimated at 24.2%.¹² Although the majority of individuals over the age of fifty demonstrate radiographic evidence of cervical degeneration, only about 25% go on to develop symptoms of neurological impairment from mechanical compression.² Unlike structural MRI, which relies primarily on qualitative assessment, diffusion tensor imaging (DTI) can be used to evaluate CSM patients quantitatively.^{26,27} DTI is an emerging technology which assesses the microstructural changes in the spinal cord not otherwise detected by conventional MRI. DTI uses the diffusion directionality of water molecules to study the microstructure of biological tissues. In the white matter tracts of the spinal cord, the preferential directionality of diffusion is known as fractional anisotropy (FA).²⁶ The white matter tracts of the spinal cord are arranged in a tightly packed orientation, leading to a high level of FA in unaffected individuals.²⁸

Emerging evidence suggests that FA may have diagnostic potential as a pre- and post-operative outcome measure in CSM.²⁸ Findings from Lee *et al.*²⁹ support the notion that FA at the level of maximal compression in the cervical spine may have diagnostic potential in assessing the severity of myelopathy in CSM patients. Maki *et al.*²⁷ evaluated 26 surgical candidates and found that FA was a good predictive factor in determining post-operative success. Rao *et al.*²⁶ investigated the utility of FA as a biomarker for severity of CSM and a prognostic biomarker for post-operative improvement. In their study, lower FA at the level of maximal compression correlated with worse preoperative clinical severity. Results also demonstrated an inverse relationship between lower preoperative FA at the level of maximal compression and postoperative improvement.²⁶

Outcomes measures

The modified Japanese Orthopedic Association (mJOA) score and the Nurick grading system are both CSM-specific indices used to grade the severity of dysfunction in patients.^{1,10} The mJOA assesses functional abilities on an 18-point scale which includes upper limb motor func-

tion, lower limb motor function, upper limb sensation and sphincter function.¹ The mJOA was adopted from the original Japanese Orthopedic Association (JOA) but was adapted to western populations. Fehlings *et al.* defined CSM severity as mild if mJOA scores were 15 or higher, moderate if mJOA scores ranged from 12 to 14 or severe if mJOA scores were less than 12.^{30,31} In a prospective study with 277 surgical candidates with CSM, the mJOA demonstrated higher validity with the Nurick score than previous research looking at the JOA.³¹ The Nurick grading system is a 6-point ordinal scale that is primarily based on employment status and gait function.¹⁰ However, the Nurick Scale demonstrates low sensitivity and poor responsiveness.^{1,31}

Management

The current standard of care for degenerative cervical myelopathy is surgical decompression.^{2,32} However, management strategies for patients with CSM are guided by different factors. Two salient factors include the rate of disease progression over time and the risk of acute spinal cord injury (SCI). One particular SCI is central cord syndrome; the resultant neurologic consequences following a low-energy hyperextension injury superimposed onto a pre-existing myelopathy.¹

In some reports, non-operative management of patients with CSM have yielded similar outcomes as operative management in patients with mJOA scores ≥ 13 (as gauged by post-operative mJOA and NDI scores).²² However, the incidence of hospitalization for spinal cord injury was 13.9 per 1,000 person-years in a non-operative group compared to 9.4 per 1,000 in the operative group, which was significant (adjusted HR = 1.57; 95% CI = 1.11-2.22; P = .011).²² Another prospective randomized trial comparing conservative to surgical management showed that outcomes based on mJOA score, recovery rate, timed 10-meter walk, and functional daily activities were comparable after two-year follow up.³³ The results of one prospective case series demonstrated that surgery for CSM is associated with significant functional recovery, but appears to plateau after six months.³⁴ Boakye *et al.*³⁴ obtained data on 58,115 patients with CSM and found that complications following spine fusion were significantly more frequent among individuals with a least three pre-existing medical comorbidities.

Many reports exist describing the conservative

management of CSM, but few provide detailed methods of application. In one report, conservative management included long durations of cervical traction and outcomes were categorized as: improvement, no improvement, and exacerbation.³⁵ In 62% of the nonsurgical patients, symptoms worsened. However, there was a strong correlation between symptom duration and treatment outcome, with longer durations portending a worse outcome.³⁵ Other reports also suggest gait training and cervical immobilization for patients with mild myelopathy.¹³

Chiropractors can play an important role in the early recognition and triage of patients with CSM. Early manifestations of CSM may include neck pain, for which many persons seek care from a chiropractor. Early surgical treatment of CSM, before symptoms become chronic and before the onset of irreversible spinal cord damage, is essential for optimal patient outcomes.^{5,6,35} Therefore, early identification of signs and symptoms consistent with CSM by chiropractors may initiate appropriate testing (e.g., MRI) and timely surgical consultation, which would yield the best possible outcome.

Guidelines exist describing absolute contraindications to cervical spine manipulation but limited high-quality data guides decision making in the presence of CSM.³⁶ Some data suggest that cervical spine manipulation may worsen neurologic symptoms of CSM.³⁷ As spinal manipulation is a common treatment implemented by chiropractors, appreciating relative and absolute contraindications to manipulation ensures patient safety. Case reports describe adverse events following cervical manipulation superimposed onto a pre-existing CSM. One case series involving 27 patients highlighted that cervical spinal cord encroachment as demonstrated through advanced imaging was not an absolute contraindication to cervical manipulation.³⁶ However, none of the included patients had evidence of severe or acute myelopathy. A five-year retrospective series involving 22 patients found that cervical myelopathy worsened in 11 patients who underwent cervical manipulation.³⁸ Another case series involving three patients found that cervical spine manipulation was purported to be a causative factor in the development of CSM.³⁹ In spite of this, detection bias in the aforementioned studies prevents making absolute conclusions about what role, if any, manipulation played in the progression of disease independent of natural history.

Fehlings *et al.*² demonstrated that surgical decom-

pression for the treatment of CSM was associated with improvements in functional, disability-related, and quality-of-life outcomes at one year of follow-up. The degree of improvement was correlated with preoperative mJOA scores (patients with mild disease preoperatively experienced the least amount of improvement whereas individuals with more severe disease experienced greater improvements). Another study revealed that between baseline and two years postoperatively, mJOA scores improved by 2.40 points and by 1.34 on the Nurick grading scale.⁴⁰ However, surgical intervention for CSM is not without associated risks. One in five patients in the multicenter AOSpine study experienced at least one complication following decompression surgery (most commonly dysphagia, dural tears, or infection).⁴⁰

Limited evidence guides the decision to perform decompressive surgery in an asymptomatic patient who has evidence of cervical canal stenosis. When consulting this demographic, factors such as patient age, co-morbidities, level of activity, the rate of disease progression, and extent of radiographic findings must be considered.⁴¹ One prospective study found that 8% of individuals with asymptomatic cord compression will go on to develop CSM after one year. Further, this study also showed that 22% in total would go on to develop CSM over the observation period (median follow-up 44 months).¹⁵ Therefore, one in five people with asymptomatic cervical spinal cord compression may develop CSM within four-years. This information should prompt clinicians to counsel their patients on the higher risk of developing myelopathy in the presence of non-myelopathic cord compression.⁴²

Conclusion

We present three unique cases of CSM and highlight the disease's epidemiology, pathobiology, clinical features, and management strategies. CSM is the leading cause of spastic paresis in adults aged 55 and older.⁵ Due to CSM's variable disease course, its overlap with other conditions, and senescence, it is critical that chiropractors have a high index of suspicion for this entity so they can initiate prompt referral for co-treatment with neurosurgery.^{1,5} Owing to an ageing global population, identifying optimal treatment strategies for this disabling condition has become a public health priority, and chiropractors can play an important role with early diagnosis and rehabilitation referral.^{1,32}

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Meniscal lesion or patellar tendinopathy? A case report of an adolescent soccer player with knee pain

Antonio Petrolo, DC¹

Background: Injuries to the meniscus are particularly prevalent in soccer players, with an incidence of 0.448 injuries per 1000 hours of playing. However, in the adolescent soccer player population, it has been reported that up to 63% of asymptomatic knees may demonstrate horizontal or oblique tears on MRI. These results may negatively influence clinical decision-making and plan of management for adolescent soccer players with knee problems.

Case presentation: A case of a 15-year-old soccer player is presented after having been diagnosed by his family physician with a left lateral meniscus tear as per MRI, following a 10-week period of anterior knee pain. He presented to a chiropractor for a second opinion before consulting with the orthopedic surgeon.

Management and outcome: Recommendations

Lésion du ménisque ou tendinopathie de la rotule? Étude du cas d'un joueur de soccer adolescent souffrant d'une douleur au genou

Contexte : Les lésions du ménisque sont particulièrement fréquentes chez les joueurs de soccer, présentant une incidence de 0,448 lésion pour 1 000 heures de pratique. Toutefois, on observe par IRM chez les joueurs de soccer adolescents que jusqu'à 63 % des genoux asymptomatiques peuvent présenter des déchirures horizontales ou obliques. Ces résultats peuvent nuire à la prise de décisions cliniques et à la planification du traitement des joueurs de soccer adolescents souffrant de problèmes au genou.

Exposé du cas : Un joueur de soccer de 15 ans a consulté son médecin de famille qui a diagnostiqué par IRM une déchirure du ménisque latéral gauche, après avoir ressenti une douleur de la partie antérieure du genou pendant dix semaines. Il a obtenu un deuxième avis auprès d'un chiropraticien avant de consulter un chirurgien orthopédiste.

Traitement et résultat : Une réadaptation progressive

¹ RCCSS(C) Sports Sciences Resident, Canadian Memorial Chiropractic College

Corresponding author:

Antonio Petrolo, Canadian Memorial Chiropractic College Division of Graduate Studies, 6100 Leslie Street, Toronto, ON M2H 3J1

Tel: 647-391-8588

e-mail: info@drantoniopetrolo.ca

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The author has no disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript. The involved patient provided consent for case publication.

for progressive rehabilitation owing to the lack of clinical evidence for meniscal abnormality were made. A primary diagnosis of left patellar tendinopathy was determined and after a 6-week comprehensive rehabilitation program, the patient made a complete recovery.

Summary: A thorough history, physical examination, and understanding of the patient's injury mechanism are suggested before confirming/refuting suspicions of meniscal abnormalities via MRI. This will help to inform better clinical decision-making as well as decrease the occurrence of unnecessary imaging.

(JCCA. 2022;66(2):157-171)

KEY WORDS: chiropractic, meniscal tear, physical examination, diagnosis, rehabilitation, patellar tendinopathy, magnetic resonance imaging, adolescent, soccer

Introduction

Soccer is the most popular sport in the world, with nearly 129,000 athletes competing professionally and over 220 million playing recreationally worldwide.¹ Injuries to the meniscus are particularly prevalent in soccer players, with an incidence of 0.448 injuries per 1000 hours of playing.² The sport-specific demands for quick cutting, pivoting, and tackling render these athletes particularly susceptible to meniscal tears.

MRI is widely used for assessing meniscal tears. Many MRI studies have documented the high accuracy rates of detecting knee pathology.³⁻⁸ A meta-analysis based on 22 studies described an overall sensitivity of 88% and specificity of 94% for detecting meniscal lesions.⁹ Consequently, MRI results may affect the treatment of patients with knee problems.^{4,10} It has been demonstrated that there is a baseline prevalence of meniscal tears in asymptomatic knees.¹¹⁻¹³ Depending on the patient's age, a prevalence of up to 36% has been reported in the general population.¹² Particularly in the adolescent soccer player population, it has been reported that up to 63% of asymptomatic knees may demonstrate horizontal or oblique tears on MRI.¹⁴ One study reported that high signal within the menis-

a été recommandée en raison du manque de données cliniques probantes d'une anomalie du ménisque. Un diagnostic initial a permis de déterminer une tendinopathie de la rotule gauche et après un programme de réadaptation complet de six semaines, le patient avait entièrement récupéré.

Résumé : Il est conseillé de procéder à une anamnèse poussée, de réaliser un examen physique et de comprendre le mécanisme de la lésion du patient avant de confirmer ou d'infirmer toute suspicion d'anomalies du ménisque par IRM. Cela permettra d'éclairer la prise de décisions cliniques et d'éviter de recourir à l'imagerie inutile.

(JCCA. 2022;66(2):157-171)

MOTS CLÉS : adolescent, chiropratique, déchirure du ménisque, diagnostic, examen physique, imagerie par résonance magnétique, réadaptation, soccer, tendinopathie de la rotule

cus may be found in 80% of asymptomatic menisci in 10-year-olds, decreasing to 35% in 15-year-olds.¹⁵ Yet another study of 51 children with suspected meniscal pathology found a sensitivity and specificity of 50% and 78% respectively for lateral meniscal tears in the under 15 age group.¹⁶ A low positive predictive value (20%), but a high negative predictive value (93–100%) of MRI for meniscal tears was determined.¹⁶ A high prevalence of abnormal findings in asymptomatic knees hampers the value of any imaging method in clinical decision making.¹⁷ It is therefore of fundamental importance that MRI findings are not used in isolation, as it may negatively influence clinical judgement and decision-making, especially in the pediatric/adolescent population.

It has been suggested that clinical examination, performed by an experienced examiner, can have equal or even more diagnostic accuracy compared to MRI to evaluate meniscal lesions.¹⁸ In one study, the overall accuracy for the clinical diagnosis of meniscal tears was 80.7% and the corresponding accuracy for MRI was 73.7%.¹⁹ In yet another study, clinical examination performed by an experienced knee surgeon was observed to have better specificity (90% vs. 60%), positive predictive

value (95% vs. 83%), negative predictive value (90% vs. 86%), and diagnostic accuracy (93% vs. 83%) than MRI for medial meniscal tears.²⁰ These parameters showed only a marginal difference in lateral meniscal tears.²⁰ These results would suggest that clinical examination by an experienced examiner using multiple meniscus tests is necessary for the diagnosis of a clinically relevant meniscal tear.²⁰

The purpose of this case report is to highlight the importance of using clinical information to inform clinical judgement and decision-making, while using MRI in conjunction to help confirm clinical suspicions, and not as a sole diagnostic tool. It is fundamental to correlate clinical information with relevant MRI findings, as incidental imaging findings may be present without clinical symptomatology or implications. This will help to determine the appropriate plan of management in adolescent knee injuries.

Case presentation

A 15-year-old, right-foot dominant, male competitive soccer player presented to a chiropractor complaining of left anterior knee pain at the distal pole of the patella as well as the distal quadriceps tendon, most apparent to the patient with intense exercise and specific movements, such as decelerating from a run and quick directional changes/cutting while playing soccer. Ten weeks prior to his visit to the chiropractor, the patient had injured his left knee in a competitive match. With his back facing goal, he had received the ball, turned, and was tackled from the left side, with the opposing player making forceful contact from the lateral aspect of the left knee to collapse into valgus. No audible noises were heard. The patient was subsequently taken off for five minutes, then returned to play and was able to finish the game with some pain in the knee. No bruising, swelling, give-way sensations, or audible clicks/crunching at the knee was reported by the patient following the match. The patient continued attending training sessions for the following six weeks after the incident occurred, although continuing to experience anterior knee pain. The patient had sought physiotherapy treatment during this time, which was completely passive in nature. The physiotherapist determined a diagnosis of meniscal irritation of the left medial and lateral menisci. The patient reported having been treated with laser and IFC treatment two times a week for four weeks, however

with no change in symptoms. After the six weeks, there was a two-week break from training and competition with the club, during which the patient was not playing soccer at all. Following this break period, training resumed and on the first day of return during a scrimmage, the patient noticed severe difficulty in producing any sort of left knee extensor force during the entire session. He described the knee as being “slow”, with difficulty pushing off the left foot during running and cutting, as well as a very low force-production in left-footed kicking with limited mobility. No clicking, give-way, or locking sensations were reported by the patient.

The patient then sought the opinion of his family physician and was subsequently referred for radiographic and MRI studies. Radiographic imaging was unremarkable. However, the MRI findings reported a subtle suspected nondisplaced oblique tear of the posterior horn of the lateral meniscus, extending to the tibial plateau (Figure 1). The patient was subsequently referred for orthopedic consult but had sought the opinion of the chiropractor before meeting with the orthopedic surgeon.

Upon presentation to the chiropractor, the patient reported left anterior knee pain that was dull and achy in nature, but sometimes very sharp with higher intensity movements (5/10 at rest, 8/10 during activity using the Numeric Pain Rating Scale (NPRS)), such as running, jumping, cutting, and deceleration from running. The left quadriceps measured 40.8 cm, compared to 41.5 cm on the right (measured 4 cm above the patella). There was no swelling apparent on either the medial or lateral aspect of the patella, or at the tibial tuberosity. The patient was unable to squat beyond 50 degrees of knee flexion due to increasing pain and pressure around the patella. Slight bilateral knee valgus was also noted during descent of the squat beginning at 20 degrees. Meniscal orthopaedic testing was negative, including Thessaly’s test, McMurray’s test, Steinman’s test, and joint line tenderness. Ligamentous laxity tests of the knee were also negative bilaterally. Thomas test revealed quadriceps tightness bilaterally (knee flexion at 120 degrees on both left and right tests), with hip flexor tone within normal limits. Upon palpation, tenderness was present at the mid-portion of the left patellar tendon (8/10 NPRS) with moderate tenderness at the inferior pole of the left patella (5/10 NPRS) and distal quadriceps tendon (4/10 NPRS). These all reproduced the patient’s chief complaint. Bilateral kneeling was particu-



Figure 1.

Left knee MRI frames (Sagittal FSE PD and intermediate weighted FS) demonstrating a nondisplaced oblique tear of the posterior horn of the lateral meniscus, extending to the tibial plateau.

larly painful on the patient's left knee (8/10 NPRS) and resisted left knee extension reproduced the chief complaint. A left patellar compression test was also found to be positive.

Upon review of the patient's clinical presentation, history, physical evaluation, and MRI findings, the chiropractor determined that the left lateral meniscal tear found in the advanced imaging study was, in fact, not clinically relevant and may very well have been an incidental asymptomatic finding, as the clinical picture did not correlate at all with the imaging findings. The differential diagnoses made by the chiropractor included left-sided patellar tendinopathy, left quadriceps tendinopathy, left patellofemoral pain syndrome, left iliotibial band syndrome, and left Hoffa's fat pad syndrome. There was no MRI evidence to suggest Sinding-Larsen-Johansson disease or Osgood-Schlatter syndrome as differentials at this time. This clinical impression was later confirmed by the orthopedic surgeon during the patient's first orthopedic consult later that week. The orthopedist had recommended against any sort of invasive meniscal procedures, but had

instead advised on a plan of conservative care with the chiropractor.

In accordance with the orthopedic surgeon's recommendations, the patient began a six-week (three sessions a week) progressive rehabilitative return-to-play program at the chiropractic clinic, which included a gradual reintegration into training sessions with his soccer club in the later phases of the program. The protocol consisted of a progressive routine of supervised exercises and manual therapy (soft tissue therapy), with detailed focus on enhancing tibiofemoral/patellofemoral range of motion, hip and ankle control/mobility, increasing load and extensibility capacities of the extensor mechanism, and eventually training the dynamic/ballistic capacities of the rehabilitating anatomical structures to be able to perform in an athletic environment. Checkpoints were met along the course of the rehabilitative program. The entire rehabilitation protocol is outlined in Table 1. Education was also provided along the way, such as technical instruction to reduce valgus stress during squatting, as well as supportive nutritional considerations, like increasing

Table 1.
Rehabilitation program

| Rehabilitation Phase | Week | Exercises | Checkpoint |
|-----------------------|---|--|--|
| Range of Motion Phase | Week 1 (Exercises done twice per day) | 1. Heel Slides (20 reps x 3 sets) 2. Rotational Tibiofemoral CAR's (10 reps x 3 sets) 3. Hip CAR's (5 reps both ways) 4. Ankle CAR's (10 reps both ways) | ✓ Full, non-loaded tibiofemoral range of motion achieved, without pain |
| Isometric Phase | Week 2 (3 supervised sessions in one week) | 1. 30, 90, and 120 Degree Wall Sits (10 seconds each x 3 sets) 2. Double and Single Leg Hamstring Bridges (10 seconds each x 3 sets) 3. Isometric Lunges (10 seconds each leg x 3 sets) 4. Deep Squats (30 seconds x 3 sets) | ✓ Exercises performed pain-free and with full range of motion |
| Eccentric Phase | Week 3, 4, and 5 (3 supervised sessions in the first week, then 2 the next week, and 1 session the following week) | 1. 25 Degree Decline Squats (10 reps x 3 sets) 2. Eccentric lunges (10 reps each x 3 sets) 3. Reverse Nordic Curls (10 reps x 3 sets) 4. Nordic Hamstring Curls (10 reps x 3 sets) 5. Single Leg Russian Deadlifts (10 reps x 3 sets) | ✓ Exercises performed with minimum 5-second descents with good control, no pain, and full range of motion. |
| Dynamic Phase | Week 4, 5, and 6 (1 supervised session the first week, then 2 the next week, and 3 sessions the following week) | 1. Double Legged Hops (forwards and lateral, 10 reps x 3 sets) 2. Single Legged Hops (forwards and lateral, 10 reps x 3 sets) 3. Forward Running Bounds (10 reps x 3 sets) 4. Skier Jumps (10 reps x 3 sets) 5. 24 Inch Box Jump/Lands (double leg – 10 reps x 3 sets, single leg – 6 reps x 3 sets) 6. 36 Inch Box Jumps/Lands (double leg – 6 reps x 3 sets) 7. Kneel Jumps (6 reps x 3 sets) 8. Sprints (6 reps of 10 seconds, full intensity) 9. Acceleration/Deceleration Runs (forwards and side-on, 6 reps) 10. Figure 8 Runs (6 reps) | ✓ Ability to perform all dynamic movements pain-free |

protein intake to five servings of 20 grams of protein per day.²¹⁻²³

The rehabilitation protocol began with regaining complete tibiofemoral range of motion, as well as enhancing the mobility/control of the hip and ankle. The patient was prescribed heel-slides (Figure 2 – 20 repetitions by three sets) and rotational tibiofemoral controlled articular rotations (CAR's) (Figure 3 – 10 repetitions by three sets) to be completed a minimum of two times daily. Hip (Figure 4 – five repetitions clockwise and counterclockwise) and ankle (Figure 5 – 10 repetitions clockwise and counterclockwise) CAR's were also prescribed to be completed concomitantly twice daily, at a minimum. Full, non-loaded tibiofemoral range of motion was achieved after one week, with no pain.



Figure 2.
Heel slide exercise used to enhance flexion/extension range of motion of the tibiofemoral joint as well as to begin recruiting hamstring and quadriceps activation. The patient A) slides their heel as close to the buttock as possible, then B) straightens into full knee extension and repeats.

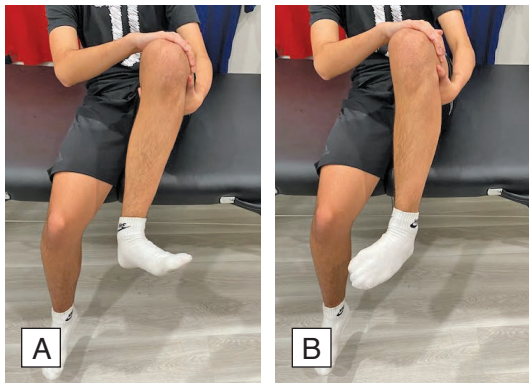


Figure 3. Rotational tibiofemoral controlled articular rotations (CAR's), used to enhance tibiofemoral range of motion and neurogenic control in the transverse plane. The patient stabilizes their femur with their hands while focusing on A) laterally and B) medially rotating the tibia.

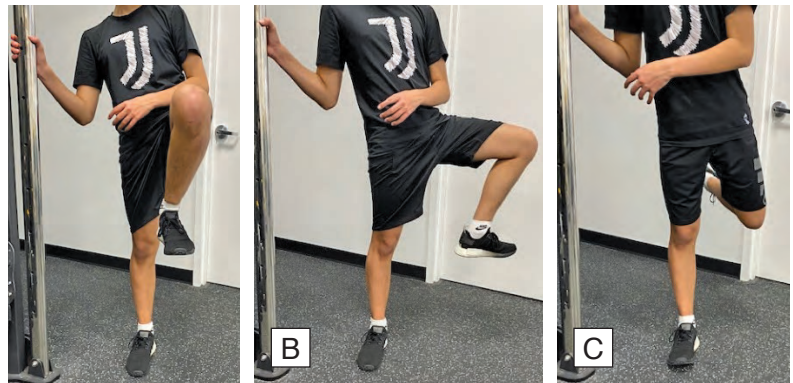


Figure 4. Hip controlled articular rotations (CAR's), used to enhance neurogenic control of the hip musculature as well as range of motion of the acetabulofemoral joint. The patient begins by A) flexing the hip as much as possible, then B) abducting laterally, and at end range C) rotating internally while simultaneously extending and abducting the hip. The patient then returns in the opposite direction to complete one full CAR cycle.

