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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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Management of knee and hip osteoarthritis: an opportunity for the Canadian chiropractic profession

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Knee and hip osteoarthritis (OA) place a significant burden on the Canadian health system and are a major public health challenge. This brief commentary discusses the recently published Osteoarthritis Research Society International guideline and the American College of Rheumatology guideline for the management of OA. Special attention has been given to the role of manual therapy, exercise, and patient education for the treatment of knee and hip OA. This article also reviews the Good Life with osteoArthritis in Denmark (GLA:D®) treatment

La prise en charge de l'ostéoartrite de la hanche et du genou : une occasion pour les chiropraticiens canadiens

L'ostéoartrite (OA) du genou et de la hanche impose un lourd fardeau économique au système de santé canadien et constitue un grave problème de santé publique. Le présent article porte sur la ligne directrice publiée récemment par l'Osteoarthritis Research Society International et la ligne directrice sur la prise en charge de l'ostéoartrite de l'American College of Rheumatology. L'auteur accorde une attention spéciale à la thérapie manuelle, à l'exercice physique et à l'information au patient dans le traitement de l'OA du genou et de la hanche. Les auteurs passent en revue le programme Good Life with osteoArthritis in Denmark (GLA:D®) servant à mettre en œuvre des

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Disclaimer: JJY is a member of the GLA:D® International Network and is currently completing his PhD under the supervision of the GLA:D® developers. He, nor the developers of GLA:D®, receive any financial compensation related to the program. He has received PhD funding support from the Danish Foundation for Chiropractic Research and Post-graduate Education, the Ontario Chiropractic Association, the Canadian Memorial Chiropractic College, the National Chiropractic Mutual Insurance Company Foundation, and a faculty scholarship from the University of Southern Denmark. No funding body had any role in the conduct of this study. No other authors have conflicts of interest to declare. Ethical approval and patient informed consent was not required for this submission, as it is a commentary article.

program for knee and hip OA and the implementation of this program in Canada. Lastly, the authors discuss the opportunity for the Canadian chiropractic profession to embrace treatment programs like GLA:D® and take an active role in the strengthening of the Canadian health system from a musculoskeletal perspective.

(JCCA. 2021;65(1):6-13)

KEY WORDS: chiropractic, commentary, exercise, health system strengthening, osteoarthritis

lignes directrices pour le traitement de l'OA du genou et de la hanche et à mettre en œuvre ce programme au Canada. Enfin, les auteurs se penchent sur l'occasion donnée aux chiropraticiens canadiens d'adopter des programmes de traitement comme GLA:D® et de jouer un rôle actif dans le renforcement du système de soins de santé canadien en prenant en charge des affections musculosquelettiques.

(JACC 2021;65(1) : 6-13)

MOTS CLÉS : chiropratique, commentaire, exercice physique, renforcement du système de soins de santé, ostéoartrite

Introduction

Knee and hip osteoarthritis (OA) is the twelfth leading cause of global disability.¹ Both the disability and overall burden attributed to OA has increased globally by over 31% in a 10-year period.^{1,2} The high levels of disability and morbidity equate to significant health system expenditures. OA was the eighth leading cause of US health expenditures in 2016 (80.0 billion United States dollars (USD) or 2.96% of total health system expenditure).³ OA costs are estimated to range from 1.0 to 2.5% of the national gross domestic product in high-income countries like Canada.⁴

In Canada, almost 4 million individuals have OA⁵ and over 122 000 knee and hip replacements are performed annually⁶. The impact of OA in Canada has been predicted to reach direct costs over 157.5 billion Canadian dollars (CAD) in 2020⁷, with over 1.2 billion CAD on replacement surgeries alone⁶. Diagnostic imaging and medication expenses also contribute to OA costs.⁸ OA is a major public health challenge⁹ and poses a significant economic burden that is expected to increase⁷ in response to societal aging and the growing obesity epidemic¹⁰. Global health systems require immediate strengthening to combat the rising societal impact of OA as current health systems are not prepared to handle the increasing demand for OA care. This commentary reviews the latest recommendations on patient education, exercise, and manual therapy for knee and hip OA. While there are numerous interventions available for OA, this commentary focuses on education and

exercise for their central role in OA management, and on manual therapy for its prominence within the chiropractic profession. Finally, this commentary highlights opportunities for the chiropractic profession to actively contribute to the strengthening of the Canadian health system from a musculoskeletal health perspective.

OA management

Recently, both the Osteoarthritis Research Society International (OARSI) and American College of Rheumatology (ACR) published updated guidelines for the non-surgical management of knee and hip OA.^{11,12} According to these guidelines, patient education including self-management strategies, land-based exercise, and weight-loss for overweight patients are considered standard management for all patients with knee and hip OA. These recommendations align with other internationally developed guidelines.¹³⁻¹⁵ One unique feature worthy of mention in the OARSI guideline is that recommendations have been made for a variety of patient profiles, including patients with no comorbidities, those with gastrointestinal or cardiovascular comorbidities, frailty, and widespread pain or depression.¹²

Manual therapy has not been included in the OARSI guideline as a result of limited supporting evidence.¹² The ACR guideline recommends against the use of manual therapy in conjunction with exercise, as limited data shows an additional benefit over exercise alone.¹¹ However, a recent systematic review found that few OA

guidelines make recommendations on complementary and alternative medicine (CAM) interventions¹⁶, despite almost 50% of knee OA patients using CAM interventions, including manual therapy¹⁷. Knee OA is also the most frequently cited reason for older adults to seek CAM therapies.¹⁸ In spite of this understanding, current practice guidelines rarely make mention for or against the utility of CAM therapies. We perceive this lack of attention to CAM in guidelines as problematic, as little guidance is available to clinicians on commonly used interventions in community practice.

Manual therapy for OA

Manual therapy refers to a collection of therapeutic interventions used by chiropractors and physiotherapists in the management of OA¹⁹, although manual therapy is also used by a variety of other healthcare practitioners. The current lack of high-quality evidence prevents manual therapy from being considered a core treatment¹⁹, which is reflected in the recent ACR and OARSI guidelines. However, the National Institute for Health and Care Excellence (NICE) guideline and the US Bone and Joint Initiative recognize the potential contributions that manual therapy can have on patient outcomes.^{13,15} The NICE guidelines consider manual therapy an appropriate adjunct treatment for hip OA¹⁵, while the US Bone and Joint Initiative recommends consideration of manual therapy when in combination with exercise¹³. A recent review on manual therapy found improvements in pain and physical function in the short- and long-term (up to six months) for patients with OA.¹⁹ This investigation included four randomized control trials (RCT) comparing manual therapy alone to other or no interventions and excluded trials that combined manual therapy with other treatment options. However, three of the included studies were rated as having a high risk of bias and only one study examined hip OA patients.¹⁹ As a result, the evidence for manual therapy in the management of OA was deemed inconclusive.

Specifically for knee OA, a systematic review including 11 RCTs concluded that the effects of manual therapy with and without exercise provides short-term benefits on pain level, functional disability, range of motion and physical performance.²⁰ These results align with an earlier review that found passive joint mobilization combined with exercise was associated with moderate reductions in pain.²¹ However, it has been suggested that the vast ma-

majority of knee OA studies are conducted by Chinese authors and therefore may be missed by English reviewers due to language barriers.²² A systematic review including 14 RCTs from both Chinese and English scientific databases concluded that manual therapy is an effective stand-alone therapy for relieving pain and stiffness while improving physical functioning in patients with knee OA.²³ However, this review included studies using only the Western Ontario and McMaster Universities Osteoarthritis Index as the primary outcome and excluded an additional 48 studies with differing outcome measures. As such, it is difficult to determine the impact Chinese literature should have on treatment recommendations.