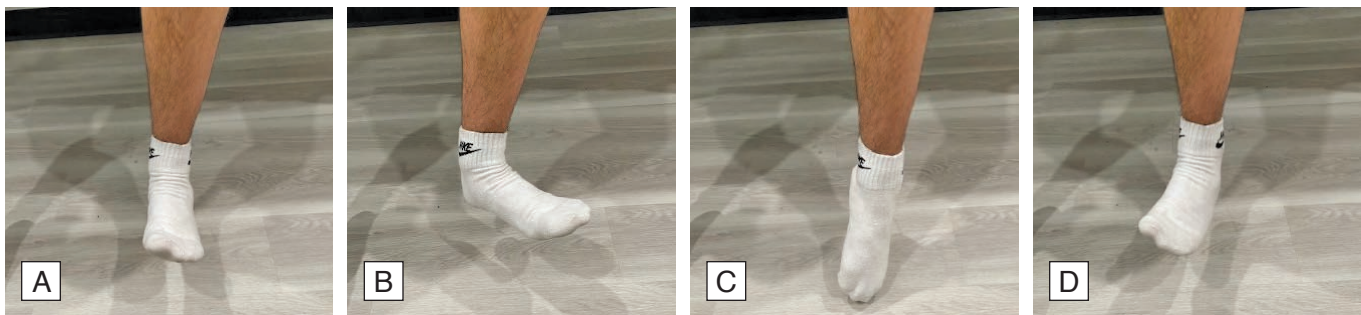


Figure 5. Ankle controlled articular rotations (CAR's), used to enhance neurogenic control and range of motion of the ankle mortise. The patient performs full circles in both clockwise and counterclockwise directions with the ankle using combinations of A) dorsiflexion, B) external rotation, C) plantarflexion, and D) internal rotation.

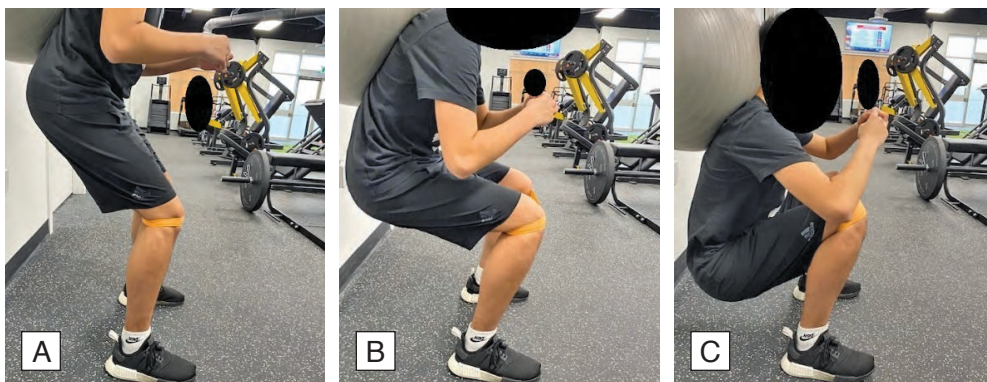


Figure 6. Isometric wall sits (with band) performed at A) 30, B) 90, and C) 120 degrees of knee flexion. The squat is used to begin strengthening the knee extensors in different orientations while the band around the knees cues the patient to externally rotate both hips so that knee valgus is decreased.



Figure 7.
Isometric hamstring bridge performed with A) double and B) single legs. This exercise is used to strengthen the hamstring, which helps to stabilize the knee.



Figure 8.
Isometric lunges (with band) used to strengthen the quadriceps while cueing the patient (with the band) to externally rotate the hip to reduce knee valgus.

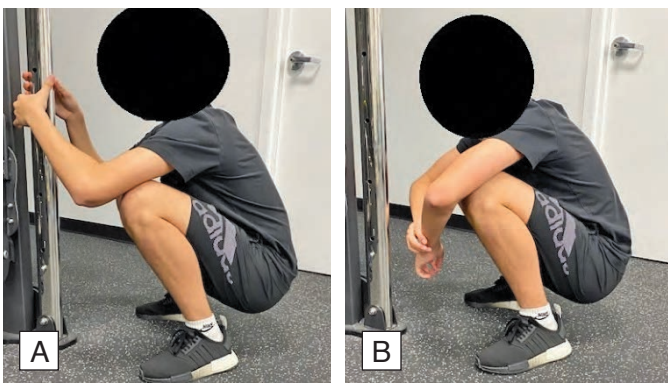


Figure 9.
Deep isometric squats performed A) with and B) without support column. This exercise is used to challenge hip, knee, and ankle mobility/range of motion.

Once this checkpoint was reached, the isometric strengthening phase of the rehabilitation program was added. The patient was prescribed wall sits (Figure 6 – three sets) at 30, 90, and 120 degrees of knee flexion to be held for 10-second intervals with breaks in between. An exercise band was placed around both knees to elicit gluteal abductor activation. Hamstring bridges (Figure 7 – three sets) were also prescribed to be held for 10-second intervals, performed with both legs and single legs. Isometric lunges (Figure 8 – three sets each leg) were prescribed and held for 10-second intervals, with an exercise band around the front knee to produce a valgus force, challenging the gluteal abductors to contract. Finally, the patient was prescribed deep squats (Figure 9 – three sets) to be held for 30-second intervals. At first, the patient would hold on to a column for support, but was encouraged to slowly begin supporting his own body weight, and eventually moving the body in clockwise and counter clockwise circles while maintaining the deep squat. This rehabilitation phase lasted one week, as all the respective exercises were able to be performed pain free and at full range at this checkpoint.

The next phase of rehabilitation was the eccentric loading phase. The patient was prescribed eccentric 25 degree decline squats (Figure 10 – single and double leg), eccentric lunges, reverse Nordic curls (Figure 11), Nordic hamstring curls (Figure 12), and single leg Russian deadlifts (Figure 13). These exercises were to be repeated 10 times for three sets, with special focus on taking at least five seconds to descend eccentrically into the bottom position for all exercises. As certain exercises became less challenging, resistance would be added to these exercises to create additional difficulty. The eccentric exercises were maintained throughout the rest of the protocol, however gradually eliminated. The first week of this rehabilitation phase contained eccentric sessions during the week, brought to two sessions the following week, then one the next, and zero in the last week of the protocol. As eccentrics were phased out, the dynamic/ballistic portion of the rehabilitation protocol was phased in.

The dynamic/ballistic portion of the protocol was progressively phased over the final three weeks of the program, beginning with one session in the first week, then two sessions the following week, and three sessions in the last week of the protocol. All sessions began with a FIFA 11+ warmup lasting 10 to 15 minutes.²⁴ The first ses-



Figure 10.
Eccentric 25 degree decline squats. The patient descends slowly into the squat to tension and lengthen muscular and tendinous knee extensor structures.

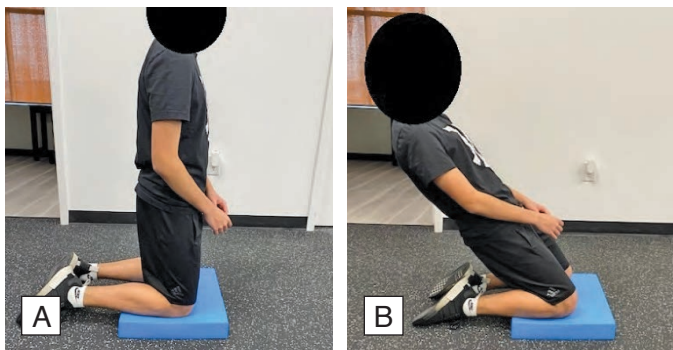


Figure 11.
Reverse Nordic quadriceps eccentrics. The patient A) begins in a kneeling position and B) descends slowly backwards as far as possible, maintaining a straight torso and thigh line. This is an eccentric exercise used to tension and lengthen muscular and tendinous knee extensor structures.

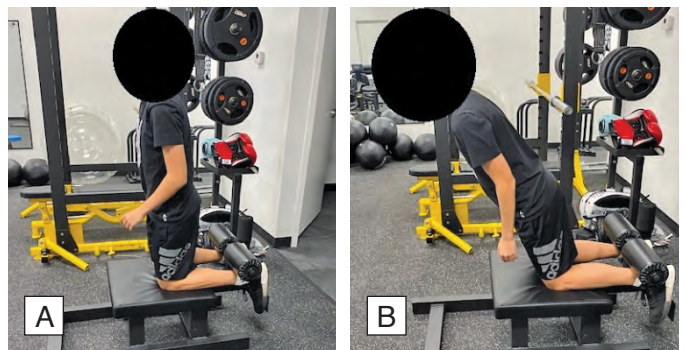


Figure 12.
Nordic hamstring eccentric curls. The patient A) begins in a kneeling position and B) descends slowly forwards as far as possible, maintaining a straight torso and thigh line. This is an eccentric exercise used to tension and lengthen muscular and tendinous knee flexor structures.

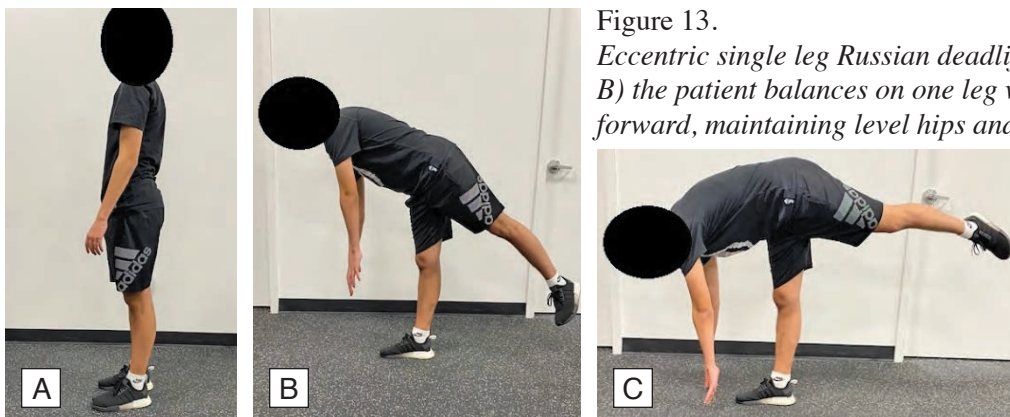


Figure 13.
Eccentric single leg Russian deadlift. From A) the starting position, B) the patient balances on one leg while C) descending slowly forward, maintaining level hips and as straight of a torso-leg line as possible. This is an eccentric exercise used to tension and lengthen muscular and tendinous proximal hamstring structures.

sion included a reintroduction to double legged hops and bounds in all orientations, with emphasis on very little ground contact time. Repetitions of 10 for three sets were used for each orientation, including forwards/backwards, lateral, and diagonals (Figure 14). A 10-minute treadmill jog was also reintroduced. Following the first session, single leg hops and bounds were reintroduced including all orientations mentioned previously for the double legged hops (Figure 15 – 10 repetitions for three sets).

Single leg forward running bounds (Figure 16) and skier jumps (Figure 17) were added, consisting of 10 repetitions for three sets. As these bounds became easier to perform, box-jumps/lands (Figure 18 – 10 repetitions double legged, six repetitions single legged for three sets) and kneel-jumps (Figure 19 – six repetitions for three sets) were added. The final phase of the dynamic/ballistic portion of the protocol included full intensity sprints on the athlete-propelled treadmill (Figure 20 – six repetitions for



Figure 14.

Quick A)B)C) forward/backward hops and D) E) lateral hops. These are plyometric exercises that challenge the dynamic capacity of the patellar tendons.



Figure 15.

Quick single-leg A)B)C) forward/backward hops (lateral and diagonal hops not depicted). These are plyometric exercises that challenge the dynamic capacity of the patellar tendons.

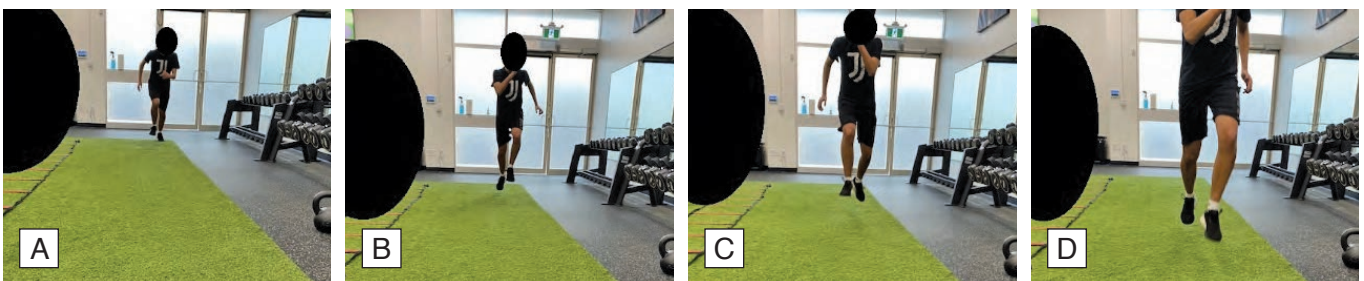


Figure 16.

Forward running bounds, with emphasis on vertical height and brief ground-contact. This plyometric exercise challenges the dynamic capacity of the patellar tendons.

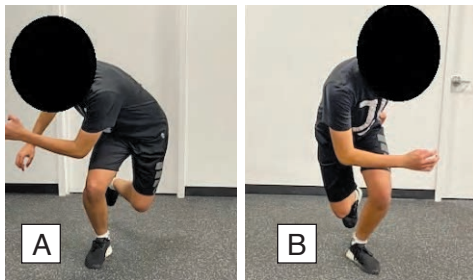


Figure 17.
Skier jumps, with emphasis on sticking the landing, then rebounding. This plyometric exercise challenges the dynamic capacity of the patellar tendons.



Figure 18.
24-inch A)B)C) double, D)E)F) single legged and G)H)I) 36-inch double legged box jumps/lands. This plyometric exercise challenges the dynamic capacity of the patellar tendons.



Figure 19.
Kneel-jumps, performed by A) initiating in a kneeling position, B) jumping, and C) landing with both legs. This plyometric exercise challenges the dynamic capacity of the patellar tendons.

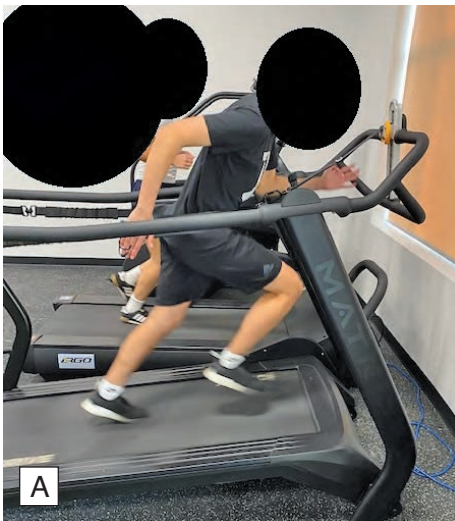


Figure 20.
Full intensity sprints on athlete-propelled treadmill. This exercise was used to refamiliarize the patient to the athletic demands of the sport of soccer.



Figure 21.
Acceleration/deceleration runs (forwards). The patient A) accelerates forwards from the first cone, B) decelerates at the third cone, C) runs backwards to the second cone, and D) accelerates five yards passed the third cone. This exercise was used to refamiliarize the patient to the athletic demands of the sport of soccer.

10 seconds each), acceleration/decelerations runs (Figure 21 – six repetitions, forwards and Figure 22 – side-on), and Figure-8 runs (Figure 23 – six repetitions).

By the end of the six-week protocol, the patient had seen substantial overall functional improvements and a decreased pain intensity during training (0-1/10 NPRS). Throughout the program, the patient was repeatedly asked about pain rating during exercise and was kept to a pain intensity threshold of no greater than 3/10 NPRS.

Upon discharge, the patient was able to complete a deep full squat pain free, box jump (and land) 36 inches double-footed and 24 inches single-footed, as well as perform high-energy sprints and bounds. There was also a noticeable change in quadriceps hypertrophy bilaterally, as both legs now measured 42 cm in thigh circumference (4 cm above patella). The patient was fully reintegrated with training sessions and competitive play with his soccer club as well.



Figure 22.

Acceleration/deceleration runs (side-on). The patient A) accelerates with side step-overs from the first cone, B) decelerates at the third cone, C) runs back (side step-overs) to the second cone, and D) accelerates forwards five yards passed the third cone. This exercise was used to re-familiarize the patient to the athletic demands of the sport of soccer.

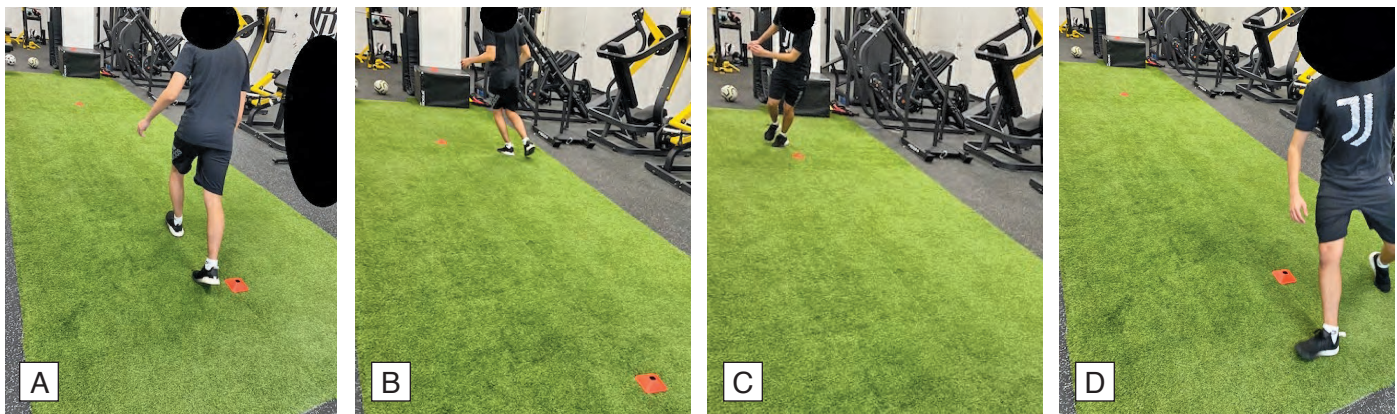


Figure 23.

Figure-8 runs, performed by A) accelerating from the start cone, B)C) decelerating and rounding the second cone, and D) returning to the first cone and repeating. This exercise was used to challenge agility and re-familiarize the patient to the athletic demands of the sport of soccer.

Discussion

This case report aims to highlight the shortcomings associated with relying solely on interpretation of MRI scans in athletic adolescent knee conditions without appropriate consideration and evaluation of the clinical presentation, historical context, and physical examination of the patient. Although the negative predictive value may be high in MRI studies²⁰, findings must first and foremost correlate with the clinical picture of the presenting patient, including a thorough history and physical examination, before invasive procedures are explored. Without appropriate consideration of the entire clinical picture of the individual patient, an inaccurate plan of management may be pursued, as well as unnecessary therapies or procedures.

In the clinical case presented, the patient's clinical presentation, history, and physical examination did not correlate with the MRI finding of the left lateral meniscal tear. In a study comparing history and physical examination with MRI, it was concluded that appropriate history taking in conjunction with appropriate physical examination provided important diagnostic factors with regards to predicted probability of meniscus tears.²⁵ More specifically, a positive McMurray's test along with historical claims of "locking" and "giving way" demonstrated a diagnostic specificity ranging between 92-96%.²⁵ The diagnostic accuracy was even further enhanced when MRI studies were performed (sensitivity of 97.4%), however only when correlated with the previous history and physical examination findings.²⁵ The patient presented in this report had not experienced any symptoms of locking or giving way, and demonstrated a negative McMurray test during examination. Additionally, a clinical utility study examining the performance of Thessaly's test demonstrated a specificity 90.7% and sensitivity 90.6% in diagnosing meniscal tears.¹⁸ This orthopedic test was also negative in our patient. MRI, however, is strongly recommended as a clarifying diagnostic tool when a clinical examination indicates a lesion of the meniscus, as the combination of clinical and MRI findings can reduce the number of blank arthroscopies to 5%.²⁶ MRI is useful, but should be reserved for situations in which an experienced clinician requires further information before arriving at a diagnosis.²⁷

As the MRI finding of a left lateral meniscus tear was determined to be clinically and symptomatically irrel-

evant in the presenting patient, the chiropractor sought a diagnosis that may better distinguish a more accurate underlying source of the patient's pain and functional limitations. Given that the patient exhibited hallmark features of patellar tendinopathy, this primary diagnosis ensued. The two characteristic features of patellar tendinopathy are as follows: (1) pain localized to the inferior pole of the patella; and (2) load-related pain that increases with the demand on the knee extensors, notably in activities that store and release energy in the patellar tendon²⁸. Patellar tendinopathy is primarily a condition of relatively young (15 to 30 years old) athletes, especially men, who participate in sports requiring repetitive loading and energy absorption of the patellar tendon.²⁸ This description aligned with the patient's demographic, history, and reproduction of symptoms. Other differential diagnoses considered in this patient case included quadriceps tendinopathy, due to the location of the pain, aggravating activities and demands of the sport (running, jumping and change in direction); patellofemoral pain syndrome; iliotibial band syndrome; and Hoffa's fat pad syndrome.

Intervention for the patient's condition was systematically aimed at initially addressing pain reduction, followed by introducing a progressive resistive exercise program to target strength deficits, power exercises to improve the capacity in the stretch-shorten cycle, and finally functional return-to-sport training.²⁹ From a passive care perspective, it has been postulated that myofascial manipulation of the knee extensor muscle group can demonstrate some positive clinical effects on reducing pain in patellar tendinopathy patients in the short-term and long-term follow-up.³⁰ From an active care perspective, we began the protocol with sustained isometric contractions, as they have been shown to induce analgesia to the affected tendon.³¹ Isometric exercises were then progressed to eccentric exercises, as they have been demonstrated in the literature to be effective in the management of tendinopathy.³² Eccentric training improves patient symptoms and reverses tendinopathy pathology, while enhancing tendinous load capacities.³² The final phase of the protocol included functional strengthening and return-to-sport training. Faster contractions can progress loads towards the stretch-shorten cycle that forms the basis for return to sports.²⁹ Exercises such as skipping, jumping and hopping are introduced initially, and later progress to agility tasks, direction changes, sprinting and bounding movements.²⁹

From a patient education perspective, it was important to inform the athlete of realistic expectations of the rehabilitation process and to understand that management of their symptoms is required throughout their sports career, whether recreational or professional.²⁹ Finally, from a nutritional standpoint, the body's ability to synthesize functional proteins for tissue repair was supported by increasing protein intake to 5 servings of 20 grams of protein per day.²¹⁻²³

Summary

Approximately 22 million youth are participants in the sport of soccer worldwide.¹ Although meniscal injuries are particularly prevalent in soccer players², MRI findings of meniscal abnormalities in the absence of a confirming history and clinical examination may be deceptive. In the presented case, there was no clinical nor historical evidence to confirm the patient's incidental MRI finding of a left lateral meniscal tear. Instead, the clinical presentation, history, and physical examination provided the more probable diagnosis of a left patellar tendinopathy. Furthermore, the literature demonstrates that the use of MRI in the evaluation of meniscal injuries in children is less reliable than in adults¹¹⁻¹⁷, which further necessitates the vital role of appropriate historical and physical examination on adolescent patients complaining of knee pain. Knee MRI studies, without a comprehensive evaluation of patient history, clinical presentation, and physical examination, must be interpreted with caution, as an improper diagnosis of a meniscus tear may subsequently lead to unnecessary surgical procedures being performed, enhancing the risk of potential health complications due to surgery for the patient, as well as financial burden on the healthcare system. MRI is best used to clarify and enhance the clinical impression of a suspected meniscal tear and is not to be used in isolation.²⁶

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A comparative audit of jurisprudence, ethics and business management (JEB) courses taught at 21 accredited chiropractic programs worldwide

Brian J Gleberzon, BA, DC, MHSc, PhD (candidate)¹

Introduction: *The objectives of this study was to conduct an updated comparative audit involving a larger and more representative group of accredited chiropractic programs in order to determine if (i) if there has been any changes in the delivery of JEB curricula since the first audit was conducted in 2010, and (ii) provide recommendations that could lead toward a standardized or model JEB curriculum worldwide.*

Methods: *This study was approved by the ERB of the University of South Wales. Twenty-one chiropractic programs agreed to provide JEB course outlines for review.*

Results: *A total of 88 different course outlines, which listed 83 different topics pertaining to JEB course content, were submitted for review.*

Conclusion: *The results of this comparative audit*

Audit comparatif de cours de jurisprudence, d'éthique et de gestion des affaires proposés dans 21 programmes agréés de chiropratique dans le monde

Présentation : *L'étude visait à mener un audit comparatif actualisé d'un ensemble représentatif de programmes agréés de chiropratique afin de (i) déterminer si des changements sont intervenus dans la présentation des cours de jurisprudence, d'éthique et de gestion des affaires depuis le premier audit en 2010, et de (ii) formuler des recommandations qui pourraient permettre de normaliser ou de concevoir ces cours à l'échelle internationale.*

Méthodologie : *Le conseil de révision déontologique de l'University of South Wales a donné son autorisation pour mener l'étude. Vingt et une directions de programmes de chiropratique ont accepté de fournir un plan des cours de jurisprudence, d'éthique et de gestion des affaires aux fins d'examen.*

Résultats : *Au total, 88 plans de cours différents, qui présentaient 83 sujets différents relatifs au contenu des cours de jurisprudence, d'éthique et de gestion, ont été soumis aux fins d'examen.*

Conclusion : *Les résultats de l'audit comparatif ont*

¹ Private practice, Toronto, ON

Corresponding author:
Brian Gleberzon, Bedford Park Chiropractic Clinic, 306- 3335 Yonge St, Toronto, ON, M4N 2M1 Canada
Tel: 416 482 4476
e-mail: brian.gleberzon@gmail.com

revealed there has been an increase in the variability of JEB course content taught to students over time. Recommendations are provided for the next steps that could lead toward a standardized or model JEB curriculum curricula.

(JCCA. 2022;66(2):172-201)

KEY WORDS : healthcare education, jurisprudence, ethics, business management, chiropractic

Introduction

In order to obtain a certificate of registration in a jurisdiction that regulates them, students enrolled in professional programs must graduate from an accredited educational institution.¹⁻⁴ The primary purpose of accreditation is to promote academic excellence and ensure the quality of a professional education.² Accreditation can also “provide assurances of educational quality and institutional integrity for governments, jurisdictional licensing and regulatory bodies, institutions, professional organizations, students, other accrediting agencies and the public at large”^{2piii}, while also providing recommendations for improvement. This process applies to programs that educate healthcare students, including chiropractors.

Chiropractic accrediting agencies ensure graduates are prepared to serve as competent, caring, patient-centered and ethical healthcare providers,¹⁻⁴ able to independently provide quality care as primary care practitioners. However, chiropractic accrediting agencies are mindful of allowing each program to operate with educational freedom and institutional autonomy.¹⁻⁴ Accrediting agencies do not define or support any specific philosophy regarding the principles and practice of chiropractic^{1,2} since that is determined by a combination of each chiropractic program, professional associations, regulatory bodies, the profession writ large and, in the final analysis, the practitioner’s own philosophy of chiropractic. Furthermore, accrediting agencies do not define the scope of chiropractic practice, since that falls under the purview of the governing jurisdiction.¹⁻³

A review of chiropractic accrediting standards reveals a lack of granularity with respect to defining requirements that must be met for a number of courses in a curricu-

montré une augmentation dans la diversité du contenu des cours de jurisprudence, d’éthique et de gestion proposés aux étudiants au fil des années. Des recommandations qui pourraient permettre de normaliser ou de concevoir ces cours ont été émises pour les prochaines étapes.

(JCCA. 2022;66(2):172-201)

MOTS CLÉS : chiropratique, éthique, formation en soins de santé, gestion des affaires, jurisprudence

lum. Meta-competencies or, alternatively, the ‘attitudes, knowledge and skills’ required for courses that teach, for example, clinical assessment or chiropractic adjustment/manipulation tend to be well articulated; however, the requirements related to course content for teaching jurisprudence, ethics and business management (JEB) are comparatively vague (Table 1).

This raises the question of whether this vagueness with

Table 1.
Examples of requirements for ethics courses at chiropractic programs stipulated by three different accrediting agencies

| Accrediting Agency | Ethics |
|--|--|
| Canadian Federation of Chiropractic Research and Accrediting Boards (CFCREAB or ‘the Federation’) ¹ | Attitudes p62-63 <ul style="list-style-type: none"> Exhibit ethical attitudes regarding the provision of patient care services, fees, financial arrangements, billing practices and collection procedures Identify and acknowledge an obligation to refrain from illegal and unethical patient care and practice management procedures Knowledge <ul style="list-style-type: none"> Develop a knowledge of ethical practice development strategies including marketing, community demographics, and patient management techniques |
| Council on Chiropractic Education (CCE) Accreditation Standards- US ² | Meta-competency p26 Curricular Objective <ul style="list-style-type: none"> Apply knowledge of ethical principles and boundaries Outcomes <ul style="list-style-type: none"> Comply with the ethical and legal dimensions of clinical practice |
| Councils on Chiropractic Education International ^{3,4} | Competencies p20 A chiropractor demonstrates awareness of and complies with the relevant laws and professional codes of conduct of their jurisdiction(s) and exhibit ethical behavior. A chiropractor complies with: <ul style="list-style-type: none"> Professional and ethical boundaries expected of the chiropractic-patient relationship |

respect to JEB course content from accrediting agencies result in significant variability between chiropractic programs and, if it does, to what extent is this variability? To address this concern, I conducted a comparative audit of JEB course outlines from English-speaking chiropractic programs in 2010.⁵ Nine North American, one Australasian and one chiropractic program from the United Kingdom responded to my recruitment requests, along with one naturopathic program. A total of 62 different topics in this subject area were delivered at these programs, although not one topic was taught at all of them. This tremendous diversity in JEB course could be seen as potentially detrimental to attempts toward developing a 'model JEB curriculum' for chiropractic programs.⁵

The purpose of this study was to conduct an updated comparative audit involving a larger and more representative group of accredited chiropractic programs from around the world in order to determine (i) if there have been any changes in the delivery of JEB curricula since the first audit was conducted in 2010 and (ii) to provide recommendations for the next steps that could lead toward a standardized or model JEB curriculum worldwide.

Methods

This study was approved by the Ethics Review Board of the University of South Wales, UK (18BG0202LR). Between the fall of 2019 and summer of 2021 faculty at prospective participant chiropractic programs were identified by purposeful sampling.⁶ Many of the participants were identified based on my professional relationship with other faculty members at their institutions. These individuals referred me to the faculty member responsible for the jurisprudence, ethics and/or business management courses at their respective chiropractic programs. If no contact was known, I undertook an Internet search of accredited chiropractic programs, hoping to identify the appropriate faculty member. Once identified, potential participants were contacted by email and asked if they were willing to participate in this study.

Potential participants who expressed a willingness to participate were sent 'Participant Information' and 'Consent to Participate' forms to read and sign. The consent form assured respondents that, although their chiropractic program would be listed as a study participant, the content of their courses would not be traceable to a specific

respondent. To achieve this anonymity, respondent programs are labelled as 'chiropractic program 1' (CP 1), 'CP 2' and so on, such numbers designated in a non-alphabetical order and determined by the total number of JEB courses taught at each program. In the event more than one chiropractic program had the same number of JEB courses designations were randomly assigned.

Both English-speaking and non-English-speaking chiropractic programs were approached to participate. However, to be included in this study, respondents at non-English speaking chiropractic programs were asked to translate their JEB courses outlines into English prior to submission. It would not only have been cost prohibitive for me to do so but asking the respondent to translate the course outline from their native language to English would reduce the risk of pertinent details being lost in translation. If translation to English was not feasible, data from that chiropractic program was excluded. Thus, only chiropractic programs with course outlines in English were used in this study. No compensation was offered for study participation in this project.

Based on the experience gained by conducting a similar audit a decade ago, I predetermined what categories of information would be germane to this study. They were: total number of JEB courses taught; credentials of course coordinator, presenter(s) or lecturer(s); total number of hours of each course; method(s) of course delivery (e.g. lecture, online modules, small group tutorials); number of hours designated to each method of course delivery; course resource material (e.g. textbooks, assigned reading, course notes); evaluation strategies (e.g. written examinations, assignments, class participation); course description: and topical outlines. This data often existed under different subheading in each submitted course outline, necessitating a careful reading of each one of them.

Upon completion, this data was transferred into new tables with the identity of each chiropractic program anonymized. Once completed, business management was subdivided into two broad categories – entrepreneurship and financial/accounting – since they were often taught separately.

Categories of data were subsequently collapsed into five subject headings: Course Structure and Distribution; Jurisprudence; Ethics; Entrepreneurship; and Financial and Accounting. Identified topics were listed alphabetically within each subject heading. An audit of course

outlines from each chiropractic program was then undertaken and analyzed.

Results

Representatives from 31 different chiropractic programs were contacted. Twenty-four agreed to participate in the study (response rate =77.4%); however, three representatives were not able to provide course outlines in English. This resulted in a final response rate of 67.7% (n=21). Course outlines were submitted from the following chiropractic programs:

- Anglo-European Chiropractic College
- Barcelona College of Chiropractic
- Canadian Memorial Chiropractic College (CMCC)
- Cleveland Chiropractic College
- Durban University of Technology
- International Medical University (Malaysia)
- Keiser University
- Life University
- Macquarie University
- Madrid College of Chiropractic (Real Centro Universitario)
- New Zealand College of Chiropractic
- Northwestern Health Sciences University
- Palmer College of Chiropractic (Davenport)
- Palmer College of Chiropractic West
- Parker University
- RMIT University
- Southern California University of Health Sciences (SCUHS)
- Texas Chiropractic College
- Université du Québec a Trois-Rivieres (UQTR)
- University of Bridgeport College of Chiropractic
- University of South Wales (UK)

Demographics of participating chiropractic programs

Participant chiropractic programs represented the following geographical regions: United States (n=10), Australasia (n=3), Canada (n=2), Spain (n=2), South Africa (n=1), Southeast Asia (n=1), and the United Kingdom (n=2).

Curriculum structure

An audit of how JEB content was distributed between courses at each chiropractic program revealed a tre-

mendous degree of curricular diversity. The number of JEB-related courses offered in each chiropractic program varied between one and 16, and the number of courses devoted to JEB content within each chiropractic program varied between one and eight (Tables 2a-b). A total of 88 different course outlines, which listed 83 different topics pertaining to JEB course content, were identified.

With respect to the overarching topics of jurisprudence and ethics, 11 of 21 chiropractic programs combined them into one course. Alternatively, jurisprudence as a standalone course was delivered at eight chiropractic programs and ethics as a standalone course was delivered at seven chiropractic programs. (Table 2b)

Ten chiropractic programs taught business management, although three chiropractic programs taught entrepreneurship as a standalone course and two taught budgeting and finance as a standalone course.

Five chiropractic programs taught jurisprudence, ethics and business management together in one course and three chiropractic programs delivered this content in other ways. For example, one chiropractic program delivered business management content in two courses: one that delivered JEB content together and another course that, although predominately reviewing the mechanisms by which spinal manipulation is theorized to produce its biological effects, included online content on business management. Two other chiropractic program interspersed JEB course content throughout courses that focus on the delivery of clinical care.

Course organization

Nineteen courses were coordinated by a chiropractor or a chiropractor with legal training – additional faculty members in various courses included lawyers, accountants or persons with an MBA or its equivalent in five chiropractic programs (two programs did not specify the credentials of the course coordinator).

The most commonly used delivery method for course content was by lecture (n=19). Eight audited courses used lectures as the sole method of course content delivery; all other chiropractic programs used more than one delivery method. Other methods of course delivery in descending order were: self-directed/ independent learning (n=7), online modules (n=6), tutorials (n=4), directed learning (n=3), workshops (n=2), seminars (n=1), debates (n=1) and clinical observations (n=1). Course outlines did not

Table 2a.
Summary of course delivery, structure and evaluation methods

| CP | Number of courses | Delivery method | Evaluation methods | Course resources | Faculty |
|----|-------------------|---|--|--------------------------------|--------------|
| 1 | 16 | Lecture, Online classes | Class attendance, Class participation Assignments Quizzes Written exams Oral presentations Small group discussions Research binder Business Plan | None | DC |
| 2 | 11 | Lecture Online classes Self-Directed Learning | Assignments In-class work Written exams Quizzes Observations Business Plan | Course notes | DC |
| 3 | 9 | Lecture | Oral presentations Assignments Quizzes Written exams Marketing Plan Business Plan | Assigned reading | DC MBA |
| 4 | 6 | Lecture Tutorial Debates Online Clinical Observations Self-Directed Learning | Reflective Reports Written Exams | ? | ? |
| 5 | 5 | Lecture | Class participation Assignments Business modules Written exams | Textbook, Course notes | DC MBA |
| 6 | 5 | Lecture | Assignment Written exam Meet with Professor | Course notes | DC MCS-P |
| 7 | 4 | Lecture Workshop | Quizzes Self-reflection Written exams | Textbook Course notes | DC |
| 8 | 4 | Lecture Tutorials Directed Learning Independent Study | ? | ? | DC |
| 9 | 4 | Lecture | ? | ? | DC Lawyer |
| 10 | 3 | Lecture | Class attendance Class participation Workbook Team project Video project Quizzes Written exams Financial Plan Business Plan | Textbooks Assigned readings | DC |
| 11 | 3 | Lecture Online Self-Directed Learning | Class participation Quizzes Written exam | | DC |
| 12 | 3 | Lecture | Class participation Quizzes Exams | ? | DC |

| CP | Number of courses | Delivery method | Evaluation methods | Course resources | Faculty |
|----|-------------------|---|--|------------------|----------------------------|
| 13 | 2 | Lecture Seminars Directed Learning Independent Learning | ? | ? | DC |
| 14 | 2 | Lecture Online | Assignment Written exam | None | ? |
| 15 | 2 | Lecture | Class participation Class presentation Written exam | None | DC |
| 16 | 2 | ? | Class attendance Team project Video project Workbook Resume Marketing Plan Financial Plan Business Plan Written exam | None | DC |
| 17 | 2 | Lecture Tutorials Online | Self-Reflection Attendance at a Discipline Hearing Assignments Small group participation Online business modules Written exam | Assigned reading | DC |
| 18 | 2 | Lecture Tutorials Directed Learning Independent Learning | ? | ? | DC |
| 19 | 1 | ? | ? | ? | DC |
| 20 | 1 | Lecture | Business plan Written exam | | DC Lawyer Accountant |
| 21 | 1 | Lecture Workshop Self-Directed Learning | ? | ? | DC |

Table 2b.
Distribution of jurisprudence, ethics and business management courses at each chiropractic program

| CP | J* | E+ | JE# | BM^ | JEBM^^ | EP** | F/A++ | Other |
|--|----|----|-----|---|--------|------|-------|-------|
| 1 | 1 | | 1 | 5 | | 8 | 1 | |
| 2 | 3 | 2 | 3 | 2 | | | 1 | |
| 3 | 3 | 3 | | 2 | | 1 | | |
| 4 | | 4 | 1 | | 1 | | | |
| 5 | | | 2 | 3 | | | | |
| 6 | 1 | | | 2 | | 1 | | |
| 7 | | 1 | | 3 | | | | |
| 8 | | | | | | | | 4 |
| 9 | 1 | 1 | 1 | | 1 | | | |
| 10 | | | 1 | 1 | | | | |
| 11 | 2 | 1 | | | | | | |
| 12 | 1 | | | | 1 | | | 1 |
| 13 | | | 2 | | | | | |
| 14 | | | 1 | 1 | | | | |
| 15 | | | 1 | 1 | | | | |
| 16 | | | | 2 | | | | |
| 17 | | | | | 1 | | | 1 |
| 18 | 1 | 1 | | | | | | |
| 19 | | | 1 | | | | | |
| 20 | | | | | 1 | | | |
| 21 | | | 1 | | | | | |
| n= | 13 | 13 | 15 | 22 | 5 | 10 | 2 | 6 |
| * = Jurisprudence course + = Ethics course # = Jurisprudence and Ethics Course ^ = Business Management Course | | | | ^^ = Jurisprudence, Ethics and Business Management Course ** = Entrepreneurship course ++ = Financial/Accounting course | | | | |

contain any information that would help differentiate between ‘workshops’ and ‘seminars’. Upon further review of course outlines, ‘tutorials’ involved small group sessions with a facilitator. Lastly, although only one chiropractic program included ‘clinical observation’ as a method of delivery of JEB course content, several other programs specifically described (and presumably all offered) some form of preceptorship or its equivalent that allowed senior students/interns an opportunity to shadow a chiropractic in private practice (e.g. ‘in the field’). This, coupled with a student’s internship with an assigned clinician may have offered additional educational opportunities on the topics of JEB that would not be revealed by the methodology used in this study (see Limitations section).

Roughly half of responding chiropractic programs listed the number of hours of some (but often not all) of the delivery method listed in their course outlines. Among

those course outlines that provided details, the number of lecture hours provided varied between seven and 48 with a mean of 21 and the number of hours assigned to self-directed learning varied between 30 and 85 (mean of 45). The number of hours of online course material varied between 12 and 61 (mean of 27) and the number of hours assigned to tutorials varied between eight and 20 with a mean of 16 (mean averages rounded up/down to nearest whole number).

The course outlines of 15 chiropractic programs provided information on evaluation methods. Of these, all chiropractic programs evaluated students using a written examination, seven used class participation, six used assignments, quizzes or the submission of a business plan (see Discussion section). Three chiropractic programs evaluated students using self-reflective reports and three allocated grades for class attendance. Two chiropractic programs (although not the same two) used the following evaluation methods: online business modules; verbal presentations; submission of a marketing plan; submission of a financial plan; team project; video project and; workbook. Lastly the following evaluation methods were used at only one chiropractic program: small group participation; submission of a ‘research binder’; clinical observations; CV/resume submission; attending a discipline hearings and; ‘meeting the professor’.

It should be noted that submission of either a financial or marketing plan (or both) was in addition to the submission of a business plan at those chiropractic programs that required them. In other words, in three chiropractic programs, financial, marketing and business plans were all considered separate projects that were submitted and graded separately.

The course outlines of roughly half of all chiropractic programs did not list any course resources; however, in those chiropractic programs that did, most stated there were ‘class notes’ or ‘assigned readings’ – only three listed specific textbooks as required readings.

Topics on jurisprudence

Twenty-four separate topics related to jurisprudence were identified during the audit (Tables 3a-d). Of these topics, the most commonly presented topic was a review of the regulations, standards of practice, guidelines and policies (hereafter collectively referred to as the ‘rules’) in the jurisdiction the chiropractic program was located ($n=15$).

Table 3a.
Summary of jurisprudence topics

| CP | Advertising (rules)* | Anti-kickback | Complaints process | Confidentiality (e.g. HIPAA) | Consent+ Capacity | Court system process# |
|----|----------------------|---------------|--------------------|------------------------------|-------------------|-----------------------|
| 1 | | | | ✓ | ✓ | ✓ |
| 2 | | | | ✓ | ✓ | ✓ |
| 3 | ✓ | | | | ✓ | |
| 4 | | | | | | |
| 5 | | | | | ✓ | ✓ |
| 6 | | ✓ | | ✓ | ✓ | |
| 7 | | | | ✓ | ✓ | |
| 8 | ✓ | | | ✓ | ✓ | |
| 9 | ✓ | | | ✓ | ✓ | ✓ |
| 10 | | | | | ✓ | ✓ |
| 11 | ✓ | | | ✓ | | |
| 12 | | | ✓ | | | |
| 13 | | | | | ✓ | |
| 14 | | | | | ✓ | |
| 15 | ✓ | | | ✓ | | |
| 16 | | | | | | |
| 17 | ✓ | | ✓ | ✓ | ✓ | |
| 18 | ✓ | | | ✓ | | ✓ |
| 19 | | | | ✓ | | ✓ |
| 20 | | | | | | ✓ |
| 21 | | | | | | |
| n= | 7 | 1 | 2 | 11 | 12 | 8 |

*Rules = Regulations; Standards of Practice; Guidelines; Policies
 +Consent = Verbal; written; informed; material risk
 # = Appearance; Deposition; Preparation; Process of litigation

Table 3b.
Summary of jurisprudence topics

| CP # | Discipline process | Duty of care | Insurance* | Law/legal System+ | Malpractice (avoiding claim) | Malpractice (elements)# |
|------|--------------------|--------------|------------|-------------------|------------------------------|-------------------------|
| 1 | | ✓ | ✓ | ✓ | | ✓ |
| 2 | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | | | ✓ | | | |
| 4 | | ✓ | | ✓ | | ✓ |
| 5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6 | | | ✓ | | | ✓ |
| 7 | | | ✓ | | | ✓ |
| 8 | | | ✓ | | | |
| 9 | | ✓ | | ✓ | | |
| 10 | | | ✓ | ✓ | | ✓ |
| 11 | | ✓ | | ✓ | | ✓ |
| 12 | ✓ | | | | | |
| 13 | | | | | ✓ | |
| 14 | | ✓ | | ✓ | | ✓ |
| 15 | | | ✓ | | | |
| 16 | | | ✓ | | | |
| 17 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 18 | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 19 | | | | ✓ | | ✓ |
| 20 | | | ✓ | | | ✓ |
| 21 | | ✓ | | ✓ | | |
| n= | 2 | 10 | 13 | 12 | 5 | 13 |

*= Malpractice (e.g. CCPA, NCMIC); office liability; life; disability
 += History; Principles; Organization; Types
 # = Negligence; Tort

Thirteen chiropractic programs taught issues related to insurance; specifically, which types of insurance chiropractors either needed to have (e.g. malpractice, office liability) or could choose to have (e.g. life, critical illness, disability) if they intended on entering private practice.

Thirteen chiropractic programs taught issues related to the elements of malpractice claims such as the definitions of negligence, the concept of a ‘but-for’ defence and what constitutes a tortious claim. Issues related to record keeping (including components of a SOAP note in addition to access, protection, storage and destruction of personal health records) was taught at 12 chiropractic programs. Consent and capacity were also taught at 12 chiropractic programs. At many of these programs, consent was further divided into different types of consent (e.g. implied, verbal, written) as well as specific issues related to informed consent including definitions and examples of material risks. Related to consent, issues surrounding confidential-

ity (such as Health Insurance Portability and Accountability Act or HIPAA) was taught at 11 chiropractic programs.

Twelve chiropractic programs devoted time to a general presentation on the legal system, including its history, principles, organization and various subspecialties (e.g. criminal, civil). Issues related to the chiropractic scope of practice (e.g. specific controlled acts permitted for chiropractors to perform in various jurisdictions) was taught at 10 chiropractic programs. This included (depending on the jurisdiction) the controlled or authorized acts of spinal manipulation/ adjustments, diagnosis, acupuncture, treating animals, taking and reading radiographs, ordering advanced diagnostic images and ordering laboratory tests. What constitutes the ‘duty of care’ owed to a patient was presented at 10 chiropractic programs.