A systematic review by Beumer *et al.*²⁴ on hip OA including 19 RCTs failed to identify any benefits associated with manual therapy when combined with exercise (water-based or land-based) or when applied as an isolated intervention. Therefore, the best available evidence does not support the use of manual therapy for short-term effects on pain and no long-term conclusions were made.²⁴ These findings are in opposition to a previous review that suggested manual therapy reduces pain and disability in the short-term and is associated with reduced usage of non-steroidal anti-inflammatories at long term follow-up.²⁵ However, this review included only two studies on manual therapy, whereas the updated review by Beumer *et al.*²⁴ included six studies.

Education and exercise for OA

Education and goal-oriented self-management are essential in the treatment of OA.²⁶ A 2014 Cochrane review including 29 studies found self-management education programs may improve self-management skills, pain, and function, but more research is needed as only low to moderate quality evidence exists.²⁷ It has been suggested that quality education for OA should inform patients on modifiable risk factors, disease pathophysiology, importance and safety of exercise for joint and general health, consequences of a sedentary lifestyle, evidence-informed treatment and coping strategies.²⁶ This knowledge empowers patients to actively and confidently manage their disease and encourages life-long physical activity participation.²⁶

The evidence for exercise therapy in the management of knee and hip OA is unequivocal. Multiple Cochrane reviews have shown benefits in the short and long-term for pain, function, and other patient outcomes for both knee

and hip OA.²⁸⁻³¹ Supervised land-based exercise significantly improves pain, function and quality of life in those with knee OA irrespective of type of exercise and delivery mode (one-on-one, group or home-based).²⁹ Moderate quality evidence suggests aquatic exercise is an appropriate alternative to land-based exercise, as clinically meaningful effects on pain, disability, and quality of life with little risk of adverse events was shown in a Cochrane review.²⁸ Verhagen *et al.*³² recently updated two Cochrane exercise reviews^{28,29} and found that sufficient evidence has existed for exercise in the management of knee OA since 1998. A similar analysis concluded that ample evidence has existed since 2002 to support the effectiveness of exercise for knee OA.³³ It is now well-accepted there is no longer a need for replication of exercise trials, as the benefit of exercise for knee OA has been clear for at least a decade.²⁴ Rather, future studies should examine different types, delivery modes, and dosing of exercise interventions, as optimal exercise programs still remain unknown.^{26,29,30}

Implementing education and exercise

Numerous programs aimed at implementing education and exercise as standard care for OA are available, such as the Physiotherapy Exercise and Physical Activity (PEAK) program³⁴ from the University of Melbourne and the OA Optimism online resource³⁵. One program garnering international attention is Good Life with osteoArthritis in Denmark (GLA:D®). GLA:D® is an evidence-informed education and exercise program tailored for individuals with knee and hip OA.³⁶ It is a not-for-profit initiative with the aim of facilitating the implementation of guideline-based management for knee and hip OA.^{36,37} GLA:D® is a standardized, yet personalized group-based exercise program consisting of two education sessions and twelve sessions of supervised neuromuscular training over a six-to eight-week period.^{36,37} According to the GLA:D® Denmark 2018 Annual Report, 350 locations offer GLA:D® to about 10,000 patients yearly.³⁸ Immediate effects of the program include reductions in pain and pain medication use, increased physical function, and improved quality of life. Long-term results suggest that pain and quality of life improvements were maintained or even improved one-year post-GLA:D® and fewer sick leaves were reported by participants.³⁸ The implementation of GLA:D® has been so successful in Denmark that one Danish health region has implemented policy requiring knee OA patients

to complete GLA:D® prior to receiving a surgical consultation. Moreover, the success of GLA:D® in Denmark has led to the international expansion of the program in Australia, New Zealand, China, Switzerland, Austria, the Netherlands, and Canada.

GLA:D™ Canada was launched in 2016 and has replicated the strong results observed in Denmark. According to the 2019 Annual Report, GLA:D® is available at 209 locations across nine provinces and one territory.³⁹ Over 3800 patients have been through the program thus far, and the results have been promising. Significant improvements in pain and function have been observed immediately after program completion and at long-term follow-up periods.³⁹ Additionally, improvements in body mass index for overweight participants have been shown.³⁹ A recent study also found GLA:D® to be cost-effective in Australia – a health system similar to the Canadian system – if just one in 12 participants (8%) avoid surgery.⁴⁰ While there are no available estimates of how many Canadian patients in GLA:D® have avoided surgery, a follow-up study from two RCTs using a similar intervention to GLA:D® found 68% of participants had avoided surgery two years post-intervention.⁴¹ Additionally, Health Quality Ontario has recommended the public funding of GLA:D as a means to reduce health system costs.⁴²

Education and exercise programs for knee and hip OA have the additional advantage of remote implementation using online care delivery platforms. A growing number of publications have shown positive results for the use of telerehabilitation in patients with chronic pain/OA of the knee and hip.⁴³⁻⁴⁶ One large RCT (148 participants) of older patients with chronic knee pain (representing knee OA) found statistically and clinically significant improvements in pain and function at three-month follow-up and in function at nine-month follow-up.⁴⁷ An internet-delivered care package consisting of online educational material, online pain-coping skills training modules, and seven teleconference sessions with a physiotherapist over 12 weeks was compared to online educational material only.⁴⁷ During the teleconference sessions, physiotherapists performed a patient assessment and prescribed a home exercise program for lower-limb strengthening.⁴⁷ Another RCT (70 patients) found a telerehabilitation intervention showed no short-term differences in quality of life, pain, function, and symptoms compared to in-person rehabilitation following total hip replacement.⁴⁸ The

telerehabilitation program consisted of videoconferencing with a physiotherapist to deliver an at-home exercise program aimed at strengthening the lower limb.⁴⁸ However, this study evaluated only the short-term effects and thus, no conclusions can be drawn regarding the long-term effectiveness of this telerehabilitation program. Additionally, a large RCT with nine-month follow-up is currently underway in Australia comparing the PEAK program to traditional in-person care for knee OA,⁴⁹ which should provide more definitive results on the effectiveness of remote delivery of education and exercise.

Despite evidence to suggest that education and exercise can be delivered at least as effectively as in-person care for patients with knee and hip OA, it is important to appreciate the role of patient and clinician preference in care delivery. Qualitative research demonstrates that older patients' perceived telerehabilitation as convenient and enjoyable, and that it promoted motivation, self-awareness, and a positive therapeutic relationship.⁵⁰ However, patients did note that telerehabilitation could not completely replace the traditional in-person interaction.⁵⁰ In another study exploring the experiences of patients and clinicians using Skype to deliver exercise for knee OA, both patients and clinicians were satisfied with the care.⁵¹ A common theme amongst both patients and clinicians was that care delivery via Skype empowered patients and created a positive therapeutic relationship.⁵¹ Clinicians, however, did report feeling uncomfortable without a hands-on assessment and with having to adapt normal clinical routines.⁵¹ Interestingly, clinicians also noted increased comfort having known that serious pathologies had been ruled out by the research team prior to patient enrollment in the study⁵¹, which is not likely reflective of clinical practice for most chiropractors.