Issues related to risk management, sexual abuse and the court process were taught at eight chiropractic programs (although not the same eight chiropractic programs). The

Table 3c.
Summary of jurisprudence topics

| CP # | Mandatory reporting* | Medico-legal reports | Oaths+ | Professional misconduct# | Record keeping^ | Regulations, standards of practice, guidelines |
|------|----------------------|----------------------|--------|--------------------------|-----------------|--|
| 1 | | | | | | |
| 2 | ✓ | | ✓ | | ✓ | ✓ |
| 3 | | | | | ✓ | ✓ |
| 4 | | | | | | ✓ |
| 5 | | | | ✓ | ✓ | |
| 6 | | ✓ | | | ✓ | |
| 7 | | | | | ✓ | |
| 8 | | | | | ✓ | ✓ |
| 9 | ✓ | ✓ | | | ✓ | ✓ |
| 10 | | | | ✓ | ✓ | |
| 11 | ✓ | | | | ✓ | ✓ |
| 12 | | | | | ✓ | ✓ |
| 13 | ✓ | | | | | ✓ |
| 14 | | | | | | ✓ |
| 15 | | | | | | ✓ |
| 16 | | | | | | |
| 17 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 18 | | ✓ | | | | ✓ |
| 19 | | | | | | ✓ |
| 20 | | ✓ | | | | ✓ |
| 21 | ✓ | | | ✓ | ✓ | ✓ |
| n= | 6 | 5 | 2 | 4 | 12 | 15 |

*= Child Abuse; Sexual Abuse; Communicable Diseases; Impairment (e.g. substance, cognitive/mental)
 += Hippocratic; Graduation
 # = Definitions of Unprofessional, Dishonorable and Disgraceful conduct
 ^ = SOAP notes; Access; Storage; Protection; Destruction

Table 3d.
Summary of jurisprudence topics

| CP # | Registration | Risk management* | Scope of practice+ | Sexual abuse # | Stakeholders^ | Termination of care^^ |
|------|--------------|------------------|--------------------|----------------|---------------|-----------------------|
| 1 | | ✓ | ✓ | ✓ | ✓ | |
| 2 | | ✓ | | ✓ | | |
| 3 | | ✓ | | | ✓ | |
| 4 | | ✓ | | | | |
| 5 | | ✓ | ✓ | ✓ | | ✓ |
| 6 | | | ✓ | ✓ | | |
| 7 | ✓ | ✓ | ✓ | ✓ | | |
| 8 | | | | | ✓ | |
| 9 | | | | ✓ | | |
| 10 | | | ✓ | | ✓ | |
| 11 | | | | ✓ | | ✓ |
| 12 | | | ✓ | | | |
| 13 | | | | | | ✓ |
| 14 | | | | | | |
| 15 | | | ✓ | | | |
| 16 | | ✓ | | | | |
| 17 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 18 | | | ✓ | | | |
| 19 | | | | | | |
| 20 | | ✓ | | | | |
| 21 | | | ✓ | | | |
| n= | 2 | 9 | 10 | 8 | 5 | 4 |

*= How to Avoid a Claim; Practicing Defensively, 'What To Do When Things Go Wrong'
 += Authorized or Controlled Acts
 # = Includes Sexual Harassment; Sexual Misconduct; Sexual Violation
 ^ = Regulatory/Licensing bodies; Advocacy/Trade Associations
 ^^ = Patient Discharge; Patient Dismissal; Patient Withdrawal from Care; Abandoning a Patient

topic of risk management included strategies to avoid or reduce the likelihood of having a claim filed against a chiropractor, the concept of practicing defensively and 'what to do when things go wrong'. The topic of sexual abuse was subdivided into related topics including sexual harassment, sexual misconduct, and sexual violation. Lastly, the discussion of the court system included a review of the entire process of litigation from preparing for court to appearing in court to being deposed as a witness or defendant.

The rules governing advertising and marketing were presented at seven chiropractic programs, although 13 chiropractic programs presented advertising and marketing from an entrepreneurial perspective (see below and see Discussion). Situations that trigger mandatory reporting (e.g. child abuse, sexual misconduct, suspicion that a colleague is practicing while impaired) was presented at six chiropractic programs. Five chiropractic programs

(although not the same five chiropractic programs) taught how to prepare a medico-legal report in addition to a review of the mandates and roles of different organizations in the chiropractic ecosystem (e.g. regulatory bodies, advocacy associations, malpractice carriers).

Termination of the doctor-patient relationship (discharge, dismissal, patient withdrawal, abandonment) was taught at four chiropractic programs. Four chiropractic programs taught types of professional misconduct and what constitutes unprofessional, disgraceful and dishonourable behavior. Two chiropractic programs discussed oaths (e.g. the Hippocratic oath, the oath students take upon graduation) and two chiropractic programs discussed the process of registration in order to obtain a certificate of registration (license) as well as the different categories of registration (e.g. general, inactive, retired). Three chiropractic programs discussed the discipline process of regulatory bodies and two of these also discussed

Table 4a.
Summary of ethics topics

| CP # | Boundary crossing (issues) | Code of Conduct | Conflict of Interest | Confidentiality/ Privacy | Continuing Education/ Lifelong learning | Controversial Topics* |
|------|----------------------------|-----------------|----------------------|--------------------------|---|-----------------------|
| 1 | | | | | ✓ | |
| 2 | ✓ | | | ✓ | | |
| 3 | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 4 | | ✓ | | | | |
| 5 | | ✓ | | | | |
| 6 | | | | ✓ | | |
| 7 | ✓ | | ✓ | | | |
| 8 | | ✓ | | ✓ | | ✓ |
| 9 | ✓ | ✓ | | ✓ | | |
| 10 | | | | | | |
| 11 | | | | ✓ | | |
| 12 | | | | | | |
| 13 | | ✓ | | | | |
| 14 | ✓ | | ✓ | | | ✓ |
| 15 | ✓ | | ✓ | | ✓ | |
| 16 | | | | | | |
| 17 | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 18 | ✓ | | ✓ | | | |
| 19 | | | | ✓ | | ✓ |
| 20 | | | | | | |
| 21 | | | | | ✓ | |
| n= | 8 | 6 | 6 | 8 | 4 | 5 |

*= Controversial topics include: vaccination; x-ray line marking; treatment of non-neuromusculoskeletal conditions; treating children; subluxation terminology and theory

Table 4b.
Summary of ethics topics

| CP | DEI* | Ethics+ | Ethical dilemma | Ethics in healthcare | Patient-centered practice | Professional communication |
|----|------|---------|-----------------|----------------------|---------------------------|----------------------------|
| 1 | | ✓ | | | ✓ | |
| 2 | | ✓ | ✓ | ✓ | | ✓ |
| 3 | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 4 | | ✓ | ✓ | ✓ | | ✓ |
| 5 | | ✓ | | ✓ | | |
| 6 | ✓ | ✓ | | | | |
| 7 | | ✓ | | ✓ | | |
| 8 | ✓ | ✓ | | ✓ | | ✓ |
| 9 | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 10 | | ✓ | | | | |
| 11 | | ✓ | ✓ | ✓ | | ✓ |
| 12 | | | | | | |
| 13 | | ✓ | ✓ | ✓ | | ✓ |
| 14 | | ✓ | | ✓ | | |
| 15 | | | | ✓ | ✓ | ✓ |
| 16 | | ✓ | | | | |
| 17 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 18 | | ✓ | | | | ✓ |
| 19 | | ✓ | | ✓ | | |
| 20 | | ✓ | ✓ | | | |
| 21 | | ✓ | | | ✓ | |
| n= | 4 | 19 | 8 | 13 | 5 | 10 |

*= Diversity, Equality and Inclusion; cultural competency; racism
+= Definitions; theories; principles (beneficence, autonomy, justice and nonmaleficence)

the complaints process. Lastly, only one chiropractic program discussed anti-kickback legislation.

Ethics

Sixteen topics were included under the umbrella term ‘ethics’ (Tables 4a-c). Nineteen of 21 respondent chiropractic programs reported they teach ethics although further details were often not provided. Thirteen of these 19 chiropractic programs specifically taught bioethics or ethics as they apply to healthcare and eight of these 19 chiropractic programs provided ethical dilemmas for class discussion.

Issues related to professional communications was taught at 10 chiropractic programs and the topics of boundary crossings as well as confidentiality and privacy was taught at nine chiropractic programs. Eight chiropractic programs discussed what constituted a profession and professionalism and eight chiropractic programs presented the principle of a conflict of interest.

Five chiropractic programs discussed the importance of patient-centered care from an ethical perspective and six reviewed professional codes of conduct. Five chiropractic programs discussed controversial topics within the chiropractic profession (e.g. vaccination, management of non-neuromusculoskeletal (NMSK) disorders, issues related to ‘subluxation’).

The topic of diversity, equality and inclusion (DEI), cultural competency and racism in healthcare was taught at four chiropractic programs. Unethical practice activities were taught at three chiropractic programs, although examples were not provided in course outlines. Three chiropractic programs discussed the use of scientific information to guide clinical decision making from an ethical perspective and three chiropractic programs discussed the chiropractic profession from the perspective of social theory, including the concept of the social contract. Lastly, two chiropractic programs discussed the importance of continuing education and lifelong learning

Table 4c.
Summary of ethics topics

| CP | Profession and professionalism defined | Social contract* | Unethical practice activities+ | Use of Scientific Research/ Literature |
|---|--|------------------|--------------------------------|--|
| 1 | | | | ✓ |
| 2 | | | | |
| 3 | ✓ | | | |
| 4 | ✓ | ✓ | | |
| 5 | | | | |
| 6 | ✓ | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | ✓ | | | |
| 10 | | | ✓ | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | ✓ | | |
| 15 | ✓ | | | ✓ |
| 16 | | | | |
| 17 | ✓ | ✓ | ✓ | ✓ |
| 18 | ✓ | | ✓ | |
| 19 | | | | |
| 20 | | | | |
| 21 | ✓ | | | |
| n= | 8 | 3 | 3 | 3 |
| *= Social theory; social closure; cultural authority + = Fearmongering; fraud; lengthy prepaid treatment packages; requirement to bring significant other to ROF | | | | |

Table 5a.
Summary of topics – entrepreneurship

| CP | Advertising marketing | Advisors | Being a boss* | Branding+ | Business entities# | Career options^ | Chiropractic industry |
|---|-----------------------|----------|---------------|-----------|--------------------|-----------------|-----------------------|
| 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| 3 | ✓ | | | ✓ | | | ✓ |
| 4 | ✓ | | | | ✓ | ✓ | |
| 5 | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 6 | ✓ | | | | | | ✓ |
| 7 | ✓ | | | | ✓ | | |
| 8 | | | | | | | ✓ |
| 9 | | | | | | | |
| 10 | ✓ | | | | ✓ | | |
| 11 | ✓ | | | | | ✓ | |
| 12 | | | | | | ✓ | |
| 13 | | | | | | | |
| 14 | ✓ | | | | | | |
| 15 | ✓ | | | | | | ✓ |
| 16 | ✓ | | ✓ | | ✓ | | ✓ |
| 17 | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | ✓ | ✓ | |
| 21 | | | | | | | |
| n= | 13 | 3 | 4 | 4 | 7 | 8 | 8 |
| *= Attributes, characteristics, mindset, visualization, leadership styles + = Personal, Office/Practice, reputational management # = Partnership, incorporation ^ = Solo/owner, associate, purchase, locum | | | | | | | |

Entrepreneurship

Thirty-one separate and distinct topics pertaining to entrepreneurship were identified during this audit (Tables 5a-e). Thirteen chiropractic programs delivered course content specific to advertising and marketing from an entrepreneurial perspective and 13 chiropractic programs discussed the process of starting a practice. Ten chiropractic programs taught content pertaining to human resources, including hiring, training, and keeping qualified and effective office staff including chiropractic health assistants.

Ten chiropractic programs discussed the importance of – and how to go about conducting – a demographic analysis in order to identify an optimal location to establish a private practice. This included discussing the pros and cons of various office locations (e.g. street level, strip mall, in-home) and different geographical locations (e.g. urban, suburban, rural).

Eight chiropractic programs discussed chiropractic as an industry, eight chiropractic programs reviewed the

process of coding for insurance claim submission (e.g. WSIB, third party payors) and eight chiropractic programs discussed the various career options available to chiropractors (e.g. solo practitioner, associate, locum).

Developing office policies and procedures was taught at seven chiropractic programs and seven chiropractic programs reviewed the various business entities a chiropractor can establish (e.g. partnership, incorporation). Six chiropractic programs taught strategies for effective communication with patients under various scenarios such as rescheduling a missed appointment, reactivating a dormant file and how to deliver a report of findings.

The benefits and challenges of different payment options (cash only versus insurance versus both) was taught at five chiropractic programs and five chiropractic programs reviewed legal contracts such as associateship agreements and commercial leases.

Four different chiropractic programs taught students the following topics: how to write a professional curricu-

Table 5b.
Summary of topics – entrepreneurship

| CP | Coding* | Consumer targeting | Contracts | CV/resume (preparation) | Demographic analysis | Elevator speech |
|----|---------|--------------------|-----------|-------------------------|----------------------|-----------------|
| 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | | ✓ | ✓ | ✓ | |
| 3 | | ✓ | ✓ | | ✓ | |
| 4 | | | ✓ | ✓ | | |
| 5 | ✓ | | | | ✓ | |
| 6 | ✓ | | | | ✓ | ✓ |
| 7 | ✓ | | ✓ | ✓ | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | ✓ | |
| 11 | ✓ | | | | ✓ | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | | | | | ✓ | |
| 15 | ✓ | | ✓ | | ✓ | |
| 16 | ✓ | ✓ | | | | |
| 17 | | ✓ | ✓ | | ✓ | ✓ |
| 18 | | | ✓ | | | |
| 19 | | | | | | |
| 20 | | | | | | |
| 21 | | | | | | |
| n= | 8 | 4 | 8 | 4 | 10 | 3 |

*= Insurance, private, WSIB, Medicare

Table 5c.
Summary of topics – entrepreneurship

| CP | Exit strategy* | Furnishing / equipment + | Hiring and human resources # | Media relations | Mission, values |
|----|----------------|--------------------------|------------------------------|-----------------|-----------------|
| 1 | | ✓ | ✓ | ✓ | ✓ |
| 2 | | | ✓ | | ✓ |
| 3 | | | | | |
| 4 | ✓ | | ✓ | | |
| 5 | ✓ | | ✓ | | |
| 6 | | | ✓ | | ✓ |
| 7 | | | ✓ | | |
| 8 | | | ✓ | | |
| 9 | | | | | |
| 10 | | | ✓ | | |
| 11 | | ✓ | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |
| 16 | | | ✓ | | |
| 17 | | ✓ | | ✓ | ✓ |
| 18 | | | | | |
| 19 | | | | | |
| 20 | | | ✓ | | |
| 21 | | | | | |
| n= | 2 | 3 | 10 | 2 | 4 |

* = Retiring, sale of office/valuation
+ = Cost, needs assessment, leasing v purchase
= Includes advertising for staff, hiring, interviewing, labour law, managing staff, Occupational Health and Safety, termination

Table 5d.
Summary of topics – entrepreneurship

| CP | Office design* | Office policy and procedures (office manual) | Payment options+ | Patient communications# | Pricing^ | Products to sell^^ |
|----|----------------|--|------------------|-------------------------|----------|--------------------|
| 1 | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 2 | | ✓ | ✓ | ✓ | | |
| 3 | | | | ✓ | | |
| 4 | | | | | | |
| 5 | ✓ | | ✓ | ✓ | | |
| 6 | ✓ | ✓ | | | ✓ | |
| 7 | | ✓ | | ✓ | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | ✓ | | | | |
| 11 | | | ✓ | ✓ | | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | | | | | | |
| 15 | | ✓ | | | | |
| 16 | ✓ | | ✓ | | ✓ | |
| 17 | | | | | | ✓ |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | | ✓ | | | | |
| 21 | | | | | | |
| n= | 4 | 7 | 5 | 6 | 2 | 2 |

*= floor plan, furnishing, stocking of supplies/product
+ = Cash or insurance or both
= Report of finding, missed appointment, rescheduling, reactivating file
^ = Chiropractic services, products
^^ = Orthotics, supplements, braces/supports

lum vitae or resume; how to create an effective brand for an individual or office; how to target potential chiropractic patients; how to create vision and mission statement for a practice; how to prepare and what attributes contribute to ‘being a boss’ and; efficient office design.

How to conduct a SWOT (strength, weakness, opportunity, threat) analysis was taught at three chiropractic programs. Three different chiropractic programs taught what equipment and furnishings are preferentially needed for a private practice and three chiropractic programs discussed which technological devices ought to be used for private practice. Three chiropractic programs taught what constitutes an optimal team of advisors for a chiropractor (e.g., lawyer, accountant, banker, financial advisor) and 3 chiropractic programs provided training on how to deliver an effective elevator speech – a short (i.e. 30 second) conversation a chiropractor may have with a perspective patient in various social settings.

Table 5e.
Summary of topics – entrepreneurship

| CP | Product protection* | Public speaking | Realistic graduate expectations | Social media | Starting a practice | SWOT analysis | Technology needs |
|----|---------------------|-----------------|---------------------------------|--------------|---------------------|---------------|------------------|
| 1 | | ✓ | | ✓ | ✓ | | ✓ |
| 2 | | | | ✓ | ✓ | | ✓ |
| 3 | | ✓ | | ✓ | ✓ | ✓ | |
| 4 | | | ✓ | | ✓ | | |
| 5 | ✓ | | | | ✓ | | ✓ |
| 6 | | | | | ✓ | | |
| 7 | | | | | ✓ | | |
| 8 | | | | | ✓ | | |
| 9 | | | | | | | |
| 10 | | | | | ✓ | | |
| 11 | | | | | ✓ | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | ✓ | ✓ | |
| 15 | | | | | | | |
| 16 | | | | ✓ | | | |
| 17 | | | | | ✓ | ✓ | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | | | | ✓ | | |
| n= | 1 | 2 | 1 | 4 | 13 | 3 | 3 |

*= patent, trademark, copyright

Table 6a.
Summary of topics – financial and accounting

| CP | Accounting | Asset protection | Audit* | Banking+ | Budget# | Credit |
|----|------------|------------------|--------|----------|---------|--------|
| 1 | | | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | ✓ | | | ✓ | ✓ |
| 3 | | | | | | |
| 4 | ✓ | | | | | |
| 5 | | ✓ | | ✓ | ✓ | |
| 6 | ✓ | | ✓ | ✓ | | |
| 7 | | | | | | |
| 8 | | | ✓ | | | |
| 9 | | | | | | |
| 10 | | | | | | |
| 11 | ✓ | | | | | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | ✓ | | | | ✓ | |
| 15 | | | | | | |
| 16 | ✓ | | | ✓ | | |
| 17 | | | | ✓ | ✓ | |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | ✓ | | | | ✓ | |
| 21 | | | | | | |
| n= | 7 | 2 | 3 | 5 | 6 | 2 |

*= Compliance; Preparation + = Sources of funding # = Office; Personal

Training for public speaking was provided at two chiropractic programs, and two chiropractic programs provided media training (e.g., how to stay ‘on message’ during an interview). Two other chiropractic programs discussed what ancillary products can be offered for sale at a chiropractic office (e.g., orthotics, braces, supports) as well as how to appropriately price them, as well as pricing for other services provided.

Lastly, one chiropractic program discussed legal options on how to legally protect a product a chiropractor may create. Only one chiropractic program devoted time in their curriculum to ‘realistic graduate expectations’, a discussion of the financial conditions and timeframes a new graduate should reasonably expect before they attain a level of success, however defined.

Financial/Accounting

Chiropractic programs taught 12 topics specifically related to issues related to finances and accounting (Tables 6a and 6b). Fifteen chiropractic programs taught issues related to financial analysis including understanding a

Table 6b.
Summary of topics – financial and accounting

| CP | Financial analysis* | Financial/ money management | Getting paid (collections) | Office administration | Student loan repayment | Taxes |
|----|---------------------|-----------------------------|----------------------------|-----------------------|------------------------|-------|
| 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 3 | ✓ | | | | | |
| 4 | ✓ | | | | | |
| 5 | ✓ | ✓ | ✓ | ✓ | | |
| 6 | ✓ | ✓ | | ✓ | | |
| 7 | ✓ | | | | | |
| 8 | ✓ | | | | | |
| 9 | | | | | | |
| 10 | ✓ | | | ✓ | | |
| 11 | ✓ | ✓ | | | | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | ✓ | | | | | |
| 15 | ✓ | | ✓ | ✓ | | |
| 16 | ✓ | ✓ | | ✓ | | ✓ |
| 17 | ✓ | | | | | ✓ |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | ✓ | | | ✓ | | |
| 21 | | | | | | |
| n= | 15 | 6 | 4 | 8 | 1 | 4 |

*= Balance sheet; Cash flow; Spreadsheet; Risk analysis; Forecasting

balance or financial spreadsheet, case flow, risk analysis and financial forecasting. Similarly, six chiropractic programs taught financial and money management, with one chiropractic program specifically discussing investment strategies and how to value a practice. Seven chiropractic programs stated they teach accounting principles (e.g. double-entry bookkeeping).

Eight chiropractic programs taught office administration as it relates to finances. Six chiropractic programs reviewed the topics of personal and office budgeting, and five chiropractic programs taught the principles of banking, with an emphasis on financing of a business venture. One chiropractic program outlined how to open a chequing account and how to make a deposit.

Four chiropractic programs taught issues related to taxes (e.g., income tax, business taxes), and four chiropractic programs discussed strategies on how to get paid (e.g., patient collections). Three chiropractic programs reviewed how to prepare for an audit and two chiropractic programs reviewed the concept of credit. Two chiropractic programs discussed strategies of asset protection and 1 of these programs also taught students methods to repay student loans.

Discussion

The results of this study suggest there continues to be tremendous variabilities between chiropractic programs with respect to their JEB curriculum, as first identified by a similar audit conducted a decade ago.⁵ Although there seems to be a general increase in the JEB course content offered to students overall, only a few chiropractic programs have greatly expanded in-depth curriculum content devoted to business management and the principles of entrepreneurship and financial literacy.

Course structure, delivery and evaluation

Although there is a shift in pedagogical circles away from it⁷, all chiropractic programs in this audit primarily used lectures to deliver JEB content, perhaps because that delivery method allowed for a more interactive format compared to content delivered online or by self-directed learning. In addition to allowing for a 'question and answer' (Q & A) opportunity in real-time, it also allows the presenter to walk students through real-life examples, and a skilled presenter can build a degree of anticipation and intrigue as the story unfolds, using relevant, real-life case

scenarios to create a dynamic learning environment as advocated by Abela⁸. Similarly, small group tutorials were commonly used to deliver JEB content, enabling discussions of both abstract and difficult subjects as well as contemporary 'hot topics'.⁸ In a study involving physiotherapy students, Skinner *et al.*⁷ reported small group formats enhanced interpersonal and effective communication skill development, cultural competency and professionalism. Skinner and colleagues contended these attributes would, in turn, be helpful when interacting with patients, their families, other healthcare providers as well as regulatory bodies and other professional organizations.⁷ According to this audit, other interactive course delivery strategies used by chiropractic programs included workshops and seminars.

All course coordinators and principle lecturers were chiropractors and almost all audited courses provided prepared course notes as learning materials. All audited courses used written examinations to evaluate students in addition to class participation, quizzes, assignments and some required submission of a business plan. The course outlines of the few chiropractic programs that require submission of a business plan provided comprehensive instructions for them (Table 7).

Selection of course topics, review of learning outcomes and assessment if they were met

No information was provided in any of the 88 course outlines submitted for review of how each respective chiropractic program selected courses topics, methods of delivery, evaluation strategies or learning objectives. In my experience, after its inaugural delivery, refinement of a course follows an iterative process based on feedback from students, faculty and curricular planners who ensure alignment with the program's exit or metacompetencies.

Of the course outlines provided by the 21 chiropractic programs reviewed in this audit, all but one (CP1) provided learning objectives (LOs). Two chiropractic programs not only listed LOs but also provided how they related to Bloom's Taxonomy and to the program's metacompetencies.