Overall, it appears that remote delivery of education and exercise interventions for knee and hip OA, and potentially other musculoskeletal conditions, is at least as effective and enjoyable as traditional in-person care delivery. As such, clinicians should not be hesitant to engage in emerging care delivery models, although more research is needed to better understand these programs. Following the emerging evidence for online delivery of education and exercise, GLA:D™ Canada is now offering online training of clinicians and remote delivery of the program to patients using an online platform. Although the decision to offer GLA:D® remotely was in part due

to the COVID-19 pandemic, online delivery of the program allows for greater access to the program, especially in more remote Canadian communities where there are limited number of healthcare professionals. While we are unaware of any evidence evaluating patient outcomes using the remote program, we expect this information to be made available in the near future.

Opportunity for the chiropractic profession

Despite GLA:D® gaining traction in Canada, there appears to be a reluctance amongst the chiropractic profession to embrace programs of this nature. While over 1000 Canadian healthcare practitioners have been trained in GLA:D®, only 11% are chiropractors compared to physiotherapists at 74%.³⁹ Barriers to participation, including cost of certification and lack of clinic space dedicated to rehabilitation, amongst others, may explain the small number of chiropractors currently offering GLA:D®. However, we view this as an opportunity for the chiropractic profession to help strengthen the Canadian health system by the adoption of programs like GLA:D® and other methods of best-practice implementation. We encourage readers to explore other education and exercise implementation programs for OA, such as the PEAK program for knee OA³⁴ and OA Optimism online resource³⁵. Fortunately, institutions like the Canadian Memorial Chiropractic College have recently begun to offer GLA:D® at their teaching clinics and we hope this will spur a greater uptake of treatment programs that do not focus on manual therapy by members of the Canadian chiropractic profession and future chiropractic graduates. Chiropractors can help offset the large expenses incurred by the Canadian health system through costly interventions like joint replacement surgeries through increased participation in programs like GLA:D®.

Conclusion

We do not wish for readers to misconstrue this commentary as a call to abandon manual therapy in the care for patients with OA. Rather, we are advocating for increased recognition of the role education and exercise play in the evidence-based management of OA. In fact, a recent publication in this journal by one of the authors of this commentary presents how chiropractors may choose to deliver manual therapy for knee OA within an evidence-based framework.⁵² However, an attitudinal shift by the profes-

sion is required. There must be a willingness amongst practitioners to embrace management strategies that do not conform to traditional approaches used in the profession, such as individual patient encounters and manual therapy-driven care plans. The recent COVID-19 pandemic should illustrate that musculoskeletal care, including that delivered by chiropractors, can be quickly adapted from traditional chiropractic care delivery models. We believe that this paradigm shift, if adopted, can position the chiropractic profession to take a leadership role in the management of OA and the future of the Canadian health system at large.

Acknowledgments

The authors would like to thank Søren T. Skou, PT PhD, for his thoughtful comments on the manuscript prior to submission.

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When boundaries blur – exploring healthcare providers' views of chiropractic interprofessional care and the Canadian Forces Health Services

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Introduction: Musculoskeletal (MSK) conditions are primary reasons prohibiting Canadian Armed Forces (CAF) personnel from being deployed, with back pain the second most common activity-limiting condition. CAF provides a spectrum of services, including chiropractic care. There is a paucity of data related to chiropractic interprofessional care (IPC) within CAF healthcare settings.

Frontières imprécises: examen des soins interprofessionnels chiropratiques du point de vue de professionnels de la santé et des services de santé des Forces armées canadiennes

Introduction : Dans les Forces armées canadiennes (FAC), les troubles musculosquelettiques sont les principaux obstacles au déploiement et les lombalgies constituent la deuxième maladie limitant les activités. Les FAC offre un vaste éventail de soins de santé dont les soins chiropratiques. Il existe peu de données sur les soins interprofessionnels chiropratiques (SIC) dispensés dans les établissements de soins de santé des FAC.

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The study was funded by a grant from the Canadian Chiropractic Association and the Ontario Chiropractic Association. The funders did not have a role in study design, analysis or preparation of this manuscript. The views expressed are solely those of the authors and do not reflect the official policy or position of the Canadian Armed Forces, the Department of Defense, or the Canadian Government.

Methods: A qualitative study, using an Interpretative Phenomenological Analysis (IPA) approach, involving 25 key informant interviews explored factors that impact chiropractic IPC. We used a systematic but not prescriptive process, based on a thematic analysis, to interconnect data to develop meaning and explanation. Initially, we explained and interpreted participant's experiences and meanings. Next, we used extant literature and theory, together with expert knowledge, to explain and interpret the meanings of participants' shared accounts.

Results: We present findings central to the domain, Role Clarity, as described in the IPC Competency Framework. Our findings call for strengthening IPC specific to MSK conditions in the CAF, including an examination of gatekeeping roles, responsibilities and outcomes.

Conclusion: It is timely to investigate models of care that nurture and sustain inter-provider relationships in planning and coordinating evidence-based chiropractic care for MSK conditions, within the CAF, and its extended referral networks.

(JCCA. 2021;65(1):14-31)

KEY WORDS : Chiropractic; Interprofessional Collaboration; Role Clarity; Military Medicine; Health Services; Military Personnel; Interpretative Phenomenological Analysis

Introduction

Musculoskeletal (MSK) conditions have a significant impact on the health and operational readiness of Canadian Armed Forces (CAF) personnel.¹ MSK conditions are primary reasons prohibiting CAF personnel from being deployed and back pain is the second most common activity-limiting condition.^{2,3} Moreover, in the 2014 Surgeon General's Report, MSK injuries were identified as responsible for 42% of all medical releases.⁴ The CAF recogniz-

Méthodologie : On a mené une étude qualitative par analyse interprétative phénoménologique (AIP), auprès de 25 informateurs importants pour connaître les facteurs qui influent sur les SIC. On a procédé par méthode systématique, et non une méthode prescriptive fondée sur une analyse thématique, pour relier les données entre elles et les interpréter. On a commencé par expliquer et interpréter les significations et les expériences des participants. Puis, à l'aide de la littérature et de la théorie actuelles et des connaissances approfondies, on a expliqué les significations des histoires racontées par les participants.

Résultats : On présente les résultats pour ce qui est de l'aspect Role Clarity (clarté des rôles) décrit dans le cadre des compétences des SIC. D'après nos résultats, un renforcement des SIC spécifiquement pour la prise en charge des troubles musculosquelettiques s'impose au sein des FAC, de même qu'un examen de la surveillance, des responsabilités et des résultats.

Conclusion : Il serait opportun de rechercher des modèles de soins permettant d'entretenir et de maintenir les relations entre les fournisseurs de soins de santé pour ce qui est de la préparation et de la coordination des soins chiropratiques fondés sur des données probantes servant à traiter des troubles musculosquelettiques dans les FAC, et aussi dans leurs réseaux d'aiguillage étendus.

(JACC. 2021;65(1):14-31)

MOTS CLÉS : chiropratique, collaboration interprofessionnelle; clarté des rôles, médecine militaire, services de santé, personnel militaire, analyse phénoménologique interprétative

es that evidence-based and cost-effective management of MSK conditions is an important issue for members and the CAF as a whole.⁵

The Canadian Forces Health Services (CFHS) provides a spectrum of healthcare services in managing members' health needs, including healthcare provided in civilian off-base facilities when services are not available on-base.⁵ In Canada, chiropractic care is an eligible CAF health practitioner benefit when prescribed by a physician,

and accessed off-base, outside the military healthcare system. Chiropractic care is authorized with a 10-visit limit per condition, after which a physician's review is required to determine if further treatment is necessary.⁶ Within the CFHS, strengthening the integration and coordination of care in primary care settings is an envisaged priority, with significant investments currently made in some areas, including mental health.⁵

However, the inclusion of multiple services in an integrated healthcare delivery model is a complex process requiring in-depth knowledge of professionals' distinct roles, responsibilities, skills, scopes of practice, and understandings of their practice settings.⁷ Exploring how these components interact in an interprofessional collaborative manner (i.e., triaging and referring patients, appropriateness of care, and ensuring continuity of care), requires attention. Chiropractors are increasingly participating as active members of interdisciplinary teams, in both primary care and hospital-based settings.⁸⁻¹⁰ Currently, there is a paucity of data about interprofessional collaboration (IPC) within the CFHS's unique healthcare environment and its community-based referral networks, related to diagnosing and treating MSK conditions.

Purpose and aim

Our national study used an Interpretative Phenomenological Analysis (IPA) approach to describe and interpret how integrated chiropractic services could be designed, implemented and evaluated within the CFHS. In this manuscript we expand on our previous work that explored key informants' perceptions of opportunities and barriers, in a variety of complex and diverse domains, related to introducing interprofessional collaborative chiropractic services in the CFHS.¹¹

Our aim in this manuscript is to focus on one aspect of the study (i.e., IPC in the CFHS), explicit to MSK conditions. Specifically, we examined emergent themes to elucidate the factors that foster or hinder chiropractic IPC within the CFHS. While recognizing that all six IPC competency domains are important, we described and interpreted findings related to the domain Role Clarity (see Box 1). Our rationale was two-fold: brevity requirements, together with robust, previously unreported data, in the form of rich, situated, and detailed narratives that expand on our earlier analysis and discussion. We hope that our findings resonate with readers on the basis of their ex-

periences and that ongoing reflection leads to deeper and original insights.¹²

Methods

We employed an IPA approach whereby we explained and interpreted key informants' perspectives on how an interprofessional collaborative chiropractic service could be designed, implemented and evaluated within the interdisciplinary CFHS. IPA is an approach to qualitative research concerned with exploring and understanding the lived experiences of a specified phenomenon.^{13, 14}

One of the hallmarks of an IPA approach is that data analysis progresses from making sense of the participant's experience, to a focus on the shared experience of participants, and from the descriptive to the interpretative.¹⁵ When applying findings, readers critically reflect to see whether published findings resonate with their experiences, perhaps nudging a re-evaluation of what was considered known or understood about the phenomena being explored.¹⁶ The onus is on IPA researchers to discuss findings through the lens of the extant literature and theory and to debate the congruence and dissonance between the findings of the study and the prevailing discourse or evidence.¹³

Approvals

Ethical approval was received from the Research Ethics Boards at the University of Ontario Institute of Technology (Ontario Tech University) (# 15-049) in Oshawa, and the Canadian Memorial Chiropractic College (CMCC) (#152019) based in Toronto. Agreement to conduct the study was provided by the Canadian Deputy Surgeon General, CFHS (7 June 2016). All participants were provided with an overview of the purpose of the study prior to providing informed consent. A regional Commander of the CFHS introduced the study and provided background information through an e-mail communication emphasizing that participation was voluntary.

Recruitment

We used purposeful sampling¹⁷ to recruit key informants. Inclusion criteria included: English-speaking health care professionals, military personnel, and researchers with experience and in-depth understandings of healthcare delivery and interprofessional collaborative practice within the military setting in Canada. Additional key informants

with knowledge and/or experience related to the delivery of health care within the CFHS, with emphasis on MSK conditions, were identified using a snowball sampling technique.¹⁷ Of the individuals approached only one person declined to participate in the study, referring researchers to individuals seen as more highly qualified to address the key research questions.

Interview schedule and procedures

Semi-structured telephone interviews were conducted employing an interview guide with open-ended questions.^{7, 18-20} The interview guide was informed by expert opinion, as well as health, social^{21, 22} and behavioral²³ theories addressing facilitators and barriers to accessing chiropractic care²¹⁻²³. After the first eight interviews, additional probes were developed and questions slightly revised (See Appendix A). Interviewing continued until the research team ascertained that saturation of responses to key questions was achieved.²⁴⁻²⁶ As data saturation is not generally a goal of the IPA approach²⁷, researchers focused on obtaining robust and rich personal accounts from participants, in order to describe and interpret the experiences, concepts and commonalities across the group.

All interviews were conducted by two members of the research team, both healthcare professionals, who were not physicians, chiropractors nor physiotherapists, thereby mitigating potential researcher bias.²⁰ The lead interviewer, an experienced qualitative researcher, was assisted by a team member who served as a note-taker and timekeeper while providing logistical support in setting-up and audio-recording; neither had prior knowledge of study participants. The interviews were conducted between September 2016 and February 2017 and were 45-to 60-minutes in duration. Interviews were audio-recorded, exported to an encrypted USB key and transcribed verbatim by an experienced transcriptionist. All transcripts were reviewed for accuracy against the recorded sessions. Content errors were corrected and any potential identifying information removed prior to coding.

Participants were invited to review the transcript (member checking) and make any necessary additions or deletions. Member checking involves taking data (e.g., verbatim transcripts) back to participants so that they can judge the accuracy of the account and is “the most critical technique for establishing credibility”²⁸ (p.314). In qualitative research, member checking or seeking

participant feedback remains an important validation strategy.¹² Twelve of 25 key informant interviews completed member-checking. Five key informants accepted the transcript with no changes, while seven made minor changes. In situations where key informants declined to be audio-recorded (n=3), both interviewers kept field notes and post-interview memos to the self; this information was subsequently included in data analysis.²⁹ Researchers did not conduct repeat interviews with any of the participants.

Data analysis

Several approaches to analyzing phenomenological data are described in the literature. Smith and colleagues (2009) proposed a distinct, systematic and flexible structure, based on thematic analysis, and consisting of several phases, for analyzing IPA data. Data analysis necessitates that researchers be open and willing to “dwell in the data,” consistent with the IPA approach taken to data collection.

In our study, dual interpretation occurred during data analysis whereby the participant made sense of a phenomenon by explaining and interpreting their own experience and the researchers used extant literature and theory, together with expert knowledge and experiences to explain and interpret the meaning of participants’ shared accounts.^{14, 15} Described as the “double hermeneutic,” Smith *et al.* (2009) underscored the circularity of the process (questioning, uncovering meaning and further questioning) involved in interpreting and understanding a phenomena.¹⁵

In IPA research, the final account offers a layered analysis of the phenomena, where the first descriptive phenomenological layer conveys a thoughtful understanding of participant’s experience. In the second layer, a probing critical analysis is conducted based on deeper interpretative work.³⁰ The findings should be plausible, indicative and provisional given that researchers, despite their best efforts, cannot fully abstract themselves from the contextual basis of their own experience.³⁰ In our earlier work¹¹, data analysis proceeded in an iterative and inductive manner in which thematic analysis of early interviews informed later data collection. After the first three interviews were completed and transcribed, each verbatim transcript was independently read and re-read by three research team members (i.e., the two individuals who facilitated or participated in all interviews and a third

team member with extensive experience in qualitative approaches and topics central to the study.)