A review of the LOs revealed them to be generic in nature and principally mirror the topics listed. That is, for the jurisprudence and business management courses LO's stated the learner would be able to 'identify' or 'recognize' or 'understand' each of the topics discussed in class

Table 7.
Examples of requirements for submission of a business plan

| Chiropractic program | Requirements | Chiropractic program | Requirements |
|----------------------|--|----------------------|---|
| CP 1 | <p><u>1.0 Executive Summary</u></p> <ul style="list-style-type: none"> • Mission statement • Date practice estimated to begin • Name of founder and their functions • Number of employees • Location of practice and branches • Map of area of practice • Description of facility • Floor plan (accurate and realistic measurements) • Site plan (view from street) • Services provided (list and prices) • Banking relationships and current investor information • Projection of practice growth • Summary of future plans • Prepare goals-project where you want to be in 5, 10 and 30 years <p><u>2.0 Organization and staffing</u></p> <ul style="list-style-type: none"> • who does what, • background • duties • detailed description of each department, organizational chart <p><u>3.0 Management</u></p> <ul style="list-style-type: none"> • Resume • Advisory Board <p><u>4.0 Marketing</u></p> <ul style="list-style-type: none"> • Diagnosis – Demographics of area of practice, including <ol style="list-style-type: none"> 1. Population growth 2. Cost of living 3. Industry in area 4. Employment by industry 5. # of households 6. Effective buying income 7. Building permits issued 8. # of DCs in area • Prognosis • Objectives • Strategy • Tactics • Control <p><u>5.0 Service</u></p> <ul style="list-style-type: none"> • What are you selling? Define products • Information about licensure requirements, board exam dates, local business license requirements and costs • Logo • List of services and products: suppliers, availability, costs, new products <p><u>6.0 Impact of economic conditions</u></p> <ul style="list-style-type: none"> • State of economy • Condition of chiropractic • Current and future demand • New technologies <p><u>7.0 Financials</u></p> <ul style="list-style-type: none"> • Be realistic • DIY • The Big Picture <ol style="list-style-type: none"> 1. Balance sheet 2. Income statement (per month for year, with 5 year projections) 3. Cash flow statement (business expenses) 4. Prepare a personal budget 5. Comprehensive list of items to purchase | CP 16 | <p><u>Team Research Paper (team project)</u></p> <p>As a portion of the requirements for this class, teams (7 to 8 randomly chosen participants) will be selected to write a comprehensive research paper about the marketing and promotion activity related to a small health care organization. (Content instructions are below.)</p> <p>The purpose of this paper is to allow students the opportunity to look deeply into the small health care business, and learn, analyze, and make recommendations related to the way in which it uses marketing and promotion to achieve success in the market place. Note: For help with this project, read chapters 7-10 in the text book and the lectures for chapters 7-10.</p> <p>The paper should be composed and submitted in Word, double-spaced, Times New Roman font, size 12, with one-inch margins. (See grading rubric)</p> <p>The format for the paper is shown below, and should be followed closely.</p> <ul style="list-style-type: none"> • Title page • Introduction: overview of business, profile (how long in business), location, number of employees (org chart), demographics of customer, founder, manager/leader, plans for growth and expansion • Analysis of marketing strategy (heart of paper): situational analysis (SWOT), manipulation of marketing mix in planning strategy, marketing goals, competitors and competitive factors • Recommendations • Summary (where is business going? Lessons learned?) • References <p><u>Team Video Project</u></p> <p>In conjunction with the team research project about marketing and promotion activity related to a small health care organization, teams will prepare a presentation summarizing the key points of their comprehensive research. It is to be delivered via a video presentation (submit your You Tube link). The class presentation will introduce each of the team members and provide the summary of the marketing program in the small chiropractic enterprise. Video presentations are to be approximately ten minutes in length</p> <p><u>Individual Marketing Plan</u></p> <p>Each class member is to write a mock marketing plan for a chiropractic business. The plan may be oriented to what you envision for your future business. Instructions for writing this marketing plan are found in Chapter 7 of the text and in the accompanying lecture. As shown in the lecture, the outline for the 5 parts of the marketing plan is as follows:</p> <ul style="list-style-type: none"> • Define mission and understand organizational objectives • SWOT • Marketing objectives • Marketing plan and supporting strategy • Implementation |

(e.g. risk management, informed consent, record keeping, types of insurances needed, importance of finding a location for a practice). Typically, the LOs for courses on ethics required the learner to ‘understand’ the principles of ethics and ‘apply’ them to ethical dilemmas.

The methodology used in this audit did not permit any kind of qualitative assessment of the course content delivered, making it impossible to assess whether course structures used across curricula meet the specific needs of student, each chiropractic program or the profession. None of the course outlines reviewed referred to any type of assessment of the course’s LOs.

In order to undertake a qualitative assessment of the LOs of the JEB course offered at CMCC, I conducted an in-depth paper survey asking students to rate their perceptions of the various components of that course.⁹ Of a class of 186 students, 175 consented and completed the survey (response rate 94.1%) and ‘strongly agreed’ or ‘agreed’ topics covered in lectures and small groups sessions were well presented and important for them to know. Similarly positive feedback was reported about the class assignment related to the lectures and small group sessions. However, students’ perceptions of the presentation, content and assignments related to the online business management modules used in that course were generally poor.⁹ The results from that study were used to make modifications to the course going forward, principally to the assignments related to the business modules. If not already done so, other chiropractic programs ought to perform similar qualitative assessments of each JEB course in their curriculum, making any course changes deemed necessary.

Jurisprudence

A number of inter-related topics can serve to further inform what should be optimally taught in a jurisprudence course. This includes trends extracted from annual reports of licensing bodies, issues germane to advertising, results from the aforementioned student survey⁹ and the results of this audit.

Annual reports

A review of the Discipline Hearings from the College of Chiropractors of Ontario’s Annual Reports between 2011-2021 revealed the same four acts of professional misconduct were most likely to result in loss of licensure: insurance fraud; practicing outside of the chiropractic scope of

practice; practicing while under suspension; and sexual abuse.¹⁰ In Ontario, sexual abuse encompasses engaging in a sexualized relationship with a patient, sexually harassing a patient, making remarks of a sexual nature, contacting a sexualized part of a patient or contacting a patient with a sexualized part of the doctor. If found guilty, the registrant faces a mandatory five year revocation of licensure, the harshest penalty in any jurisdiction.¹¹ This is a consistent finding across jurisdictions that regulate chiropractic. It therefore behooves courses that teach jurisprudence to devote considerable time to these topics.

Advertising

Advertising presents a special challenge in chiropractic, as evident by the fact this audit found it is often taught from both a jurisprudence and a marketing perspective. This is not entirely surprising, since advertisements often attract significant media attention, especially if they refer to the management of neuromusculoskeletal (NSMK) conditions (especially conditions that primarily affect children), allude to unsubstantiated claims of cure or convey anti-vaccination sentiments.

Evans, Perle and Ndetan sought to assess the quality of information with respect to wellness available on chiropractors’ websites.¹² Based on a review of 47 randomly retrieved websites, the researchers characterized the information often available as ‘useless’ since they contained information contrary to common public health initiatives.¹² A more recent cross-sectional study of a representative sample of the websites of French chiropractors ($n=287$) found 8 of 10 websites mentioned one or more non-MSK disorders or symptoms, although the authors emphasized it was unclear if this reflected inaccurate communication or if treatment for non-MSK conditions was provided by the chiropractors.¹³ A review of the websites of Danish chiropractors reported one of four referenced management of non-MSK conditions.¹⁴ These differences between jurisdictions may reflect cultural, educational or regulatory differences.

A number of recent events involving advertising could stimulate robust discussion during small group discussions. Examples include: the lengthy legal battle subsequent to an investigation by news reporter Simon Singh in the UK¹⁵; widespread media scrutiny subsequent to a chiropractor’s post on social media of him adjusting an infant with colic in Australia¹⁶⁻¹⁹; sensationalistic cov-

er stories in national newspapers and magazines focusing on chiropractic care for infants and children²⁰⁻²⁷; the actions of the College of Chiropractors of British Columbia making it an act of professional misconduct for chiropractors to advertise various claims related to pregnancy and delivery²⁸ and; anti-vaccination statements by some chiropractors on their social media platforms³⁰⁻³⁴ as well as responses by chiropractic regulatory bodies, advocacy associations and researchers to these claims³⁵⁻⁴¹.

Contemporary controversies within the chiropractic profession

I conducted a thematic analysis of interviews of 30 influential stakeholders who were asked to share their perceptions of the obstacles, challenges and opportunities facing the chiropractic profession currently and in the future.⁴² Several contemporary controversies were independently discussed by the diverse group of interviewees germane to this study.

In discussions that veered into characteristics of practice activities, interviewees observed many controversies still persist in the profession, some tracing their origins back to its emergence onto the healthcare scene in the late 1890s (e.g. vaccination, management of non-NMSK conditions, differing ideologies bordering on tribalism).⁴² Given how these topics continue to persist in the chiropractic milieu, it may be beneficial for future chiropractors to be made aware of them, and a jurisprudence course may be the most logical place to do so. Over the past several years, I increased the lecture time devoted to these controversial issues in the JEB course I coordinated and a recent student survey of that course found over 90% of students perceived learning about these controversies was important for them to know.⁹

Ethics

There's an adage among ethicists: What's the answer to every ethical dilemma? Answer: It depends! In stark contrast to issues related to jurisprudence and the legal system, which tends to be proscriptive and paints many issues in black and white, ethical dilemmas are often viewed through a shades-of-grey prism. It is for this reason discussion of ethically complex situations can be debated during either lectures or facilitated small group sessions.

One ethically complex situation the author recently

discussed from different perspectives involved a Facebook group of male dental students at Dalhousie University. Those students created a Facebook chatroom and ranked their opinion of the sexual desirability of their female classmates⁴³; however, a crime reporter labelled it a victimless thoughtcrime.⁴⁴ Another situation involved a published article that characterized the behaviour of a number of female vascular surgeons as unethical because they posted pictures of themselves on their social media consuming alcohol or wearing what the authors deemed inappropriate and offensive attire.⁴⁵ In response, not only did many female vascular surgeons flood social media with pictures of themselves in bikinis, the journal apologized for the inherent sexism of the article and retracted it.⁴⁶

Struggling with trustworthiness

Recent publications underscore the fact that chiropractic students should be taught the ethical challenges they will face and how their decisions may not only jeopardize their licence to practice but may how members of the public perceive the profession's overall trustworthiness.

A 2016 Gallup poll asked randomly chosen members of the public to rate the honesty and ethical standards of different professionals.⁴⁷ Nurses ranked highest, with respondents rating their honesty and ethical standards very high (29%) and high (55%), followed closely by pharmacists, medical doctors, engineers, and dentists. By contrast, only 5% and 33% of respondents rated chiropractors' honesty and ethical standards as either very high or high, respectively, slightly ahead of bankers, journalists, lawyers and state governors.⁴⁷ These findings parallel an earlier report by Ipsos, a marketing research company, that conducted a reputational comparison of 9 leaders in NMSK care.⁴⁸ Respondents were asked for their opinions of their familiarity, favourability, trustworthiness and likelihood to recommend of professions including family doctors, physiotherapists, orthopedic surgeons, physiotherapists and chiropractors.⁴⁸

Ipsos reported medical doctors ranked the highest with respect to these four categories and physiotherapists (PTs) ranked second highest. Chiropractors ranked sixth. Looking at the results in detail, although respondents were equally familiar with both PTs and chiropractors (54%) 51% of respondents were likely to recommend PTs compared to only 42% for chiropractors. Even more telling,

Table 8.
*Reputational comparison for NMSK health care professionals**

| Health care professional | LTR+ | Trust | Favourability | Familiarity |
|--------------------------|------|-------|---------------|-------------|
| Medical Doctor | 58% | 84% | 88% | 94% |
| Physiotherapist | 51% | 82% | 86% | 74% |
| Orthopedic Surgeon | 58% | 82% | 86% | 54% |
| NMSK Experts | 50% | 72% | 72% | 14% |
| Massage Therapist | 55% | 55% | 80% | 70% |
| Chiropractic | 42% | 42% | 46% | 71% |
| Naturopath | 37% | 37% | 40% | 32% |
| Psychologists | 36% | 9% | 60% | 54% |
| Psychiatrists | 34% | 6% | 22% | 54% |

*Extracted from Ipsos
+LTR= Likelihood To Recommend

86% of respondents had a favourable opinion of PTs compared to only 46% for chiropractors and 82% trusted physiotherapists compared to only 44% for chiropractors (Table 8).⁴⁸

Unethical practice activities

Perle, Lamarche and I conducted a workshop during the 2011 Association of Chiropractic College and Research Agenda Conference (ACC-RAC) that sought to explore and account for the significant rise in ethical violations among chiropractors – most notably insurance fraud – that often leads to disciplinary action and loss of licensure.⁴⁹ This despite the fact students and practicing chiropractors alike are forewarned of the legal repercussions associated with such unethical behaviour. The 30 workshop participants were tasked with addressing three objectives: (i) identify challenges graduates will encounter that complicates their ability to develop a successful, ethical, patient-centred chiropractic practice, (ii) identify challenges that may lead them to succumb to unethical behaviour, and (iii) develop strategies to overcome these challenges.⁴⁹ Participants unanimously identified raising student debt as the chief motivator of unethical practice activities. This was coupled with what workshop participants observed as an unwillingness of students to put in the ‘sweat equity’ needed to establish a successful practice. Other participants perceived some students have a

sense of entitlement and expect a lucrative practice to be handed to them, indicating an inability to delay gratification and instead seek what was characterized as the ‘illusion of wealth’. These attitudes may have been further fortified by poor role-models who have obtained financial success despite dubious ethical behaviour. These factors often led graduates to either seek out role models or to enrol in practice management seminars that teach ethically questionable business activities,⁴⁹ some of which specifically target older chiropractic patients.⁵⁰

The thematic analysis of influential stakeholders, despite diverse backgrounds ideologies, revealed unanimous agreement that unethical practice activities are the bane of the profession.⁴² When asked to specify what constituted unethical practice activities of concern, interviewees gave similar examples: unnecessary and over-lengthy treatment plans with exorbitant prepayment requirements; overly discounted fee schedules; use of pressure or scare tactics, characterized as fear-mongering (‘scare care’); block booking and; overly scripted report of findings.⁴² Several commentaries have similarly opined the chiropractic profession will not obtain the cultural authority it seeks until these practices, along with anti-scientific beliefs, are abandoned.⁵¹⁻⁵⁴

Cultural competency, DEI and Racism (DEI-R) in health care

The past decade has witnessed the emergence of social movements including #MeToo, #TimesUp, LGBTQ2S+ and Black Lives Matter, all designed to increase cultural awareness for justice of individuals who have been historically victimized. These movements impact healthcare providers. As an example, a survey of a convenient sample of female faculty at a CMCC revealed half of respondents (n=17) were sexually harassed by their patients.⁵⁵ A recent interview of seven female Australian chiropractors reported similar circumstances of inappropriate sexual behaviour by patients.⁵⁶ Another article asked ‘what do you do when the patient is a racist?’⁵⁷, a phenomenon on the rise toward not only BIPOC healthcare providers in general but healthcare providers of Asian descent in particular due to racist theories about the origins of Covid-19.⁵⁸ And yet, this audit revealed only four chiropractic programs that address DEI, only one of those programs focused on racism directed toward the doctor and a PubMed search failed to reveal any studies on DEI-R training in chiro-

practic, and no study has been published on cultural competency training in chiropractic education since 2014.^{59,60}

Business management

There are several reasons supporting the need for robust business management education for healthcare providers in general, and chiropractic students in particular. One primary reason is related to challenges resulting from the indebtedness healthcare professional students find themselves in subsequent to obtaining a doctorate-level education. This challenge is particularly daunting in chiropractic.

Challenges and solutions to the cost of doctorate-level education

Chisholm-Burns *et al.*⁶¹ reported the cost of a doctorate-level education varies between US\$100,000 and US\$200,000, based on 2018 data from the US Department of Education, and that these costs are rising exponentially. This cost included tuition, fees and cost of living; however, it did not include the hidden cost of lost job opportunity as a consequence of students unable to secure full or even part time employment while at school due to the rigours of the curriculum.⁶¹

In order to assess the debt-to-income ratio of five doctor-credentialed professions (medicine, dentistry, optometry, pharmacy and veterinarian medicine) Chisholm-Burns *et al.*⁶¹ conducted a retrospective analysis of either mean or median student debt loan data between 2010-2016 and compared it the median income of those professions over the same time period. In this analysis, a debt-to-income ratio greater than 100% indicated debt was greater than income, while ratios less than 100% indicated income was greater than debt. The researchers noted their analysis did not include debt accrued during undergraduate education.⁶¹

Using these data sets, with the exception of medicine, the researchers reported the debt-to-income ratios for each health profession reviewed consistently exceeded 100% between 2010 and 2016, whereas debt-to-student ratios for physicians ranged between 89% to 95% during the same time period.⁶¹ To address this debt-to-income disparity Chisholm-Burns *et al.*⁶¹ suggested educational programs provide opportunities for students to learn about personal finances, including budgeting, saving and managing debt, allowing for a better understanding of

the true cost of taking out a loan. The researchers also suggested students be offered counseling services to help them understand student debt repayment strategies.⁶¹

Shields and Dudley-Javoroski⁶² observed the cost of a physiotherapy education has risen between two and three times more quickly than growth in entry-level salaries. This led the researchers to ask (i) what is the economic value of a physiotherapy career relative to other healthcare professions? and; (2) Is the graduate debt reported for physiotherapy manageable according to recommended salary-weighted debt service to ratio benchmarks?⁶²

To answer these questions, the authors used a method of analysis know as Net Present Value (NPV). NPV is an economic model of cost-benefit analysis that calculates the monetary difference between the benefit to be gained (e.g. lifetime salary) less the cost of education and opportunity cost of foregone earnings from alternate careers. The NPV for physiotherapy was compared to other healthcare professions including medicine, dentistry, nursing, veterinarian medicine, optometry and chiropractic.⁶²

At the debt level reported by recent graduates (US\$86,563) the NPV for physiotherapy was higher than occupational therapy, optometry, veterinary medicine and chiropractic but lower than dentistry, pharmacy, nurse practitioners, physician assistants and all medical specialties included in this study. At a debt level of US\$150,000, the NPV for physiotherapists falls below all careers except for veterinarians and chiropractors. Students with a debt of over US\$200,000 may not achieve the recommended repayment benchmark and of students whose student debt exceeds US\$266,000 physical therapy NPV no longer exceeds that of a bachelor's degree. This led the authors to conclude that physiotherapy education was a good investment but only to a certain point of student loan indebtedness stating "*students should carefully consider the amount of debt they are willing to assume in order to obtain a physiotherapy education*",^{62p190} a statement that undoubtedly applies to chiropractic as well.

Amin, Hoffmaster and Misko⁶³ reported pharmacy school graduates had a median debt of US\$170,000 in 2019 but a median annual salary of only US\$128,900. In order to assess the effect of a personal finance elective on students' financial management literacy and confidence, the researchers conducted a voluntary, anonymous survey of graduation classes of pharmacy students at the North-

east Ohio Medical University (NEOMED) between 2018 and 2021.⁶³

Two hundred and eight-seven students graduated from the pharmacy program at NEOMED between 2018 and 2021. Of these students, 106 students (37%) participated in the survey. Fifty seven (54%) of these respondents did not enrol in the personal finance elective whereas 49 (46%) did. There was a significant higher rate in overall confidence with respect to their ability to manage their finances among those students who had enrolled in the personal finance course compared to those who did not. This finding led the authors to call for the prioritization of financial knowledge and skills within the doctor of pharmacy curriculum.⁶³

Economic trends for chiropractors

Economic challenges facing chiropractors, especially newer graduates, has been well documented for several years. In 2008 (based on pre-2004 data) Mior and Laporte⁶⁴ reported that the number of chiropractors in Ontario, Canada had doubled between 1990 and 2004 but utilization rates remained relatively static and average net annual income declined adjusted for inflation in 2002 dollars.

Specifically, the number of registrants in Ontario between 1990 and 2004 increased from 1668 to 3213. During the same time period, annual net income decreased from CDN\$97,892 to CDN\$80,171. Parallel to this data Mior and Laporte⁶⁴ reported the ratio of chiropractor-to-population declined from 6453 to 5743 despite the fact the population increased by over 500,000 people during that time. Looked at another way, based on an estimated utilization rate of 10%, the authors calculated the optimal ratio between chiropractor and patients ought to be 1:7099; however, the actual ratio in Ontario was 1:4372, indicating a significant over-supply of chiropractors in that province.⁶⁴ Similar to the study by Chisholm-Burns *et al*⁶¹, Mior and Laporte⁶⁴ reported student debt load at the time of graduation increased significantly during the review period.⁶⁴ As an example, in 1995-1996 only 12% of students graduated with debt loan in excess of CDN\$80,000; this percentage increased to 52% by 2003-2004⁶¹ (Author's note: tuition for incoming students for the four-year program at CMCC for the 2021-2022 academic year is CDN\$27,224⁶⁵).

Three important addendums should be kept in mind

when considering the data reported by Mior and Laporte.⁶⁴ First, at the time of this writing (summer 2022) there were roughly 5,250 registrants in Ontario, representing a 65% increase since 2004. Second, the number of students accepted for admission to CMCC increased from 150 to 200 when the campus relocated to a larger facility in 2004. Third, prior to 2004 a substantial number of CMCC students were from Quebec (30-40 on average) and returned to that province upon graduation; however, with the establishment of a chiropractic program at UQTR in 2004 this not only resulted in an increase in the total number of Canadian chiropractors per year but undoubtedly led to a further increase in Ontario chiropractors since the 30 to 40 admission spots no longer being filled by Quebec students where now filled by applicants from Ontario and other provinces.

More recently, the Ontario Chiropractic Association (OCA), a volunteer advocacy organization representing roughly 80% of Ontario chiropractors reported mean gross income adjusted for inflation declined from CDN\$163,000 in 2003 to CDN\$94,000 in 2016.⁶⁶

The study by Shields and Dudley-Javoroski⁶² included data particularly relevant to chiropractic. The entry level salary for chiropractors was reported to be US\$47,460, the lowest of 17 healthcare professions reviewed and only marginally higher than the entry level salary of a person with a Bachelor's degree (US\$40,456). Compared to 17 healthcare professions, chiropractic had the second lowest salary compound annual growth rate (CAGR) and the second lowest salary change between 2007 and 2016. Lastly, chiropractic was at the bottom of present value (PV) analysis modelling.⁶²

The 2022 Government of Canada JobBank reported salary range for chiropractors ranged from a low of CDN\$24,746 to a high of CDN\$122,316, with a median annual salary of CDN\$60,077.⁶⁷ This is similar to data reported by PayScale which reported the average annual income for chiropractors in Canada was CDN\$75,126.⁶⁸ It should be noted another site reported the annual average yearly salary to be CDN\$148,000.⁶⁹

The JobBank provided salary ranges for a number of healthcare professionals.⁶⁷ Naturopaths earn slightly less than chiropractors with annual salaries ranging between CDN\$24,746 to CDN\$107,748, with a mean income of CDN\$52,517. Dentists earn roughly twice as much as chiropractors and medical doctors earn roughly twice

Table 9.
*Comparison of annual incomes for various Canadian health care professionals (Canadian Dollars)**

| Health care professional | Low | Mean | High |
|--------------------------|----------|------------|-----------|
| Chiropractic | \$24,746 | \$ 60,077 | \$122,316 |
| Dentistry | \$30,128 | \$118,394 | \$261,517 |
| Medical Doctor | \$83,379 | \$ 216,864 | \$414,390 |
| Naturopath | \$24,746 | \$ 52,517 | \$107,748 |
| Optometrist | \$24,746 | \$ 86,115 | \$167,858 |
| Pharmacist | \$54,112 | \$ 104,646 | \$144,300 |
| Physiotherapist | | \$ 68,460+ | |

* Government of Canada. 2020. JobBank. www.jobbank.gc.ca
 + Based on median hourly rate of \$40.75, 35-hour work week and 48 week per year

as much as dentists. The JobBank did not report salaries of physiotherapists in Canada but instead reported their hourly rate, which varied between CDN\$28/hour to CDN\$49.65/hour with a median of CDN\$40.75/hour. Assuming a 35-hour work week and 48 weeks of work per year, using the median hourly wage rate, the annual mean salary for a physiotherapist calculates to CDN\$68,460 (Table 9).⁶⁷

Leveraging business management education to combat the allure of unethical practice behaviours

Attendees at the aforementioned 2011 ACC-RAC workshop⁴⁸ unanimously agreed student debt led new graduates to gravitate toward practice management programs that teach participants practice behaviours that are ethically questionable. Examples of ethically questionable practice behaviours include overly-scripted responses to patient questions and lengthy pre-paid packages that push patients toward unnecessary and excessive number of visits. These questionable practice activities may ultimately lead to moral blind spots resulting up to and including insurance fraud.⁴⁸

Workshop participants provided several strategies to combat this problem. Chief among them was for accredited chiropractic programs to provide more robust business management curricula that emphasizes financially successful strategies undergirded by ethically-based practice activities. Workshop participants recommended business management courses ought to teach both practice manage-

ment skills along with patient management skills. Such skills recommended for curriculum inclusion include: contract assessment (e.g. associateship agreements, leases, purchase of a practice); basic accounting skills; effective advertising; demographic analysis; staff training and insurance requirements for professional practice.⁴⁸

Workshop participants also suggested students be presented with real-life examples of ‘bad behaviours’ exhibited by field doctors and the consequences they faced. Conversely, workshop participants also recommended students be presented with ‘success stories’ – stories from field practitioners who obtained a high level of financial success while staying within the four corners of ethical practice activities. For the JEB I coordinated, I adopted this strategy by creating a library of faculty interviews chronicling their professional journey, beginning with their decision to enrol in a chiropractic program, continuing with their experiences in private practice and culminating with their decision to pursue a career in chiropractic education.⁹

The importance of curating a team of successful alumni who could serve as mentors and role-models who inspire students to practice with dignity and pride was also suggested by workshop participants.⁴⁸ These recommendations were echoed during a workshop I conducted with McCarthy and duRose during the 2018 Educational Conference of the World Federation of Chiropractic in London, England.⁷⁰

Literature review of business management education in chiropractic

In 2008, based on interviews of 64 chiropractors nationwide, Henson *et al.* identified an educational gap between perceived business skills possessed versus business skill required.⁷¹ The authors concluded that the chiropractic profession needed significantly greater business and practice management skills. Among their recommendations was for an industry-wide effort to develop business education programs specifically designed for chiropractors, perhaps at a graduate level and spearheaded by national or international associations.⁷¹