Initial notes and observations were made in the margin of the texts, and key descriptive comments and phrases were highlighted. Additionally, researchers began to make more interpretative comments, in some cases questioning what the comments revealed about the participant’s understanding of the phenomenon.

Next, the three researchers met regularly to begin the process of developing emergent themes, partly informed by their initial margin notes and observations. Discussion focused on reviewing and reaching consensus on coding, examining and defining codes, and developing a referent codebook. The coding structure and the related transcript reference data were entered into qualitative data analysis software (NVivo Pro Version 11.4.1 for Windows, QSR International (Americas) Inc., Burlington, MA, USA). This final step was helpful in illuminating the connections between themes and sub-themes, and served to highlight differences and similarities, leading in some cases to re-naming themes as researchers acquired a deeper understanding of the data.¹⁵

As data analysis progressed, and building on our earlier work, we further examined participants’ experiences to explore and interpret findings relevant to Role Clarity of the IPC framework. Specifically, we organized and interpreted themes into major and minor components, supported by an intensive line-by-line analysis of the texts. Again, researchers’ formative thoughts and reflections were noted, with ideas and developing interpretations brought forward and debated. Theoretical sensitivity was strengthened by repeatedly comparing and verifying themes to the actual texts.³¹ We used our knowledge of the available literature and theory, including the IPC framework, to interpret salient themes further. Although researchers attempted to bracket themselves out of the study by acknowledging values and biases on a regular basis, in interpretative (hermeneutic) phenomenology, it is widely accepted that researchers’ values affect the object of study.^{32,33}

The Interprofessional Care Competency Framework (Box 1) offered a theoretical lens for researchers to manage, organize and ultimately interpret findings, specific to Role Clarity. With Role Clarity emerging as a central phenomenon underpinning recent work, we used an IPA approach to return to our database, reviewing the

Table 1.
Sampling strategies
and background of study participants.

	Background	Invited	Interviewed
Purposive sample	MD	6	6
	PT	9 ^a	8
Snowball technique	MD	1	1
	PT	5	5
	DC	5	5
	Non-health care	1 ^b	0
Total		27	25

^aWithdrew (n=1). ^bDeclined to participate (n=1).

published literature and theoretical frameworks, to explore and interpret facilitators and barriers to Role Clarity, as well as specific contextual and intervening conditions. This approach, consistent with the dual interpretation described earlier in the manuscript, also reflected the circularity of the process vis-à-vis interpreting and understanding a phenomenon.¹⁵

Results

Participants

Table 1 provides information on study participants’ professional backgrounds. They included military personnel (52%), public servants and contractors employed by the CAF (24%), and civilians (24%), distributed across Canada. Military participants included ranks of Chief Warrant Officer, Lieutenant, Captain, Lieutenant Colonel, and Colonel. Slightly more than half of the CAF key informants were deployed at least once over the course of their career. Participants self-identified as medical doctors (MD), physiotherapists (PT), and chiropractors (DC). The chiropractors, all situated off-base, provided care to CAF members. Of the study participants, the majority were male (n = 76%).

Our findings focussed upon the competency domain of Role Clarity. We organized our findings under a series of

sub-headings based on the Interprofessional Care Competency Framework And Team Assessment Toolkit (See Box 1) and supported them using salient verbatim quotes.

Knowledge gaps related to role clarity

We found little evidence to suggest that within the CFHS, healthcare professionals involved with managing MSK conditions, were interested, or motivated, to explore the interdependencies between their own roles and the roles of others, in an effort to optimize each members' scope. Some CFHS physiotherapists discussed their role limitations and the need for consultation with other members of the healthcare team. This was based on their perceptions of knowledge, skills, roles, scopes, and sometimes on lengthy wait-lists for physiotherapy services on-base. Although the referral processes for MSK conditions varied from base-to-base, they were largely contained within their intra-professional networks (i.e., physiotherapist to physiotherapist).

A chiropractor working in an off-base multidisciplinary clinic, offered the following perspective on the lack of role clarity specific to the treatment of spinal pain:

Essentially in our healthcare system if you have a heart condition you go to a cardiologist, if you have cancer you go to an oncologist, but if you have back pain who do you go to? You can go to a chiro, a physio, a massage therapist, an osteopath. You can go to any of those people and with any of those people you have no idea what kind of care you are getting because within each of those professions there is a huge spectrum of peoples expertise in dealing with spinal pain. And all kinds of philosophical approaches... From a consumers point of view, there is no portal of entry into the healthcare system for someone with spinal pain. It is a wide-open door and you can go anywhere you want and get any kind of care that anyone wants to give you. (DC, K20)

Blurring of boundaries

We found strong evidence on the blurring of boundaries relative to the roles that physiotherapists and chiropractors play in the treatment of MSK conditions within the CFHS. This emerged as a key factor hindering role clarity as explicated by a chiropractor below:

The line between what a physio does and what a chiro does at this point is so grey, it is difficult to decide, 'Well, should somebody see a chiropractor or a physiotherapist?' Because physiotherapists provide manipulation, they are licensed to diagnose. The only difference in their (physiotherapists') scope of practice is that they don't have the ability to order and interpret x-rays. Outside of that, their scope of practice is very similar. (DC, K20)

A CFHS physician addressed the lack of role clarity, concurring with the majority of key informants on the perceived "overlap" between MSK service providers. In part, the problem was attributed to a lack of knowledge pertaining to unique professional roles: "The problem is, and we are never taught as to when would a chiropractor be more beneficial than a physio, or vice versa, or if they are both the same." Elaborating further, the physician stated:

When I was seeing patients in a Care Delivery Unit setting, I would have patients who either didn't respond to physiotherapy, who I would refer to a chiropractor, or vice versa, in fact... So, I think it is just part of the treatment options as such. (MD, K14)

A CFHS physiotherapist shared perspectives on changing scopes of practice for physiotherapists and chiropractors, including the confusion among patients and healthcare providers with respect to the unique role each provider can play. In the quote, the key informant explains the confusion, through the professional lens of a military physiotherapist, who has been deployed. The reference to decreasing numbers of referrals to off-base chiropractors supports the perspectives expressed by other non-military key informants who were located off-base:

...So the difference that we used to see between the two professions is now a lot more blurred and there is a lot more shades of grey... So, if someone comes in, where before twenty years ago and said, 'I want to see a chiropractor', essentially what they were asking for is manipulation. Now, if they come-in and say, 'I want to see a chiropractor', it's not necessarily what they are asking for. Their

friend could be seeing a really good therapist that is treating them not with manipulation, but more of myofascial techniques, exercise therapy, which would be the exact same sort of treatment that they would end up receiving from a physiotherapist on-base... We see our outsourcing, not just for chiropractic, but for manipulation of any kind, to be very low in the (XXX) region because we actually have those expertise right on-base. (PT, K25)

In discussing the blurring of boundaries between physiotherapists and chiropractors, an off-base chiropractor introduced the notion of the “primary spine practitioner,” suggesting that both professional groups, on the basis of their current scopes of practice, could fulfill the role. In the second quote, the chiropractor clarifies that at this point in time the notion of a primary spine practitioner has not been fully explored by key stakeholders, including healthcare professionals and provides a brief description of the role:

So physiotherapists are capable within their scope of practice of taking on the role of primary spine practitioner, as are chiropractors. The difference I see is that chiropractors are more focused in training and in their expertise, and in their experience, in everything really, to take on that role straight out of school... So, again, both are licensed to diagnose, but chiropractors, straight out of school, can perform manipulation. So, there is a lot of understanding and there is a lot of knowledge that I think chiropractors have straight out-of-school that physios don't necessarily have... They can go in that direction and they can build that scope of practice but it is not as much as let's call it the 'academic culture of physiotherapy' as it is in chiropractic. (DC, K20)

That primary spine practitioner is somebody who should be able to provide that conservative care for general musculoskeletal disorders and spinal disorders, but also know how to screen for red flags, refer when appropriate, identify yellow flags, and be able to refer to appropriate imaging in order to further their diagnosis. That entity does not exist in our healthcare system right now.” (DC, K20)

Reflecting on deployment as a barrier to the integration of non-uniformed healthcare professionals in the CFHS, a physician emphasized the need to clarify perceptions of “redundancy,” referring to the overlapping roles of physiotherapists and chiropractors. The physician's comments also address resource limitations associated with offering post-graduate training and skill development opportunities to physiotherapists employed by the CAF:

Let's just be clear on what it is that they (chiropractors) are going to be doing because otherwise there is that perception of redundancy. The physios are telling me, 'Well, why not just train more physios in manual therapy,' because those are expensive courses and because we expect our physios to be deployable and go to wherever the country asks them to go, which wouldn't be the case for chiropractors. (MD, K11)

Knowledge gaps re: unique contributions of each profession

Findings with respect to participants' knowledge of the unique contributions of both physiotherapists and chiropractors were mixed. For example, a CFHS physiotherapist replied to a question asking under what conditions would referral to a chiropractor be appropriate:

I would say no (conditions for referral). I would say there is specific need for evidence-based management of musculoskeletal conditions. That is what I demand of the on-base physios and all outsourced providers. Because that is what the Surgeon General expects... There is nothing that chiro offers that is both unique and evidence-based, so for me it is about getting access to evidence-based care for MSK issues. (PT, K6)

We have developed very good partnerships with some chiropractors in the area and I think they are phenomenal therapists. But I hesitate to say that the care that they provide differs greatly from (care delivered) by the very experienced physios that we also outsource to... (PT, K25)

Despite opinions posited by participants, there is evidence of favorable outcomes of chiropractic care of active

duty military. In particular two randomized controlled trials comparing standard medical care (usual care, medications, physical therapy, pain clinic) and standard medical care with the addition of chiropractic care, favoured the latter for each primary outcome in the short term for patients with low back pain.⁶

In other situations, participants clearly identified the unique strengths and particular expertise of other health-care professionals involved in the management of MSK conditions, recognizing their own role and its limitations. A chiropractor stated:

So, what I end up referring to physiotherapists for is for the treatment of conditions that are within their area of expertise and outside of my area of expertise. We have a physiotherapist who does a lot of pre- and postnatal care, pelvic floor rehabilitation, and things like that. That is completely outside my expertise... Same thing for concussion, which is not my expertise. (DC, K20)

A CFHS physiotherapist contemplated the conditions under which referral to an off-base healthcare professional would be recommended, emphasizing the importance of trust, respect and a successful track-record in treating CAF members for MSK conditions.

It is kind of a development of trust in the community with certain clinicians, where you know the paperwork has been done well, the patient has been well looked after... So, it is all about track-record, personal and/or professional interactions... If I wanted to see a chiro, who would I want to go and see? Well, I want to see someone with really good credentials, and a really good track-record, and where we have had that in the past (PT, K16)

Reflecting on the confusion regarding professional roles and scopes, a chiropractor cautioned that while interprofessional collaboration and communication is important, having “too many cooks stirring the pot” can be detrimental to patient care. For example:

...If someone (a patient) is seeing too many health-care practitioners, you tend to get protracted or an over abundance of care. Patients get confused

with information: the conditions are medicalized... So, there are two sides to care and that is giving the patient clear messaging and not over-treating them and not over-medicalizing their condition and not subjecting them to too much passive care, but at the same time ensuring that what you are offering them is optimal care. (DC, K20)

A CFHS physiotherapist stated that perceptions of role confusion between physiotherapists and chiropractors were important to address, partly to contain health-care costs: “Chiropractors cost way more; their salary is way higher than a physio. You could get two physios for one chiropractor (*laughs*).” In the following quote, the physiotherapist emphasized patient confusion issues,

Policymakers need to look at the bigger picture and use the resources that we have to collaborate better with the people that are already in the CFHS... My biggest fear of bringing a chiropractor into the military service is replication of service when other needs are clearly a priority... (PT, K18)

Describing personal experiences working with chiropractors, the physiotherapist’s comments mirror the notion expressed above by a chiropractor that, in some situations, interprofessional MSK care can be detrimental when patients are caught in the middle:

There wasn’t a heck a lot of difference in what the chiro was doing and what the physiotherapist was doing, and in some cases, the patient kind of kept going in a little bit of a circle between the two professions. (PT, K18)

Optimizing scopes of practices as a necessary next step

Our findings on role clarity suggest that the majority of CFHS key informants (physiotherapists, physicians, policymakers) viewed chiropractors more as a therapy (i.e., manipulation), rather than as a profession working within a full scope of practice. This perspective can potentially limit access to chiropractic care.

The following quotes, from a mix of participants (physiotherapist, physician, chiropractor), supported the

notion of chiropractors being viewed as an intervention rather than as a profession offering a full scope of service:

So the most specific criteria to determine if someone is a good candidate for chiropractic care is your ability to determine if there is some form of joint restriction that needs manipulation. (PT, K9))

I think every chiropractor is slightly different, their manipulation technique... So, some will use an instrument to manipulate joints, some will use manual [approaches], there are many different techniques. Some of them, the osteopaths, use muscle energy, as far as I understand, to manipulate joints into the right position. You would have to ask the physios; some physios have been trained... to perform some type of manipulation techniques which are oddly very similar to what a chiropractor offers, as well. (MD, K14)

I have heard physiotherapists say, 'Well, we can do everything that a chiropractor can do.' And that is becoming more of an issue now, especially with these manual therapy training sessions where physiotherapists are learning how to manipulate joints. It is for that reason that I specialized in doing a lot of the flexion decompression, because that is strictly a chiropractic technique. (DC, K15).

With this convergence of the professions, whether they go to one or the other it ends up almost being the same... If someone needs manipulation, they can get manipulation from a physio or a chiropractor; if they need acupuncture they can get acupuncture from a physio or a chiropractor. They need active release therapy... that can be done by a physio or chiropractor. So, really there is no one modality of treatment..., that you would say, 'OK, well, a physio just does this and a chiro just does that.' If you said to me, 'We can give you an extra chiropractor, or you can give me an extra physio,' I would say, 'OK, well, essentially, in the end, it ends up being the same.' (PT, K25).