Mirtz, Hebert and Wyatt⁷² distributed a 48-item survey to a group of non-practicing chiropractors inquiring about various aspects of the profession, namely, financial, educational, psychosocial and political. Seventy valid responses were received for analysis. A majority of re-

spondents believed business ethics in chiropractic were questionable and that overhead expenses and student loans were barriers to practice success. Among those respondents who were associates they believed they were encouraged to prolong patient care and that their salaries were too low. Overall, they believed chiropractic was not a good career choice and would not recommend it.⁷²

In order to assess financial attitudes, knowledge and habits of chiropractic students Lorence *et al.* distributed a cross-sectional survey to a convenient sample of 250 students enrolled in business classes at Palmer College of Chiropractic-Davenport in 2011⁷³, advancing on a similar study conducted by Zhang *et al.*⁷⁴ a decade earlier. Based on 57 returned surveys the researchers found most respondents (74%) would accumulate over US\$125,000 in student debt by graduation, with 26% owing between US\$150,000-175,000 and 28% estimated they will owe more than US\$175,000.⁷³ In general, financial knowledge was found to be low. To quote the authors: “*Students enrolled at one chiropractic college have unrealistic future salary expectations, high levels of actual and planned loan acquisition, an underestimation of their own risk tolerance, low levels of basic financial knowledge, and poor current money management skills*”.^{73p63} Ultimately, Lorence and her colleagues concluded these chiropractic students demonstrated inadequate financial literacy and did not engage in many recommended financial habits which could result in increased financial liability, levels of stress and possible business failure.⁷³

Ciolfi has published two studies investigating the current level of business acumen among chiropractors.^{75,76} In the first of these studies Ciolfi and Kasen⁷⁵ examined the relationship between chiropractor’s perceived level of business knowledge required and their perceived level of current business knowledge. In 2013, two hundred and seventy-four chiropractors completed an online survey investigation this relationship for eight key business items. Based on Spearman’s correlation testing the researchers found a statistically significant positive correlation for perceived knowledge required and perceived current level of knowledge for six variables: organizational behaviour; strategic management; marketing; legal and ethical; managerial decisions and; operations; however, finance and accounting were not found to be statistically significant. The Wilcoxon Signed Ranks testing indicated a significant difference for three paired items: strategic

management; marketing and; legal and ethic. No statistically significant correlation between level of knowledge required and level of knowledge possessed was found for two variables, accounting and finance. In addition to benefits to graduates, the authors concluded improving the level of business knowledge education might not only contribute to its cultural authority but “*could add value to the profession as an attractive health care career thereby strengthening enrolment and business sustainability of chiropractic educational institutions*.”^{75p6}

In something of a follow up study Ciolfi, Azad, Al-Azdee⁷⁶ and their colleagues sought to examine perceptions of business education among 16 Ontario chiropractors who graduated from four different chiropractic programs (12 CMCC, 2 Palmer, 1 National, 1 Northwestern). Questions were designed to analyze two levels of the quality of business education they received: (i) perceived level of business level acquired and (ii) current level of knowledge for six business topics. The following topics were explored: accounting and finance; organizational behavior and human resources; legal and ethics issues; strategic management; managerial decision making and; operational management.⁷⁶

Interviewees perceived requirements for business skills are both broad and essential, embracing most if not all business domains. The majority of interviewees reported that ethical training and jurisprudence was very well done. However, this same group reported the status of business education they received while in the program minimally contributed to the business skills required upon graduation. For example, 13 of 16 interviewees reported finance and accounting were not covered, two reported it was not covered enough and 1 reported they would have liked to have had more. Eight interviewees reported organizational behaviour and human resources were not covered and 14 interviewees reported strategic management was not covered at all. Twelve interviewees do not recall managerial decision-making content being covered in class and nine reported there was no education provided on operational management. This led the authors to conclude there is a gap between skill-oriented business training in chiropractic and the skills needed to practice within the profession.⁷⁶

Sikorski and colleagues conducted an anonymous survey of graduating chiropractic students in 2015-2016 regarding their prior business experience, their perception

of business courses taken before and during their chiropractic education, business abilities and needs and their practice plans for the future.⁷⁷ Eighty one of 114 surveys (response rate 71%) were completed for review. Less than half of respondents had taken college-level business courses prior to entering the chiropractic program. Almost 90% of respondents took one or more of the three electives on business skills offered during their chiropractic education. Sixty-eight percent of respondents planned on being an associate upon graduation and to be in private practice after five years.⁷⁷

In descending order, surveyed chiropractic students perceived there was a need for further education on the following topics: Business operations (organizing and managing day-to-day activities); accounting (recording, reporting and analyzing financial data); billing/reimbursement; finance (process of acquiring, investing and managing business resources); business taxes (including business, employee and income taxes); economics (managing business income, expenses and resources); starting a practice; employee management; strategic planning (setting business goals and objectives); marketing/advertising and; ethics/risk management and jurisprudence (protecting your practice and professional license).⁷⁷ Lastly, Sikorski *et al.*⁷⁷ found there was a statistically significant positive relationship between students with either prior business experience and/or college business education and their confidence in operating a healthcare practice.

Review of the literature of JEB courses taught in other healthcare disciplines

A review of the literature of JEB course content from other healthcare disciplines found 52 articles from the medical, dental, nursing and pharmacy professions (see Appendix 1 for search strategy). Using various methodologies, 13 articles were comparative audits of jurisprudence/ health law, ethics and business management (sometimes referred to as ‘health economics’) courses in healthcare educational program. Tables 10a-c compare course categories discussed in those articles to this one.

One audit of ethics, health law and health economics taught at 62 of 125 American medical schools reported all programs have a dedicated course on bioethics whereas only 59% required a course in health law.⁸⁰ That audit reported ethics courses ranged between nine and 125 hours

Table 10a.

*Comparison of this study to audits of JEB courses taught at other health care programs**

| Study | List of topics/content | Presentation methods** | Description of organization of courses+ | Assessment methods^ |
|-----------------------------------|------------------------|------------------------|---|---------------------|
| Present study | ✓ | ✓ | ✓ | ✓ |
| Goldie et al ⁷⁸ | ✓ | ✓ | ✓ | ✓ |
| Lehmann et al ⁷⁹ | ✓ | ✓ | | |
| Persad et al ⁸⁰ | | | ✓ | |
| Kolva et al ⁸¹ | ✓ | ✓ | ✓ | ✓ |
| Preston-Shoot et al ⁸² | ✓ | ✓ | ✓ | |
| Busari et al ⁸³ | | ✓ | ✓ | |
| Giubilini et al ⁸⁴ | ✓ | ✓ | ✓ | ✓ |
| Niccum et al ⁸⁵ | ✓ | | ✓ | |
| Arnaert et al ⁸⁶ | ✓ | | | |
| Mattingly II et al ⁸⁷ | ✓ | | | |
| D’Assunção et al ⁸⁸ | ✓ | ✓ | ✓ | |
| Smith et al ⁸⁹ | | | | ✓ |
| Wong et al ⁹⁰ | ✓ | ✓ | ✓ | ✓ |

Table 10b.

*Comparison of this study to audits of JEB courses taught at other health care programs**

| Study | Description of instructor | Number of course hours – jurisprudence | Number of course hours – ethics | Number of course hours – business / health economics |
|--------------------------------|---------------------------|--|---------------------------------|--|
| Present study | ✓ | ✓ | ✓ | ✓ |
| Goldie et al, 2001 | | ✓ | | |
| Lehmann et al, 2004 | ✓ | | ✓ | |
| Persad et al, 2008 | ✓ | ✓ | ✓ | |
| Kolva et al, 2009 | | | | |
| Preston-Shoot and McKimm, 2010 | ✓ | | | |
| Busari et al, 2011 | ✓ | | | ✓ |
| Giubilini et al, 2016 | | | | |
| Niccum et al, 2017 | ✓ | | | |
| Arnaert et al, 2017 | | | | |
| Mattingly II et al, 2018 | | | | |
| D’Assunção et al, 2021 | | | | |
| Smith et al, 2021 | | | | |
| Wong et al, 2022 | | | | |

Table 10c.
Comparison of this study to audits of JEB courses taught at other health care programs*

| Study | Course material | Evaluation of students by faculty^^ | Review of LOs | Educational strategy> |
|--|-----------------|-------------------------------------|---------------|-----------------------|
| Present study | ✓ | | | |
| Goldie et al, 2001 | | | | ✓ |
| Lehmann et al, 2004 | | | | |
| Persad et al, 2008 | | | | |
| Kolva et al, 2009 | | | ✓ | |
| Preston-Shoot and McKimm 2010 | ✓ | ✓ | | |
| Busari et al, 2011 | | | | |
| Giubilini et al, 2016 | | | | |
| Niccum et al, 2017 | | | | |
| Arnaert et al, 2017 | | | | |
| Mattingly II et al, 2018 | | | | |
| D'Assunção et al, 2021 | | | | |
| Smith et al, 2021 | | | | |
| Wong et al, 2021 | | | | |
| *Methods used to conduct audits included surveys/questionnaire, scoping reviews and literature searches **Presentation methods include lecture, small group sessions, online modules + Description of where in the curriculum courses are positioned ^ Assessment methods include written examinations, assignments ^^Faculty were surveyed on their perception of how prepared students are >Examples include student and teacher -centred; problem solving; community-based | | | | |

(median 27.5), were typically taught in the first year of medical school and the instructor had at least one publication on the topic of bioethics. Health law courses ranged between 2 and 60 hours (median 10.3), were evenly distributed throughout the four-year program and taught by an instructor with at least one health law-relevant publication.⁸⁰ Lastly, 66% of medical programs required coursework in health economics (not entrepreneurship or financial literacy), ranging between 0.5 and 32 hours (median of 8 hours).⁸⁰

Preston-Shoot *et al.*⁸² reported 26% of surveyed UK medical faculty believed students were ‘well prepared’ with respect to jurisprudence education, 47% reported they were ‘adequately prepared’ and 16% of faculty perceived students were ‘inadequately prepared’. Among the 25 UK medical schools who participated in that review, 84% had not undertaken any systematic outcome study

of law learning.⁸² The dissatisfaction expressed by some respondents with respect to health law education was due to either inadequate time dedicated to it in the curriculum or the absence of law-related learning objectives.⁸²

Twenty-two articles investigated bioethics courses. It is noteworthy that the introduction to virtually each article stated there is no standardized or agreed-upon best method to teach bioethics. As an example, Lehman *et al.*⁷⁹ conducted a survey of medical ethic education at American and Canadian medical schools and reported significant variation with respect to content, delivery methods and placement of courses within the curriculum. The researchers also reported only 48% of academic deans reported their schools formally evaluated student’s moral reasoning and only a third evaluated student behaviour in ethically different scenarios.⁷⁹ Lastly, even within the same program, Lehman *et al.* reported there was often a lack of both coordination and integration of ethics education between preclinical and clinical courses.⁷⁹ To overcome this lack of coordination Wong *et al.* opined: “A spiralled, vertically, and horizontally integrated ethics curriculum was widely hailed as the ideal pedagogical approach to teaching ethics”.^{90p170}

One startling observation was, of the 22 articles that discussed teaching bioethics, not a single one mentioned the importance of teaching bioethics as they apply to healthcare business practices and only one course of the many courses in the six reviews of business management courses taught to healthcare providers discussed ‘business ethics’ at all.⁸³

The underlying theme of the 14 courses investigation the teaching of business principles to healthcare students was best captured in the following concluding statement: “Management education in health care appears to be generally considered essential and necessary. There is, however, no clear consensus as to when in the medical education continuum, how, and for how long management education should be provided”.^{91p186} Only one study discussed teaching entrepreneurship to students in general terms⁹² and only two studies^{86,93} presented topics for teaching financial literacy or business management skills needed to operate a successful clinical practice. Lastly, Kolva *et al.*⁸¹ found only one of the business management course in their systematic review of the literature that reported long-term outcome measures of competency-focused curricula.

Table 11.
Recommended topics, methods of delivery and evaluation methods that could be used for chiropractic JEB courses, based on this audit

| Course | Topics | Method of delivery | Evaluation methods |
|-------------------------|---|--|--|
| Jurisprudence | <ul style="list-style-type: none"> • Legal system • The 'Rules' • Record keeping • Consent, capacity, confidentiality • Scope of practice • Negligence • Sexual abuse • Insurance • Advertising/ marketing • Termination of doctor-patient relationship • Complaints • Discipline • What to do when things go wrong • Contemporary issues | <ul style="list-style-type: none"> • Lecture • Facilitated small group tutorials • Presentation of real-life scenarios | <ul style="list-style-type: none"> • Open book examination • Assignments • Attending Court Proceeding or Discipline Hearing |
| Ethics | <ul style="list-style-type: none"> • Ethics definitions • Ethical principles • Social contract • Codes of conduct • Privacy • Boundary crossings vs boundary violation • Professions • Professionalism • DEI, racism, cultural competency • Unethical practice activities • Contemporary issues | <ul style="list-style-type: none"> • Lecture • Facilitate small group tutorials • Presentation of real-life examples | <ul style="list-style-type: none"> • Lecture • Reflection • Assignments |
| Entrepreneurship | <ul style="list-style-type: none"> • Chiropractic as an Industry • Career options • Being a boss • Advertising/ marketing • Contracts • SWOT analysis • Demographic analysis • Communication skills • Office policies and procedure • Human Resource issues • Realistic graduate expectations | <ul style="list-style-type: none"> • Lecture • Workshop/Seminars • Clinical preceptorship • Self-directed learning | <ul style="list-style-type: none"> • Business Plan • Marketing Plan • Assignments |
| Finances and Accounting | <ul style="list-style-type: none"> • Financial literacy • Taxes • Investment strategies • Financial analysis, forecasting, and management • Budgeting • Accounting principles • Investment strategies • Retiring with financial security | <ul style="list-style-type: none"> • Lectures • Workshops • Seminars • Online • Self-directed learning | <ul style="list-style-type: none"> • Class participation • Assignments • Personal budget • Finance Plan |

Potential applicability of the results of this study

The results of this study could potentially be used to move toward a standardized or 'model curriculum' for chiropractic JEB courses. One potential use of this data would be for course coordinators, departmental chairs and curricular planners to identify gaps in the JEB courses taught at their respective chiropractic program and fortify each course as need be. Table 11 provides examples of possible topics, delivery methods and evaluation strategies

that could be incorporated into chiropractic JEB courses, based on the findings of this audit. Curricular gaps could also be identified by surveys of students, faculty and external stakeholders. Learning objectives for each JEB course should be well-articulated and align with the meta-competencies of each chiropractic program. Objectives measures of student performance should be conducted and changes to courses made accordingly.

Accrediting agencies could use the information in this

study to develop more precise competencies that must be met while not infringing on the academic freedom of each chiropractic program.

Leveraging the results from this study, subject matter experts (SMEs) could conduct workshops at international conferences and reach consensus on a standardized or model JEB curriculum, mirroring the process used by a group of technique faculty that reached consensus and recommended a standardized curriculum for teaching chiropractic technique.⁹⁴ Alternatively, a Delphi process could be used, developing seed statements and recommendations that would be rated by SMEs worldwide. A similar process was recently used by Hawk *et al.*⁹⁵ that developed clinical practice guidelines for the role of chiropractic care for health promotion and clinical preventive services for adult patients with MSK pain. That said, one obstacle to developing a standardized or model JEB curriculum is the significant differences between jurisdictions worldwide with respect to legislation, especially scope of practice.

Limitations

There are several limitations to this study. Since I asked for the submission of JEB course content once, this audit was essentially only a snapshot. It is possible course outlines changed in the meantime. It is possible there was some confusion among respondents who only provided outlines for the jurisprudence and ethics courses but not business management courses, or the other way around. It is also possible that the person who responded to my request was not aware of other courses in the chiropractic program that taught the requested information. As an example, Sikorski *et al.*⁷⁷ published the results of a survey of chiropractic students' perception of their business preparedness. In that article, Sikorski *et al.*⁷⁷ listed and described nine business management courses, a number of which were not provided to me for review in this study. Similarly, some content may be purposefully not taught in JEB courses since course coordinators may know it taught elsewhere; for example, issues surrounding child abuse may be taught in courses on pediatrics.

The methodology used in this study could not capture JEB course content provided to students by faculty on an ad hoc basis throughout a chiropractic program, and it is entirely likely that supervising clinicians or external preceptors (e.g. approved field doctors) provide senior stu-

dents/interns with advice and guidance related to these topics during their placements.

Some course outlines provided for review were relatively vague with respect to their topical outlines, and it is possible not all subjects presented during class were listed in the course syllabi. For example, it is highly unlikely a jurisprudence course would not cover consent, record keeping and negligence, and yet not all jurisprudence course outlines listed those topics. However, similar to the comparative audit previously performed, I resisted the temptation to contact course coordinators for clarification, since it is possible they would state that pertinent subjects were in fact discussed but not listed even if they were only discussed in passing, lest they give the appearance their course is not comprehensive.

It is possible chiropractic programs not included in this audit would have provided sufficient information to have altered the results. A more thorough Internet search may have led to JEB course coordinators from chiropractic programs who did not respond to my request to participate. Limiting this study to English-only course outlines may have also impacted this study's results. Future studies could endeavour to include non-English JEB course outlines.

A significant limitation of this study is the fact I was the only person to extract and compile the data. This resulted in a lack of triangulation. Thus, despite my best efforts, it is entirely possible there were errors during the review of course outlines as well as during data extraction and compilation.

Conclusions

Compared to the comparative audit I conducted previously there has been a significant increase in both the number JEB courses offered and the depth to which they are taught. However, there was also an increase in curricular variability between chiropractic programs. Although some chiropractic programs provide robust jurisprudence or ethics or business management course(s), no one program provides a robust program in all three.

Although there has not been shift toward a standardized or model JEB curriculum, the results of this comparative audit may facilitate various processes that ultimately lead to a standardized or model JEB curriculum in terms of course structure, topics, methods of delivery and evaluation that all chiropractic programs can adopt.

Acknowledgment

The author would like to thank Dr. Kent Stuber for his invaluable editorial suggestions during the preparation of this manuscript for publication.

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Appendix 1.
Literature search strategy

Searched PubMed using following MeSH terms, filtered 'best match'

| | |
|----|---|
| A. | Jurisprudence |
| | (((((“Curriculum”[Mesh]) OR (“Models, Educational”[Mesh])) OR (“Teaching”[Mesh]) OR “Education”[Mesh])) |
| | AND (((“Students, Medical”[Mesh]) OR (“Education, Medical”[Mesh])) OR (“Students, Health Occupations”[Mesh])) |
| | AND (“Jurisprudence”[Mesh]) OR (law*[Title/Abstract] OR legal*[Title/Abstract])) |
| B. | Ethics |
| | (((((“Curriculum”[Mesh]) OR (“Models, Educational”[Mesh])) OR (“Teaching”[Mesh]) OR “Education”[Mesh])) |
| | AND (((“Students, Medical”[Mesh]) OR (“Education, Medical”[Mesh])) OR (“Students, Health Occupations”[Mesh])) |
| | AND (((“Ethics”[Mesh]) OR (“Ethics, Clinical”[Mesh])) OR (“Ethics, Business”[Mesh]) OR (“Ethics, Medical”[Mesh])) |
| C. | Business |
| | (((((“Curriculum”[Mesh]) OR (“Models, Educational”[Mesh])) OR (“Teaching”[Mesh]) OR “Education”[Mesh])) |
| | AND (((“Students, Medical”[Mesh]) OR (“Education, Medical”[Mesh])) OR (“Students, Health Occupations”[Mesh])) |
| | AND (((“Practice Management”[Mesh]) OR (“Entrepreneurship”[Mesh])) OR (“Small Business”[Mesh]) OR (“Commerce”[Mesh])) |

CARLoquium 2022

Chiropractic Academy for Research Leadership (CARL)
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The Chiropractic Academy for Research Leadership (CARL) is an innovative program that provides mentorship, training, and leadership opportunities to the next generation of chiropractic researchers through an open application process. The first CARLoquium was launched by in 2021 by the CARL Fellows as a means to meet and disseminate research findings from the chiropractic community during the COVID-19 pandemic with the second CARLoquium held virtually in March 2022. To date, the conference has featured numerous keynote speakers, hundreds of abstracts and continues to provide a cost-effective avenue for our researcher community to gather.

(JCCA. 2022;66(2):202-219)

KEY WORDS: chiropractic, research

Travaux d'un congrès
Le Chiropractic Academy for Research Leadership (CARL) est un programme novateur qui offre un mentorat, une formation et des débouchés de leadership à la prochaine génération de chercheurs en chiropratique grâce à un processus d'application ouverte. Le premier congrès du CARL a été lancé en 2021 par ses membres pour faire part des résultats des recherches effectuées par la communauté de chiropratique au cours de la pandémie de COVID-19, le deuxième congrès s'étant tenu virtuellement en mars 2022. Jusqu'à maintenant, de nombreux conférenciers d'honneur ont été invités et des centaines de résumés ont été présentés au congrès qui continue d'être une façon abordable de rassembler la communauté de chiropratique.

(JCCA. 2022;66(2):202-219)

MOTS CLÉS : chiropratique, recherche

Emergency department care for older adults diagnosed with low back pain

Katie de Luca, PhD¹

Gustavo Machado, PhD²

Andrew McLachlan, PhD³

Chris Maher, BAppSc, PhD, DMedSc²

Background: *In Australian emergency departments (ED), 30% of all back pain presentations are for older adults. Relatively little is known about the care that this population receives during an ED stay, including admission to hospital.*

Aim: *To describe the ED management of older adults diagnosed at discharge with a lumbar spine condition and to determine predictors of healthcare use in this population.*

Methods: *A retrospective analysis of electronic medical record data of adults aged ≥ 65 years were diagnosed on discharge, with a lumbar spine condition. Demographic, clinical care and costs data were extracted from Sydney Local Health District Targeted Activity and Reporting System; with descriptive analyses and multilevel mixed-effects logistic regression models performed.*

Results: *There were 4,093 presentations to EDs, with most being female (58.3%). Across all lumbar spine discharge diagnoses, 39.9% had some form of lumbar imaging and 34.1% were subsequently admitted to hospital. The most commonly administered pain-relieving medicines were opioid analgesics (67.1%), followed by paracetamol (63.9%) and NSAIDs (33.0%). Predictors of healthcare utilisation and hospital inpatient admission were receiving received a laboratory test and receiving any opioid. For 1,648 lumbar spine diagnoses in 2019-20, the mean (SD) total cost of care per presentation was \$5,629 (\$11,982).*

Conclusions: *There were more than 4,000 presentations to EDs by an older adult with low back pain of lumbar spine origin. Opioid analgesics were the most commonly administered pain medication, and more than half of all patients received combined opioids and paracetamol. Alternative pathways of care to minimise ED presentations are needed, alongside the development and implementation of new models of care in pre-hospital and post-hospital settings.*

¹ CQUniversity, Brisbane, Australia

² Institute for Musculoskeletal Health, University of Sydney, Sydney, Australia

³ Sydney Pharmacy School, University of Sydney, Sydney, Australia

Preliminary results from the BACK Complaints in the Elderly: Chiropractic – Australia study. A cohort profile

Katie de Luca, PhD¹

Simon French, PhD²

Anika Young¹

Objective/Aim: *One in seven adult chiropractic patients are aged >65 years and of these, 60% present with a back problem. The aim of the BACK Complaints in the Elderly: Chiropractic – Australia study is to examine the clinical course of LBP in older adults who seek chiropractic care.*

Methods: *The study design was a 12-month, prospective longitudinal cohort study. Inclusion criteria was a 'new' episode of LBP. Questions about sociodemographic factors, lifestyle characteristics, health, pain, functional status, cognition, adverse events, medications, satisfaction with chiropractic and quality of life were asked at baseline and at follow up (2 and 6 weeks and at 3, 6, 9 and 12 months). Longitudinal SMS pain data was cap-*

¹ CQUniversity, Brisbane, Australia.

² Macquarie University, Sydney, Australia

ured daily for two weeks and then weekly for 11.5 months. Descriptive statistics will report the cohort profile.

Results: 226 chiropractic patients were enrolled into the study, with 52.4% female and a mean age of 67.6 (s.d. 8.6) years. Only 7.9% reported LBP for the first time, and 65.0% described pain that extended into the lower limb. At baseline, mean VAS for LBP at baseline was 4.2 (s.d. 2.5) and the highest proportion for ODI scores was 48% for moderate disability. The STarT back question-

naire identified 41.9% of participants as having low risk of chronicity.