In contrast, a minority of CFHS key informants, reflecting on their professional and personal experiences

(i.e., seeking chiropractic treatment for themselves or family members) with patients with MSK conditions, emphasized the unique assessment and therapeutic skills of chiropractors. Such thoughts have been highlighted in other reports suggesting how health policies define complementary and alternative professions (including chiropractic) as individual therapies, rather than as a profession with a wider scope of practice.³⁴

Findings suggested that within the CFHS it was not uncommon for key stakeholders to equate chiropractic care with spine care. There was consistency amongst most participants that access to services within the spectrum of care is for a specific intervention, rather than for the profession's full scope of practice. In other words, consideration for referral for chiropractic services was made primarily for spinal manipulation to treat a particular spinal disorder, most commonly chronic low back pain. A CFHS physician stated:

...We're not making a good usage of chiropractic practitioners in our organization... I'm looking more at quality than quantity. I don't think we need to do more but I think we can do better in referring the right individuals at the right time instead of doing what we do now which is paying a lot of money for chronic low back pain with very little results. (MD, KI)

However, a minority of participants, particularly physicians who had established both personal and professional relationships with chiropractors, considered also accessing chiropractors for their expert clinical opinion.

'Who ultimately is the spine care specialist?' because we lump all kinds of people in that domain. I think given the nature of the speciality, and how much time chiropractors spend on the spine, I would have to agree that... chiropractors, ...come closest to a spine care specialist. (MD, K11)

Exploring how chiropractors can be involved, the majority of participants called for an integrated team, consistent with a patient-centred spine care model. In this model, providers are respected and distinguished for their uniqueness, with care provided together with others, rather than in isolation. In this scenario, providers do not be-

come the intervention. Rather, collaboration is developed through relationships built on trust, respect and shared decision-making, taking advantage of differing complementary skills in multiple settings across the continuum of care. According to experts in collaboration:

“...It involves sharing knowledge, perspectives and responsibilities, and a willingness to learn together. This requires understanding the roles of others, pursuing common goals and outcomes, and managing differences.” (CANMEDS 2015, p. 7)³⁵

Facilitating access to health services

Chiropractic services within active duty military health-care settings is typically accessed through a gatekeeper.⁶ Our findings suggested the gatekeeper role with respect to off-base referrals was a major barrier to the access of chiropractic services with the CFHS. Typically, the gatekeeper was identified as a lead physiotherapist and/or the Base Surgeon. Frequently, the decision to refer was predicated on the clinician’s individual preferences and experiences, rather than a systematic approach. Consistent with the work of others^{36,37}, our findings suggest that the diversity within the chiropractic profession limits referrals and creates significant barriers to IPC. Below, we provide additional perspectives on the gatekeeper role in the CFHS, with the goal of elucidating turf issues, professional biases and, possibly role discrimination.

The current way that it works... is that a Medical Officer can make the recommendation to the physiotherapy department, but it is ultimately the physiotherapy department that makes the ‘yes’ or ‘no’ call. [regarding the need for referrals off-base] (PT, K15)

A CFHS physician described the delivery of healthcare services on-base as interprofessional, emphasizing “That is the outset; that is the theory.” He explained further:

In practice, as with all things whether it is medicine or any other profession, whether people talk to each other is more a matter of personality and previous life experience than it has to do with either the profession or organization they work in.

Although we can tell people how they should practice, ultimately we are not micromanaging... So, in a perfect world they would all be exchanging, collaborating and talking to each other, but knowing from experience, this is not always the case. This is the first caveat... theory and practice are two very distinct entities. (MD, K11)

A CFHS physiotherapist reflected on past and present military postings, concluding: “We haven’t really seen a significant need for chiropractic referral to an external healthcare provider.” A second physiotherapist elaborated further, stating: “We [physios] are able to provide every skill set and every possible intervention that a CAF member may require as part of their treatment plan...” A third physiotherapist considered a hypothetical situation, described as an “odd case,” where a referral to a chiropractor might be authorized:

The odd case where a spinal manipulation is indicated for a particular condition such as fixated facet joint, something of that nature, where they have a mechanical obstruction that has a low amplitude, high velocity mobilization may be beneficial for, we have the flexibility to refer to a chiropractor, as they specialize in this technique. (PT, K3)

A CFHS physiotherapist shared views on the gatekeeping process and the factors motivating some CAF members to pursue chiropractic care. The assumptions made explicit in the following quote may appear paternalistic and the perception may raise questions surrounding gatekeepers’ motivations and lack of transparency in outsourcing decisions:

So, what typically happens, the patient comes in and says, ‘I want chiropractic care’ and the doctor says, ‘Well, have you done any physio?’ This is where the patient and the physician can be in a little bit of a position of power. They may say something like, ‘No, I have tried physio and it doesn’t work.’ In my experience, a large portion of these patients have come once or twice for physio and have stopped doing their exercises and have basically been non-compliant. There are a percentage

of patients that have done physio, have done their due diligence, have worked hard but have not gotten the results they want, there are some of those patients and those patients are very few and there is just not that many out there... So very seldom is that choice of chiropractic care based on a bio-mechanical assessment and sound assessment findings. (PT, K9)

Facilitating access to understanding of roles

When discussing issues associated with role clarity, and the perceived duplication of services between physiotherapists and chiropractors relative to MSK conditions, one physiotherapist (PT, K9) espoused critical questions: “Is there any reason to send anyone for chiropractic care? What is the scientific evidence to suggest that chiropractors can do a better job than our physiotherapists and what is the determining factor for this?” Importantly, another CFHS physiotherapist posed the same questions, but in a slightly different manner:

What would the difference be? What would be the net overall benefit of having a chiropractor in the clinic when the services provided are essentially going to be the same? ...If you really want to look at how a chiropractor would function in a military setting just look at how a physiotherapist is functioning in a military setting and it would be the same. (PT, K25)

A CFHS physiotherapist with managerial experience, emphasized organizational barriers, including current labour-management relations, to the integration of chiropractic services into CDUs across the country. For example, “The public service union is an extremely strong union right now... If somebody else comes into this clinic that provides the exact same services as our physiotherapists provide but are getting paid substantially more, the union would have something drastic to say about that.” (PT, K25)

A physician addressed interprofessional care in the CFHS with emphasis on the complexities of bringing healthcare professionals together for the common good of a patient: “The scopes of practice, collegiality, respect, and everyone has to know their ‘arcs of fire,’ how to engage...” (MD, K14).

Referring more specifically to the possibility of including off-base chiropractors as members of the healthcare team, the physician asked:

Who gets involved when its physio and chiropractor that are both involved with one patient? I think at the moment we try physio with similar physio, similar [same thing with] chiropractor, and not mix-and-match. Obviously some patients are very complex; maybe there is a case of having both specialties providing care simultaneously. (MD, 14)

A CFHS physician began his interview by stating, “MSK and mental health are my two largest presenting complaints.” Later on, he addressed barriers associated with the blurred roles of physiotherapists and chiropractors in the delivery of MSK services. The key informant posits that within both professional groups there are significant inconsistencies in approach, services and patient outcomes that complicates referral and outsourcing decisions.