Discussion: At baseline, more than 90% of older adults with LBP had a past history of LBP, disability levels were high and lower limb pain was common. As we finish 12 month longitudinal data collection, the study will allow a better understanding of the demographics, clinical course and predictors of LBP in older adults.

Exploration of chiropractic students' motivation toward the incorporation of new evidence on chiropractic maintenance care

Katherine A Pohlman, DC, MS, PhD¹

Kent J Stuber, DC, MSc, PhD²

Zakary Monier, MS¹

Adam Browning, MS¹

Christopher Malaya, DC, PhD(c)¹

Vanessa Morales, DC, MS¹

Ryan Muller, BS¹

Per Palmgren, DC, MMedEd, PhD³

Leon Tom, DC¹

Andreas Eklund, DC, PhD³

Background: Chiropractic maintenance care (ChiroMC) refers to the long-term care strategies introduced when a majority of clinical benefit has been reached from standard treatments. Previous work has systematically investigated the indications, content, and frequency of ChiroMC and found that low back pain patients can be subgrouped by psychological characteristics. Further, given the wide range of outcomes between these groups, the application of ChiroMC in clinical practice needs to be executed with these groupings in mind. The MAINTAIN tool was developed to assist in classifying patients into their subgroup in clinical settings. This study was designed to explore the optimal way to train chiropractic students on the use of the MAINTAIN tool.

Objective: To explore final year students' attitudes towards incorporating new ChiroMC-focused evidence.

Methods: This layered, mixed-method, inductive ap-

proach explored students' attitudes towards incorporating new ChiroMC-focused evidence with surveys, monologues, dialogues, and qualitative feedback from chiropractic students at Parker University (Dallas, TX, USA) between January 2021 to November 2021. This study asked all 5th – 10th trimester students (n=563) to complete a quantitative questionnaire that evaluated their attitudes/understanding of patient-centeredness (PPOS) and chronic pain (HC-PAIRS), as well as their current perspectives on incorporating evidence. The qualitative components began with four open-ended, reflective questions sent to all 8th and 9th trimester students (n=215). This was followed with individual semi-structured interviews with students theoretically sampled to further explore responses to the reflective questions. The final phase consisted of one-on-one semi-structured interviews developed from the previous phase with a theoretical sampling of students used again. Descriptive statistics were used to summarize the quantitative questionnaire. For the qualitative phases of the study, responses to the open-ended responses and

¹ Parker University, Dallas, USA.

² Canadian Memorial Chiropractic College, Toronto, Canada.

³ Karolinska Institutet, Stockholm, Sweden

semi-structured interviews were reviewed by multiple team members. Codes and themes were generated for the responses with team members meeting to determine coding agreement and establishing a coding tree.

Results: The qualitative questionnaire was completed by 74.4% of students (n=419). The majority of students had already received their bachelor's degree (84.5%), were male (57.5%), and had a mean grade point average of 3.15 (SD:0.369). Evidence perspectives were diverse: Biomechanical, n=140(33.4%), General Problem/Biomechanical, n=18(4.3%); Biomechanical/Organic Visceral, n=6(1.4%); General Problems, n=110(26.3%); Somatic Dysfunction, n=49(11.7%), Vertebral Subluxation, n=96(22.9%). The PPOS (1-6; high score desired) had a mean score of 3.9 (range: 1.72-5.17) and the HC-PAIRS (1-7; low score desired) had a mean score of 4.2

(range: 2.20-6.27). Concepts identified through the qualitative phases included the need to facilitate basic understanding of MC terminology. There was a large emphasis on the impact of the supervising clinicians' role on discussing evidence, seeing evidence in-action, and how to continue learning after graduation. Interviews identified the need to establish that research is something that builds education and experience, not simply an addition to education, along with the need to increase student's research literacy/confidence.

Discussion: As the MAINTAIN tool is furthered explored to assist with treatment plan development, key concepts from this study may assist with optimizing training strategies, including operationally defining terminology, involving instructors who are fundamental to students' training, and increasing research literacy.

Pressure pain thresholds in a real-world chiropractic setting – topography, changes after treatment, and clinical relevance?

Casper G Nim, PhD¹

Sasha Aspinall, PhD²

Rasmus Weibel, MSc¹

Martin G Steenfelt, MSc¹

Søren O'Neill, PhD¹

Background: Changes in pain sensitivity, as indicated by pressure pain thresholds (PPT), are a commonly suggested mechanism for the pain relief often experienced following spinal manipulative therapy (SMT). While there is agreement that PPT increases systemically, and more so at the SMT site, the research has primarily been conducted in highly experimental setups and often using an asymptomatic population. The clinical relevance of PPT changes following SMT is unclear, as many important factors differ between experimental and clinical setups. Therefore, we investigated PPT before and after chiropractic care in a clinical setting (in which we expected patients to receive SMT) and investigated relationships with various potentially clinically-relevant factors.

Methods: We recruited participants from four Danish chiropractic practices between May and August of 2021. A total of 129 participants (72% of the invited) were included. We measured PPT at eight pre-determined test sites (six spinal and two extra-spinal) immediately before the chiropractic consultation (pre-session) and immediately after (post-session). We used linear regression approaches to investigate the PPT changes in relation to the following factors: i) segmental distance to the nearest SMT site, ii) rapid clinical response, and iii) number of SMTs performed.

Results: All participants received one or more SMT treatments (range 1 to 12) as we expected. The mean before/after PPT change was 0.14 Kg (95% confidence intervals = -0.01 to 0.29). No significant associations were found in relation to distance between the PPT test site and nearest SMT site, the clinical response of participants to treatment, or the total number of SMTs performed.

¹ Medical Research Unit, Spine Center of Southern Denmark, University Hospital of Southern Denmark, Middelfart, Denmark.

² College of Science, Health, Engineering and Education, Murdoch University, Perth, Australia

Discussion: *This real-world trial of private practice chiropractic patients receiving SMT failed to demonstrate a substantial systemic increase in PPT following the clinical encounter. None of our selected a-priori factors were*

correlated with PPT changes. This is not in line with previous publications and questions the generalizability of using highly experimental setups to determine the neurophysiological mechanism of SMT in a clinical setting.

What does spinal manipulative therapy specificity mean to you? An international survey of chiropractors

Casper G. Nim, PhD¹

Robert J. Trager, DC²

Martha Funabashi, PhD³

Henrik H. Lauridsen, PhD⁴

Søren O'Neill, PhD¹

Stephen Perle, DC, MS⁵

Greg Kawchuk, DC, PhD⁶

Introduction: *Chiropractors often use spinal manipulative therapy (SMT) to manage spinal pain. In order to apply SMT, chiropractors may undertake several steps, starting with attempting to locate a clinically relevant site to provide SMT. This is followed by applying a specific force to that site, often in a precise direction (i.e., the thrust vector), and finally inducing a specific local force to the site (e.g., movement in the vertebral motion segment). It is believed that these steps are indicators for the clinical effect of SMT and could be labeled as providing “specific” SMT. However, recent research has called the validity of the specific identification and application of SMT into question. Nevertheless, chiropractors appear to value specificity in SMT but the term may mean different things to different people as it has not been explored previously by research. We aim to understand what SMT specificity means for chiropractors globally and how the chiropractic profession values concepts of SMT specificity.*

Methods (preliminary): *We will develop a survey that*

examines both the meaning and perceived importance of SMT specificity for chiropractors as a function of their role in healthcare. The survey will be developed as follows: i) We will search the literature for systematic reviews relating to SMT and SMT procedures in PubMed and Epistemonikos. The results will be manually screened according to the inclusion and exclusion criteria. Inclusion criteria are systematic reviews of trials investigating “specificity terms” or “effects” of SMT. We will then extract information regarding SMT procedures, application site, technique, and clinical effects from included studies. These items will provide the initial framework for the items included in the survey. Next, a consensus of relevant items to include will be decided by a team of SMT experts (chiropractors, researchers, and the author team). The survey will be piloted on volunteer chiropractors. We will translate it to relevant languages using Beaton’s cross-cultural adaptation technique modified version. This survey will also include items related to chiropractors’ perceived role in the health care system and provider characteristics according to the Institute for Alternative Futures grouping. We expect to invite Chiropractors from registered National Associations in including Denmark, Norway, Sweden, Canada, the United States, Australia, and Switzerland. Data will be reported descriptively and will report on how SMT specificity can be defined and what it means to clinicians and regressions models will

¹ Spine Centre of Southern Denmark, Middelfart, Denmark.

² Connor Whole Health, University Hospitals Cleveland Medical Center, Cleveland, USA.

³ Division of Research and Innovation, Canadian Memorial Chiropractic College, Toronto, Canada.

⁴ Department of Sport Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark.

⁵ School of Chiropractic, College of Health Sciences, University of Bridgeport, Bridgeport, USA.

⁶ Department of Physical Therapy, University of Alberta, Edmonton, Canada

be used to determine if the perceived role in healthcare is associated with the importance of SMT specificity.

Discussion: This will be the first study to assess chiropractors' perceptions of SMT specificity. The results will

illustrate what clinicians consider SMT specificity to represent and its importance. The outcomes from this study could inform future trials relating to providing specific SMT and how this should adequately be designed.

Diversity of the chiropractic profession in Canada: a cross-sectional survey of Canadian Chiropractic Association members

Danielle Southerst, DC¹

Nora Bakaa, DC, MSc²

Pierre Côté, DC, PhD¹

Luciana Macedo, PT, PhD²

Lisa Carlesso, PT, PhD²

Joy MacDermid, PT, PhD³

Silvano Mior, DC, PhD^{1,4}

Background: Despite rapidly increasing diversity of the Canadian population, there is no available data on the diversity of the chiropractic profession with respect to gender, sexual orientation, race, ethnicity and community of practice. Diversity provides a foundation for culturally competent care delivery at the provider level and is paramount in the pursuit of a culturally congruent model of chiropractic care.

Objective: To explore the diversity of the Canadian chiropractic profession.

Methods: All registered members of the Canadian Chiropractic Association (N=7721) were invited to participate in a web-based survey between May and June 2021. Survey questions explored diversity with respect to personal demographics (age, sex, gender, sexual orientation, race, ethnicity, language) and practice characteristics (community setting, practice type).

Results: We received a total of 3143 survey responses (response rate – 41%). The average age of chiropractors in our sample was 44.7 years (standard deviation (SD) 12.7). Forty-five percent of chiropractors surveyed were female with the same proportion (45.2%) identifying as women. Ninety-one percent of the sample identified as

heterosexual. With respect to race, 78% of respondents were Caucasian. Seventy percent of chiropractors in our sample identified themselves as ethnically Canadian and 29% were European. In comparison to the Canadian population, most visible minorities were underrepresented. This was most pronounced for Black and Indigenous chiropractors. With respect to ethnicity, chiropractors who were Canadian, American or from Oceania were overrepresented in our sample compared to others, specifically North American Indigenous, Caribbean, and South, Central and Latin American ethnicities. Sixty-one percent of chiropractors practiced within a major city and most work in interdisciplinary clinics (42% complementary and 33% rehabilitation).

Discussion: This study provides an initial description of diversity within the chiropractic profession in Canada. Although women make up nearly half of the profession nationally, very few identify as a gender minority. Overall, there is little racial and ethnic diversity in the profession compared to the Canadian population, with Black and Indigenous peoples underrepresented. This study provides a foundation for future work exploring provider-level attributes that contribute to cultural competence. Future work should focus on patient-level attributes and assess the activities of professional organizations and institutions in support of equitable delivery of chiropractic care.

This research was funded by the Canadian Chiropractic Association.

¹ Institute for Disability and Rehabilitation Research, at Ontario Tech University

² School of Rehabilitation Sciences, McMaster University

³ School of Physical Therapy, Western University

⁴ Division of Research, Canadian Memorial Chiropractic College

Attitudes, beliefs, and recommendations for chronic low back pain patients: cross-sectional surveys of a chiropractic teaching clinic

Ryan D. Muller, BA¹

Jesse C. Cooper, DC²

Jordan A Gliedt, DC³

Katharine Pohlman, DC, MS, PhD¹

Background: *Attitudes and beliefs of providers have an influence on patient outcomes. Despite the prevalence of chiropractors' confidence and engagement in the care of spine and chronic pain conditions, chiropractors' attitudes and beliefs related to chronic spine pain and its impact on patients are not fully known. The attitudes and beliefs of chronic low back pain (CLBP) patients in chiropractic students and faculty has also not been evaluated.*

Objective: *To assess attitudes and beliefs of students and faculty of a chiropractic teaching institution in 2018 and 2020 regarding CLBP and evaluate their recommendations for work and activity in vignettes of patients with CLBP.*

Methods: *The Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) and clinical vignettes were requested to be completed by chiropractic faculty and all students at Parker University in April 2018 and July-December 2020. The HC-PAIRS is a 15-item measurement tool developed to assess the attitudes and beliefs of health care providers regarding functional expectations for patients with CLBP and 4 factors (Functional Expectations, Social Expectations, Need for Cure, Projected Cognition). It has been shown to be a valid and reliable assessment tool for HCPs using a 1-7 point rating scale. The higher the score, the stronger the belief that CLBP justifies disability and the limiting of activities. Similarly, the 3 clinical vignettes have been found to be valid ways to explore physicians' recommendations regarding work and activity levels for CLBP patients.*

Results: *Response Rate: Student response rates in 2018 and 2020 were 497/781=63.6% and 325/1176=27.6%. Faculty were 23/30=76.7% and 22/53=41.5%, respectively. HC-PAIRS Results: Both students (2018=4.41, 2020=4.42) and faculty (2018=3.66, 2020=3.49) had a slight decrease in scores with students' decrease being*

statistically significant (mean change=0.19, $p<0.05$) but not the faculty's score decrease (mean change=0.17, $p=0.55$). Faculty did have statistically significantly lower scores than students both years ($p<0.05$). In both years, faculty had lower scores than students in all factors except for Projected Cognition in 2020 (faculty=5.45, student=5.36). Both faculty and student scores decreased for Functional Expectations (faculty=3.51,3.14; student=4.36,4.11) and Need for Cure (faculty=3.38,3.02; student=4.41,4.00). Faculty scores increased for Social Expectation (3.14,3.26) and Projected Cognition (5.00,5.45) and scores did not change for students. Clinical Vignette Results:

The percentage of faculty that provided adequate activity (62.1%,66.7%) and work (41.0%,45.5%) recommendations increased from 2018 to 2020, but were not statistically significant. The percentage of students that provided adequate activity recommendations decreased (33.9%,30.3%), while adequate work recommendations increased (22.1%,23.8%); both were not statistically significant.

Discussion: *This initial exploration of students and faculty at a chiropractic teaching institution's attitudes and beliefs of CLBP patients found student mean scores (4.22-4.41) to be on the higher end of other published health-care professional students' scores (3.49-3.66). Faculty mean scores (3.49-3.66) were also on the higher end of HC-PAIRS scores from HCP's scores (2.58-3.80).*

Response rates in 2020 were much lower due to COVID. While spurious decreases occurred, they were not clinically meaningful. Future work should investigate specific strategies to modify attitudes and beliefs regarding CLBP and assess if these changes do enhance patient outcomes.

¹ Parker University, Dallas, Tx, USA

² Baylor Stott and White Health, Round Rock, USA

³ Medical College of Wisconsin, Milwaukee, USA

Dosing of lumbar spinal manipulative therapy and its association with care escalation: an analysis of insurance claims

Brian Anderson, DC, MPH, PhD¹

Steve McClellan, MS²

Background: *Dose-response for chiropractic care has been studied clinically in relation to low back pain (LBP), neck pain and headache. However, the relationship between dose of spinal manipulative therapy (SMT) and healthcare utilization from a health services perspective has yet to be investigated.*

Methods: *Our cohort consisted of LBP related episodes from an insurance claims database representing the covered members (≥ 18 years) of a large fortune-500 company (2012-2018). Episodes of care were identified by 90 day claim free periods, and only the initial episode of care was included. Procedure codes 98940-98942 were used as markers for SMT. Care escalation was defined as the presence of one or more of the following: Imaging (x-ray, MRI, CT scan); Injection procedure; Emergency Department (ED) visit; Opioid medication fill; Surgical procedure. Escalation included the presence of any of these procedures. Age, gender, allowed insurance reimbursement, claim count and risk score were collected for each episode and included as covariates in modified Poisson*

regression models to estimate relative risk (RR) of care escalation based on SMT dose.

Results: *A total of 11,114 low back episodes were identified and included in our analysis. Four SMT dosing groups were identified: (1) no SMT (n= 8,137); (2) one SMT visit (n=404); (3) 2-12 SMT visits (n=1,763); (4) 13 (+) SMT visits (n=810). After adjusting for covariates, and using group 1 as the reference: SMT group 2 was associated with the lowest risk of imaging (RR 0.56, 95% CI 0.45-0.69), ED visits (RR 0.06, 95% CI 0.01-0.23), Opioid medication fills (RR 0.39, 95% CI 0.23-0.66) and any escalation (RR 0.46, 95% CI 0.38-0.55); SMT group 3 was associated with the lowest risk of injections (RR 0.32, 95% CI 0.26-0.40) and surgery (RR 0.45, 95% CI 0.33-0.62); SMT group 4 was associated with an increased risk of imaging utilization (RR 1.39, 95% CI 1.27-1.52).*

Conclusions: *With few exceptions, SMT dose ≥ 1 showed a protective effect against the use of imaging studies, injections, ED visits, surgery, opioid medications, and any escalation when compared to no SMT. These results provide important information to practitioners and policy-makers regarding the impact of SMT dose on healthcare utilization.*

¹ Palmer Center for Chiropractic Research, Palmer College of Chiropractic, Davenport, USA.

² Integrative Musculoskeletal Care, Tallahassee, USA

Musculoskeletal comorbidities of chronic low back pain participants presenting to U.S. Veterans Health Administration chiropractic clinics enrolled in a randomized clinical trial

Gregory Roytman, DC^{1,2}

Christine Goertz, DC, PhD³

Cynthia Long, PStat, PhD⁴

Anthony Lisi, DC^{1,2}

¹ Yale Center for Medical Informatics, Yale School of Medicine, New Haven, CT

² VA Connecticut Healthcare System, West Haven, CT

³ Department of Orthopedic Surgery, Duke University School of Medicine, Durham, NC

⁴ Palmer Center for Chiropractic Research, Davenport, IA

Background: *Previous work has shown increased prevalence of musculoskeletal comorbidity (MSKC) in chronic low back pain (cLBP) participants. However, the specific types of MSKCs have not yet been described. There has equally been little inquiry into MSKC among participants presenting to chiropractic care.*

Objective: We aim to describe the prevalence and type of MSKC in cLBP participants presenting to chiropractic clinics in the Veterans Health Administration (VHA) of the United States who are enrolled in an existing randomized clinical trial.

Methods: A descriptive analysis of EHR data from participants enrolled in a multi-site pragmatic clinical trial on cLBP (Veterans Response to Dosage in Chiropractic Therapy [VERDICT]) in the VHA between February 1, 2021 and December 31, 2021. International Classification of Diseases 10th Edition (ICD-10) codes were collected for each participant using a 12-month lookback relative to each participant's date of enrollment across four VHA chiropractic clinics. We defined categories of MSKCs using previously established lists of musculoskeletal diagnoses: neck, mid-back, upper extremities, lower extremities, headache, and non-regional musculoskeletal

complaints. Non-regional musculoskeletal complaints included ICD-10 codes ranging from myalgia to Chronic Pain Syndrome and Fibromyalgia. Participant placement in MSKC categories was not mutually exclusive.

Results: During the time-period, 154 participants were enrolled in the study. Of these 6.5% had 0 MSKCs, 40.9% had 1-2, 40.9% had 3-4, and 11.7% had 5-6. Non-regional MSKCs were identified in 68.2% of participants, lower extremity in 63.0%, upper extremity and mid-back in 35.7%, neck in 34.4%, and headache in 34.7%.

Conclusion: Consistent with existing literature, cLBP participants enrolled in the VERDICT clinical trial had MSKCs in large percentages, with only a small minority not having any MSKCs. Therefore, consideration of MSKCs may be important for diagnosis and management of cLBP participants.

Descriptive comparison of force-time profiles of diversified and terminal point technique measured with a novel hand-held force sensing load cell: a protocol design

Luke Ross, MChiro¹
Katie De Luca, PhD²
Mike Swain, PhD¹
Martha Funabashi, PhD³
Steven Tran, MSc³
David Starmer, DC, MHS³
Aron Downie, PhD¹

Background: Low back pain and other musculoskeletal conditions are among the leading causes of disability globally. Chiropractic utilises high velocity, low amplitude spinal manipulative therapy (HVLA SMT) to treat a range of musculoskeletal and health related conditions. HVLA SMT plays a central role in pain management as it has been shown to decrease pain and improve function. Quantifying forces delivered during HVLA SMT (force-time profile) is important when considering the efficacy of therapy and safety of the patient. Chiropractors apply

a range of manipulative techniques, but it is unknown how technique choice influences the force-time profile of the HVLA thrust. Previous studies have quantified HVLA SMT, but have used multiple measurement devices, varied sensor placement, and heterogeneous study designs, making technique comparison difficult. The use of a single sensing device across different techniques under controlled conditions will solve this issue.

Aim: To descriptively compare two styles of high velocity low amplitude spinal manipulative therapy commonly used by chiropractors, using a novel measurement device.

Methods: A hand-held force sensing load cell ("puck") will be used to measure HVLA SMT thrusts delivered by

¹ Macquarie University, North Ryde, Australia

² Central Queensland University, Brisbane, Australia

³ CMCC, Toronto, Canada

three experts upon a mannequin. Experts (participants) are registered chiropractors/educators who have a minimum five years of clinical experience in Diversified and terminal point technique (TPT). The puck will be positioned on the mid “thoracic” region of a prone mannequin upon a standard treatment table. The puck will be positioned between the participant’s hand and the mannequin. Participants will deliver 10 Diversified thrusts to the mannequin. Participants will then deliver 10 TPT thrusts on the mannequin while positioned on a “drop” treatment table. The drop piece within the table is raised (approximately 20mm) to the “cocked” position before each TPT thrust. Measurement outcomes are key parameters of the force-time profile. For each thrust (60 total) the following parameters will be recorded: mean preload force (N), take off force (N), loading rate (N/ms), total peak force (N) and duration (ms). The mean of each set

of 10 force-time profiles will be described and compared between each technique.

Expected results: It is expected the force-time profiles of Diversified and TPT thrusts will differ. Additionally, it is hypothesised force-time profiles will differ between participants. It is anticipated that the Diversified-thrust will generate larger total peak forces, while TPT-thrust will generate a greater loading rate and have two force peaks; the first due to practitioner thrust and the second from the drop table reaction force.

Conclusion: The use of a novel hand-held puck will allow the measurement and comparison of force-time profiles between different HVLA SMT styles due to its portability. By using a single measurement device in future studies, we may gain insight into clinical effect based on different force-time profiles.

Association of chiropractic integration in a Canadian community health centre with prescription of opioids for non-cancer spinal pain: a mixed methods analysis

Peter C. Emary, DC, PhD(c)^{1,2,3}

Amy L. Brown, DC³

Mark Oremus, PhD^{1,4}

Lawrence Mbuagbaw, MD, PhD^{1,5,6,7}

Douglas F. Cameron, DC³

Jenna Didonato, HBSc (Kin)²

Jason W. Busse, DC, PhD^{1,8,9,10}

Background: Opioids are commonly prescribed in North

America to relieve musculoskeletal pain and improve function. However, opioids provide only modest benefits and are associated with important harms including addiction, overdose and death.

Objective: We undertook a mixed methods analysis to examine the association between receipt of chiropractic services in a Canadian community health centre (CHC) and opioid prescriptions among adult patients with non-cancer spinal pain.

Methods: We used a sequential explanatory mixed methods design. In the quantitative phase, we conducted a retrospective cohort study of all electronic medical records of recipients and non-recipients of chiropractic services at the Langs CHC in Ontario, Canada between January 1, 2014 and December 31, 2020. We used Cox proportional hazards regression analyses to evaluate the

¹ Department of Health Research Methods, Evidence and Impact, McMaster University, Hamilton, Ontario, Canada

² Chiropractic Department, D’Youville College, Buffalo, New York, USA

³ Private Practice, Cambridge, Ontario, Canada

⁴ School of Public Health and Health Systems, University of Waterloo, Waterloo, Ontario, Canada

⁵ Biostatistics Unit, Father Sean O’Sullivan Research Centre, St. Joseph’s Healthcare-Hamilton, Hamilton, Ontario, Canada

⁶ Centre for the Development of Best Practices in Health, Yaoundé, Cameroon

⁷ Division of Global Health, Stellenbosch University, South Africa

⁸ Department of Anesthesia, McMaster University, Hamilton, Ontario, Canada

⁹ Michael G. DeGroote National Pain Centre, McMaster University, Hamilton, Ontario, Canada

¹⁰ Chronic Pain Centre of Excellence for Canadian Veterans, Hamilton, Ontario, Canada

association between receipt of chiropractic care and time to opioid prescription, adjusted for patient demographics, co-morbidities, visit frequency, and calendar year. In the qualitative phase, we conducted one-on-one interviews with patients and general practitioners (GPs) to explore perceptions of chiropractic integration and its impact on opioid prescribing. Qualitative data were coded and analyzed using content and thematic analysis and integrated with our quantitative findings.

Results: We extracted data from 945 eligible patient records and completed 23 interviews (14 patients, 9 GPs). Over our 7-year study period, 24% of patients (227 of 945) with non-cancer spinal pain received an opioid prescription. The risk of receiving opioids was 52% lower in chiropractic recipients versus non-recipients (adjusted hazard ratio [aHR] = 0.48; 99% confidence interval [CI], 0.29 to 0.77) and 71% lower in patients who received chiropractic services within 30 days of their index visit (aHR = 0.29; 99% CI, 0.13 to 0.68). Patients whose index

visit date was in a more recent calendar year were less likely to receive opioids (aHR = 0.86; 99% CI, 0.76 to 0.97). Higher frequency of visits (aHR = 1.02; 99% CI, 1.02 to 1.03), older age (aHR = 1.02; 99% CI, 1.01 to 1.04), smoking (aHR = 1.62; 99% CI, 1.12 to 2.35) and depression (aHR = 1.77; 99% CI, 1.20 to 2.61) were positively associated with receipt of opioids. Follow-up interviews suggested that self-efficacy, access to chiropractic services, opioid stigma, and desire for pain relief were important influencing factors.

Conclusion: Our analysis found that patients with spine pain who received chiropractic care were less likely to receive opioids than patients who did not receive chiropractic care. Four themes emerged in our qualitative interviews to help provide a richer understanding of this association. A multi-stage, mixed methods randomized controlled trial is needed to verify our findings and establish causality between these variables.

Characteristics of chronic musculoskeletal pain sufferers treated in a university-affiliated complementary and integrative health care clinic

Cheryl L. Lyon, ND¹

Kena A. McDermott, DC¹

Kimberly M. Sanders, ND¹

Tina M. Freilicher, PhD²

Mark H. Pitcher, PhD²

Background and objective: Chronic pain is a substantial driver of high health care costs and disability, especially among certain demographic and socio-economic groups. Indeed, disparities in the experience and treatment of pain based on age, sex and race are significant. A host of factors, including nutrition and inherited genetic polymorphisms may contribute to these disparities. Considering that patients seeking complementary and integrative health (CIH) approaches for chronic pain are dramatically under-studied, we assessed the role of nutritional, genetic and other factors in a sample of chronic

musculoskeletal (MSK) pain sufferers from a unique patient population seeking complementary and integrative health (CIH) care at an urban university-affiliated clinic.

Methods: A total of 99 eligible participants were recruited from the University of Bridgeport (UB) Clinics. We assessed participant demographics, medical histories, pain frequency and severity, and administered a validated food frequency questionnaire assessing omega-3 polyunsaturated fatty acid (PUFA) intake. Whole blood fatty acids and fatty acid desaturase (FADS) rs174537 polymorphism status were also measured.

Results: Participants with chronic pain were significantly older, and more likely to report White race and use of omega-3 fatty acid supplements. Women reported significantly greater pain severity and exhibited higher levels of linoleic acid (LA) and lower levels of arachidonic

¹ School of Chiropractic, College of Health Sciences, University of Bridgeport, Bridgeport, Connecticut, USA

² College of Health Sciences, University of Bridgeport, Bridgeport, Connecticut, USA.

acid (AA). Additionally, cervicgia was approximately twice as prevalent in women, whereas low back pain was approximately twice as prevalent in men. Blood saturated fatty acids (SFA) were significantly lower and mono-unsaturated fatty acids (MUFA) were significantly higher in the chronic pain group. Supplement users reported significantly less pain interference with life enjoyment and had higher levels of total and individual omega-3 PUFA, SFA and trans-fatty acids (TFA), and lower levels of total and individual omega-6 PUFA. FADS rs174537 genotypes were not associated with pain status.

Conclusion: To our knowledge, we are the first to describe characteristics of chronic MSK pain sufferers in an urban, university-affiliated CIH population. Our findings indicate pain disparities based on age, sex and race, and alterations in blood fatty acids in this unique population. Additionally, while usage of omega-3 fatty acid supplements did not appear to affect pain frequency or overall pain severity, it may have beneficial impact on perception of chronic pain with quality of life, however; concerns of supplement contamination require further study.

A comprehensive set of systematic reviews of the literature on mechanisms of spinal manipulation, specifically on: i) objectively measured anatomical/biomechanical changes related to spinal manipulation, ii) objectively measured physiological changes related to spinal manipulation, and iii) clinical effects related to spinal manipulation

Kenneth J Young, DC, PhD¹
 Charlotte Leboeuf-Yde, PhD
 Cecilia Bergström, PhD
 Iben Axen, PhD
 Petra Schweinhardt, PhD
 Catherine Harris, MS
 Steven Vogol, PhD
 Roger Kerry, PhD
 Olivier Gagey,
 Amber Beynon, PhD
 Kenneth Chance-Larsen, PhD
 David Evans, PhD
 Vasileios Georgopoulos, PhD
 Guillaume Goncalves, PhD
 Lindsay Gorrell, PhD
 Steen Harsted, PhD
 Nathan Hutting, PhD
 Edward Lee, PhD
 Christopher McCarthy, PhD
 Casper Glissman Nim, PhD
 Luana Nyirö, PhD

Background: *In order to understand the way any therapy works, three elements need to be scientifically studied: 1)*

the anatomical/biomechanical/physiological responses in the human body objectively measured after the therapy is applied, 2) clinically relevant effects as demonstrated through validated outcome measures, and 3) the

¹ University of Central Lancashire, Preston, United Kingdom.

link between the two, i.e. determining whether and how an anatomical/physiological change translates to clinical effects. This generally requires a reductive approach, isolating the “active ingredient” in the therapy by discarding any unnecessary non-active ingredients. This also holds true for manual therapy, specifically joint manipulation, if manipulation is to be given the credit for clinical improvement in patients. Although many mechanisms for the clinical effects have been proposed, none have become well-established, and there is a paucity of strong evidence supporting these. Therefore, it would be useful to understand the current state of the evidence for the effect of spinal manipulation on spine-related anatomical structures and the resultant associations with clinically relevant effects. This, in turn, would help direct future efforts in further developing evidence for manual therapies.

Methods: Systematic reviews of the literature without meta-analysis.

Current status: Review 1 PROSPERO protocol registered, review teams assembled, search terms defined.

Results (hypothesised): Our hypothesis is that there are postural, anatomical and physiological changes in spinal structures as a result of high velocity, low amplitude (HVLA) manipulation, but that an unknown quantity of high-quality research has been conducted that provides definitive links associating clinically significant effects with these changes. We expect to find much fertile ground for future investigations into spinal manipulation.

Conclusions (hypothesised): Ultimately, this understanding will help inform patients as to what happens inside their bodies when their spines are manipulated. It may provide clinicians with better information when discussing therapeutic interventions with patients, so that patients can make better informed choices. The results from this study will also help indicate gaps in knowledge, thus highlighting useful areas for further study.

Proof of concept – automated qualitative scoring of movement patterns using joint center positions collected using motion capture

Steen Harsted, PhD¹

Casper G. Nim, PhD²

James J. Young, DC, PhD¹

Background: Qualitative scoring of movement patterns is a common element in gross motor test batteries for children and adults. The typical procedure in these tests is to have a subject perform a given movement while an examiner observes and subsequently scores the movement by evaluating subject-posture at or between key events (e.g., in forward jumping: +1 point if “Arms are extended in front of the body and above the head at toe-off”). Markerless motion capture makes it possible to easily capture and accurately quantify human locomotion without disturbing the natural movements of the subject being evaluated. Furthermore, most systems can describe subject posture as 3D joint-center positions on a frame-by-frame basis. This makes it possible to create software algo-

ritms that automatically identify key events and evaluate postures for most movements evaluated in popular movement screening batteries. The present work proves the concept of automating the qualitative scoring of standing broad jumps. The work shows how the identification of key events and the subsequent postural evaluation of subjects performing standing broad jumps can be automated using joint center positions and simple algorithms.

Discussion: The proposed method makes it possible to quickly and reliably evaluate large quantities of motion-capture data. However, the technique needs to be fine-tuned and validated before applying it in cohort studies or clinical practice. Furthermore, the accuracy of the automated qualitative scoring algorithm will be limited by the quality of the motion capture data it is applied to.

Perspectives: Primary proposed research: The Motor Skills in PreSchools (MiPS) cohort contains motion capture data of +600 children performing standing broad

¹ University of Southern Denmark, Department of Health Science and Clinical Biomechanics, Odense, Denmark.

² University of Southern Denmark, Department of Regional Health Research, Odense, Denmark

jumps at the ages of 3, 4, 5, and 6 years. If the proposed method proves valid, future research can use it to describe the early locomotor development of jumps in typically developing children. Other potential research: The proposed method of using joint-center positions to break a

movement down to key events and evaluate posture can be applied to a wide range of activities. Therefore, automated scoring of popular screening tests, such as the Functional Movement Screen, are obvious targets for future development of the method.

Assessment of a downloadable application with avatar guidance for PT-prescribed home exercise after total knee arthroplasty: a 30-day feasibility study

Joel Carmichael, DC, PhD¹

Sheryl Flynn, PT, PhD²

Tamara Struessel, PT, DPT¹

Stefano Bini, MD³

Michael Bade, PT, PhD^{1,4}

Jennifer Stevens-Lapsley, PT, PhD^{1,4}

Objective: *To investigate the feasibility, usability, and comparative functional outcomes using app-based (APP) versus paper handouts (CONTROL) to guide home exercises after total knee arthroplasty (TKA).*

Design: *Prospective feasibility study*

Setting: *Rehabilitation laboratories at two regional medical centers*

Participants: *Individuals with knee osteoarthritis undergoing unilateral TKA (APP group: N = 26; mean age, 67.0 ± 8.2y; CONTROL group: N = 31; mean age, 64.7 ± 7.7y)*

Interventions: *This study compared the user experience of a downloadable app-based to guide postoperative home exercises and instruction compared to the same/similar information delivered by paper handouts. All participants used home exercises for 30 days after TKA.*

Main outcome measures: *The System Usability Scale (SUS) score was used to assess patient experience. SUS scores were dichotomized (≥ 72 or < 72) to determine app usability against a 75% a priori criterion for mean APP group score. Feasibility was evaluated by personal com-*

puting device ownership and study use, technology-based barriers to participation, and completion of app-based testing after 30 days. Exploratory measures compared change from baseline to 30 days for functional and patient-reported outcomes between groups to further examine the feasibility of the app in guiding clinical assessments.

Results: *The APP group's mean System Usability Scale (SUS) score of 79.2% at 30 days exceeded the 75% threshold for acceptable usability. The app met two of three predetermined priori criteria for feasibility in the TKA population. Personal computing device use in this study failed to meet the feasibility criterion. No differences between the APP and CONTROL groups were observed for functional or patient-reported outcomes.*

Conclusions: *The app-based platform met the a priori criteria for usability for 79% of APP participants. Our findings suggest that app-based home exercise and education after TKA has acceptable feasibility and usability. The app-guided patient assessment capability also demonstrates preliminary feasibility for guiding and administering functional and self-reported outcomes assessments.*

¹ Department of Physical Medicine and Rehabilitation, School of Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO;

² Blue Marble Health, Altadena, California,

³ Department of Orthopedic Surgery, University of California, San Francisco, CA,

⁴ Geriatric Research Education and Clinical Center, VA Eastern Colorado Healthcare System, Denver, CO.

Fusion versus decompression surgery alone for lumbar degenerative spondylolisthesis: a Bayesian cost-utility analysis protocol

Ines Unterfrauner, MD¹

Miquel Serra Burriel, PhD²

Javier Muñoz Laguna, DC^{3,4}

Nils H. Ulrich, MD¹

Jakob M. Burgstaller, MD DMD PhD^{5,6}

François Porchet, MD⁷

Ilker Uckay, MD¹

Cesar A. Hincapié, DC PhD,^{2,3*}

Mazda Farshad, MD MPH^{1*}

Background: *Lumbar degenerative spondylolisthesis (LDS)—a condition in which there is slippage of one lumbar vertebra in relation to an adjacent vertebra—represents one of the most common spine-related degenerative pathologies worldwide. Despite recent clinical practice guideline efforts across multiple health systems, the comparative cost-utility of fusion versus decompression surgery alone for LDS remains controversial.*

Aims: *To evaluate the cost utility of decompression plus fusion surgery versus decompression surgery alone in patients with Meyerding grade I or II LDS over a 3-year follow-up for the primary outcome, assuming a provider's perspective for the Bayesian cost-utility analysis (CUA) across three health systems (Swiss, UK, US).*

Methods: *The best available randomized clinical trial evidence to-date will be used to compare decompressive laminectomy with laminectomy combined with posterolateral instrumented fusion. Data from the Lumbar Stenosis Outcome Study (LSOS) will also be extracted to complement missing data values from the trials. A Bayesian pref-*

erence-based algorithm will be applied, and quality-adjusted life-years will be calculated from the results of the EQ-5D-3L and the Short Form-36 at baseline and 3-year follow-up after the two surgical interventions. In the absence of EQ-5D-3L utility data, other condition-specific outcome measures with a mapping algorithm will be incorporated into the model. A standard discount rate will be applied for costs and benefits. Direct healthcare costs will be obtained from official country-specific cost per unit prices available for Switzerland, UK, and the US. Probabilistic sensitivity analysis will be performed to assess the robustness of the model.

Relevance: *Given the prevalence of LDS and challenges associated with rapidly ageing populations worldwide, the application of value-based care principles is imperative in orthopedic surgery and healthcare generally. Our Bayesian CUA findings will offer an innovative and standardized mechanism for comparing resource use and health outcomes, and therefore guide surgical decision making in LDS management.*

* Contributing equally as senior authors

¹ Department of Orthopedics, Balgrist University Hospital, University of Zurich, Zurich, Switzerland

² Epidemiology, Biostatistics and Prevention Institute (EBPI), University of Zurich, Zurich, Switzerland

³ Department of Chiropractic Medicine, Faculty of Medicine, Balgrist University Hospital and University of Zurich, Zurich, Switzerland

⁴ Department of Preventive Medicine and Public Health, Faculty of Medicine, Universidad Autónoma de Madrid, Madrid, Spain

⁵ Horten Centre for Patient Oriented Research and Knowledge Transfer, University of Zurich, Zurich, Switzerland

⁶ Institute of Primary Care, University of Zurich and University Hospital Zurich, Zurich, Switzerland

⁷ Department of Orthopedics and Neurosurgery, Schulthess Clinic, Zurich, Switzerland

Knowledge and beliefs questionnaires for musculoskeletal pain conditions: a systematic review protocol

Leticia Amaral Corrêa¹

Stephanie Mathieson, PhD²

Mark Hancock, PhD³

Arianne Verhagen, PhD⁴

Leandro Alberto Calazans Nogueira, PhD⁵

Annie Young¹

Simon French, PhD¹

Background: Identifying patients' knowledge and beliefs about pain is relevant to a patient-centred treatment. The best method of measuring knowledge and beliefs about musculoskeletal conditions is unclear. An overview on measurement properties of available questionnaires to assess knowledge and beliefs about musculoskeletal conditions is lacking.

Objective: To investigate the measurement properties of available questionnaires that measure knowledge and/or beliefs about musculoskeletal conditions.

Methods: A systematic review will be conducted following the CONsensus-based Standards for the selection of health Measurement INSTRUMENTS (COSMIN) guideline. Electronic databases MEDLINE, EMBASE, CINAHL, and Web of Science will be searched. The search strategy will include three groups of search terms representing (1) construct, (2) population, and (3) instrument, in addition to a search filter on measurement properties. The search strategy will be devised in consultation with a librarian and no restriction on language, publication period or publication status will be applied. Citation tracking (in Scopus) of eligible studies and contact with experts will be conducted in order to minimise the risk of missing relevant articles. We will include primary studies of any study design that developed and/or tested measurement properties of self-reported questionnaires assessing knowledge and/or beliefs

about musculoskeletal conditions, targeting people with musculoskeletal conditions or people from the general population. A study will be excluded if the questionnaire was developed and tested exclusively for clinicians or participants with recent trauma history. Search results will be screened by abstract and full text independently by two review authors. Extracted data will include bibliographic details, study characteristics, participants characteristics, questionnaires characteristics, measurement properties results, interpretability, feasibility, and distribution of scores. Authors will be contacted if more information is needed. The methodological quality of included studies will be assessed using the COSMIN Risk of Bias checklist and each item will be scored as "very good", "adequate", reliability (internal consistency, measurement error, and test-retest, inter-rater and intra-rater reliability), validity (content validity including face validity, criterion validity, and construct validity including structural validity, hypotheses testing, and cross-cultural validity), and responsiveness, according to the COSMIN taxonomy definition. The overall assessment of each measurement property of each questionnaire will be classified based on the COSMIN updated criteria. Also, the quality of evidence will be rated using a modified Grading of Recommendations Assessment Development and Evaluation (GRADE) approach. An overall recommendation will be formulated as: (A) Suitable for use: PROMs with evidence for sufficient content validity (any level of evidence) AND at least low-quality evidence for sufficient internal consistency; (B) Potentially suitable for use: PROMs categorised not in A or C; or (C) Not recommended: PROMs with high quality evidence for an insufficient measurement property. Data will be presented descriptively. A pooled result using meta-analysis of the parameters will be conducted if adequate data is available.

¹ Department of Chiropractic, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, Australia.

² Institute for Musculoskeletal Health, Sydney School of Public Health, Faculty of Medicine and Health, The University of Sydney, Australia.

³ Department of Health Professions, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, Australia.

⁴ University of Technology Sydney, Graduate School of Health, Physiotherapy, Ultimo, Australia.

⁵ Rehabilitation Science Postgraduate Program at Augusto Motta University Centre (UNISUAM), Rio de Janeiro, Brazil.

Significance: *The results of this review will contribute to researchers and clinicians making evidence-based decisions on what instrument to use to measure knowledge and/or beliefs about musculoskeletal conditions. Sensi-*

tivity analysis of different low-pass filter cut-off frequencies on lumbar spine kinematic data and its impact on the agreement between accelerometers and a motion capture system

Sensitivity analysis of different low-pass filter cut-off frequencies on lumbar spine kinematic data and its impact on the agreement between accelerometers and a motion capture system

Mona Frey, BKin¹

Dr Jonathan Williams, PhD²

Dr Alexander Breen, PhD²

Dr Diana De Carvalho, DC, PhD¹

Introduction: *Spine kinematics are an important measure in the assessment of mechanical back pain. Accelerometers are a cost-effective and practical alternative to motion capture (MC) systems. However, these sensors are subject to high frequency noise, thus raw data must be filtered before analysis and interpretation. A common filter utilized for this purpose is a low-pass (LP) Butterworth filter, however, the specific filtering parameters such as the cut-off frequency (f_c) have been questioned and there is no definitive answer in the literature. The objective of this study was to:*

- (1) *systematically investigate the effect of different LP Butterworth filter f_c on accelerometer and motion capture data for peak lumbar spine flexion values, and*
- (2) *to determine the optimal f_c to appropriately smooth low velocity movement data without changing the peak ROM measurement.*

Methodology: *Twenty asymptomatic female participants (age 30-65 years) were instrumented with accelerometers and MC markers overlying the L2, L4 and S1 spinous processes. Participants then completed a standardized, guided flexion trial with the pelvis constrained. Participants performed a trunk flexion and return-to-neutral bend at constant 6%/s. Synchronized data were sampled at 60Hz. The flexion ROM for the upper segment (L2-L4), lower segment (L4-S1), and whole lum-*

bar segment (L2-S1) were calculated using custom code. Data were iteratively LP filtered with a 4th order bidirectional Butterworth filter with f_c between 1-14Hz. The filtered data were then used to calculate peak ROM for all segments and the range, mean, 95% confidence interval (CI), and root mean square error (RMSE) of peak ROM for each f_c .

Results: *LP Butterworth filter f_c minimally affected peak ROM for both accelerometers and MC (max diff: 0.66° and 0.23°). Therefore, a lower LP f_c (e.g., 1Hz) can justifiably be applied to accel and MC data without compromising outcomes in comparison to filtering at a higher f_c (e.g., 14Hz). Thus, a lower f_c may be used when smoother data are needed without compromise to peak values. The difference between the systems at each f_c was also minimal (max diff: 0.82°) indicating that accelerometers can be used as an acceptable alternative to MC systems. For context, the differences between systems and LP filter f_c were smaller than the effects of age and sex and the standard error of measurement of lumbar flexion for MC (0.96-7°).*

Discussion: *Both Butterworth LP filter f_c and measurement type had a minimum effect on peak ROM, demonstrating that published data using different cut-off frequencies are still comparable. Secondly, we showed that MC systems and cost-effective accelerometer solutions may be used interchangeably to determine segmental and total lumbar angles with acceptable agreement during low velocity movements. While a LP filter f_c of 1Hz can be applied to spine kinematics data to provide smoother*

¹ Memorial University of Newfoundland, St. John's, Canada

² Bournemouth University, Bournemouth, United Kingdom

data without negatively affecting outcome measures of interest, this may be due to the relatively slow flexion motion used in this experiment. Future studies should seek

to determine the effect of LP filter f_c on flexion at different speeds.

Social network and lexical analysis of CARLoquium 2021

Mark Fillery, MSc¹

Shari Wynd, DC, PhD²

Brian Budgetell, DC, PhD¹

Background: Academic conferences are an important element of the research ecosystem, and so stakeholders will want to understand what to expect of upcoming conferences and what to make of past events. There are no broadly accepted metrics by which to gauge the success of a conference, and it may be that, in general, no formal post-hoc analysis is performed.

Objectives: The purpose of this study was to pilot a number of methodologies to characterize the poster presentations and the presenters at CARLoquium 2021.

Methods: The conference proceedings from CARLoquium 2021 were downloaded as a pdf and converted to a worksheet using Excel power query. The names, primary affiliations, and countries of the presenters were extracted, as were titles of presentations and the names of co-authors. Numbers of presentations per country and per institution were calculated and graphed in Excel. A corpus of presentation titles was created in Excel and processed in VosViewer 1.6.18 to create a network visualization of nouns and noun phrases which commonly co-occurred in presentation titles. The identification of over-represented terms (also called ‘keywords’ in linguistics) was confirmed by statistical comparison performed in WordSmith Tools V8, using a reference corpus of general English. A network map of contributors was created in the network application Gephi 0.9.2 by mapping presenters, as ‘sources’, onto all of their co-authors, as ‘targets’. Node sizes were weighted according to the number of presentations on which a participant was listed as a contributor, and nodes were coloured according to whether or not a contributor was a faculty member/fellow of CARL.

Results: Data were obtained for 108 poster presenta-

tions. Seventy-eight percent (85 of 108) of presentations originated from just 4 countries: Canada (27), Denmark (21), Australia (20) and the USA (17). Thirty-nine percent (42 of 108) of presentations originated from 4 institutions: the University of Southern Denmark (12), Macquarie University (12), Balgrist University Hospital (10) and Canadian Memorial Chiropractic College (8). Lexical analysis of titles showed a predominance of terms associated with clinical practice, especially as it related to musculoskeletal care. References to the basic sciences and education were extremely sparse.

Faculty and fellows of CARL represented 22% (117 of 537) of contributor listings although they only represented 9% (30 of 339) contributors. Two contributors exhibited very high levels of connectedness within the network as measured by ‘degree’: 26 and 20, respectively, compared to an average of 2.38 for all participants. Furthermore, one of these contributors exhibited an extraordinarily high level of influence as measured by Eigenvector centrality: 1.0 compared to an average of 0.05 for all participants.

Discussion: This is the first application of network analysis to an academic conference in chiropractic, and so there are no standards against which to measure the results presented herein. However, the organizers may wish to consider whether the diversity of topics and contributors, and the social dynamics of CARLoquium 2021 reflect their goals for the conference.

¹ Canadian Memorial Chiropractic College, Toronto ON Canada

² Texas Chiropractic College, Pasadena Tx USA