We find chiropractors, some of them are excellent, right, provide such great advice, they provide modalities, they are effective, patients are satisfied. And others that are missing the mark and tell me that their spine has something to do with diabetes or their pancreas, you know. It doesn't make any biological sense and we don't always know that ahead of time until we try them (laugh). So there is some overlap in terms of what they provide and we are careful about that because by the time you get to 20 sessions of physio and we are considering chiropractic care, or they have done a few sessions of chiro care and you are considering some different modalities there is an overlap. (MD, K12)

In the above quote, the CFHS physician alluded to some chiropractors providing questionable services, not supported by current scientific evidence, and the questions this raises for those fulfilling gatekeeper roles within the CFHS. This observed diversity in individual chiropractic practices, reportedly raises questions of the trustworthiness of certain practices and creates uncertainty among decision-makers, which in turn negatively impacts the frequency of chiropractic referrals and their ultimate intergration.³⁸

The observed diversity and competing factions within professions is common³⁹ but within the chiropractic profession continues to be a source of challenge in advancing the image of a unified profession⁴⁰ and promoting inter-professional collaboration^{36, 38}. The challenge is further complicated by chiropractors holding pseudoscientific beliefs⁴¹ and whom draw national media attention to the profession.⁴² Our findings, situated within the broader public discourse surrounding the efficacy of some chiropractic practices, suggest that despite current research supporting the chiropractic profession's well defined scope of practice and the integration of chiropractors into mainstream healthcare delivery⁴³, considerable confusion exists surrounding the scope and unique value-added contributions of the profession within the CFHS, and Canadian society, at large.

When discussing issues associated with diagnosing and treating MSK conditions in the CAF, a CFHS physician emphasized “having the right providers at the right time for the patient (MD, K1). When explaining critical knowledge gaps, the physician does not distinguish between chiropractic and manipulation therapy:

“The majority of the members that we refer out [for chiropractic care] have developed chronic musculoskeletal and low back pain disorders... I think the benefit of doing manipulative therapy and other types of chiro approaches on these people is very limited. I am not sure that we have the outcomes desired either, by referring them out at that late stage in the process... It's important on our side to educate more of our prescribers or providers about what can chiropractic or manipulation therapy bring to an individual based on their condition and what are the most likely conditions that will respond to chiropractic or mainuplative care?” (MD, K1)

The physician concluded the interview by providing a fairly recent and positive example related to mental health. In the following quote, he described how the CFHS strengthened IPC and enhanced role clarity, with emphasis on communication, education and outreach:

“We've been able to develop better ways of communicating with external mental health clinicians... We do a lot internally, but we outsource a significant portion of mental healthcare, as well... We've been able, through local communication and outreach, to educate... clinicians in the community about the specific needs of the military and what we need from them in return from our consultation.” (MD, K1).

The physician (MD, K1) stated that although the military had yet to come-up with a standardized approach or a national strategy, local initiatives, involving off-base mental health clinicians, demonstrated the positive outcomes associated with “better outreach and better communication with external providers.”

Discussion

Currently, CAF members have access to chiropractic services within the spectrum of care and at the discretion of CFHS providers. Within this context, our overall findings inform health policies, practices and applied research that could address existing barriers to effective referrals and improve quality of care.³⁷ However, it is simplistic to suggest that barriers can be addressed and opportunities fully realized without an in-depth understanding of the factors underpinning IPC related to MSK conditions, at multiple levels: CAF member, healthcare professional, healthcare team, organization, profession, and civil society.

Interprofessional practice is often discussed in the literature from the perspective of key and enabling competencies. Recognizing the complexities of IPC practice and the limitations of current theoretical underpinnings informing our understanding of ‘competencies,’ Flood *et al.* (2019) call for expanding the discourse⁴⁴. Utilizing a phenomenological hermeneutic approach, the authors conclude that “working in the ‘spirit’ of interprofessional practice goes beyond competencies... [It] cannot be reduced to separate aspects, it is about everything” (p. 493).⁴⁴ This finding has relevance to our work, with special emphasis on the barriers we identified related to role clarity and interprofessional communication. For example, in the Communication domain, efforts to evaluate IPC competencies related to interpersonal skills, using current assessment tools/resources, are limited in their ability to “capture the spirit” – that is, the “compartment the person brings, shaped by culture, history, life experience, influenced by mood, time and challenge...”⁴⁴ In consideration of our findings

of the perspective of a limited chiropractic scope of practice, if one is to advance an ontological approach to IPC and Interprofessional Education (IPE), according to Flood *et al.* each individual must “strip oneself of the professional mask, to be revealed as ‘human’, a person with feelings, ideas, history and hope” (p.498)⁴⁴.

The development of interprofessionality (i.e., the field of interprofessional practice and interprofessional education) implies a better understanding of the determinants and processes that influence both IPC and IPE.⁴⁵ This emerging concept is grounded in the notion that silo-like division of professional responsibilities “is rarely naturally nor cohesively integrated in a manner which meets the needs of both the clients and the professionals” (p. 9).⁴⁵ Our findings suggesting limited understanding of the role of chiropractors beyond providing manipulative supports the notion that practitioners are often limited in their abilities to recognize professional values, stereotypes or misconceptions of other healthcare professionals. Such limited abilities may be grounded in neoliberalism, where professions focus on their autonomy, services and entrepreneurial competitive interests rather than on professionalism, where the best interest and concern of the patient are foremost considered.⁴⁶ Ultimately, in order to address factors that hinder chiropractic IPC within the unique culture of the CFHS, strategies need to be developed with the goal of establishing more cohesive and less fragmented practices. Similar barriers have been identified in other settings wherein insider groups' subordination of outsider groups close access to opportunities and resources and use demarcatory strategies to monitor, create and control boundaries, thus securing a privileged access to markets.^{21,39} To this end, our work calls for increased attention to the role of gatekeeper in model design and testing. In addition, we need to further explore the patients, CAF service members, lived experience to capture their perspective and opinion of such a collaborative role.

Increasingly, Canadian experts in IPC emphasize the need to move from an emphasis on individual competencies to an examination of competencies at the team-level. This requires an increased understanding of and respect for professional roles, their complex interactions, and the facilitators and barriers to interprofessional teamwork. Lingard *et al.* (2012) employed the theoretical lens of activity theory to explore the inherent complexities associated with IPC and IPE.⁴⁷ The findings challenge two his-

torical premises: the notion that stable professional roles exist, and the ideal of a unifying objective of ‘caring for the patient’ (p. 876).⁴⁷ Our conclusions support the notion that amongst MSK service providers, roles and scopes of practice are increasingly fluid and often blurred, perceived to vary from base-to-base, and are often context-specific. We support the conclusions of Lingard *et al.* that collaborative expertise involves being attuned and responsive to this fluidity” (p. 875).⁴⁷ Further, although “patient-centred care” was earlier identified as a key facilitator to integrating chiropractic care in the CFHS¹¹, we concur with Lingard *et al.* (2012), that this ideal is shared widely among diverse professional groups⁴⁷. Therefore, “as a motivation for collaborative action it is in constant tension with other relative motives, such as appropriate resource allocation and trainee education” (p. 876).⁴⁷

Given the ongoing re-design of healthcare systems, integrating aligning institutions with organization-specific missions and work cultures will be a priority. Within this context, interprofessional co-managing will be expected, requiring new ways of working and enhanced capacities for managers and team leaders in relationship development. According to Clausen *et al.*, based on an integrative review of educational interventions to enhance competencies for IPC among nurse and physician managers, competencies for collaborative management practice have yet to be addressed.⁴⁸ Novice managers will need to build strategic and effective partnerships to increase productivity, mobilize knowledge across teams and settings, and eliminate perceptions of systemic overlap or role duplication in order to ensure positive impact for patients. Our findings reinforce the significance of strengthening IPC specific to MSK conditions in the CFHS, including an examination of gatekeeping roles, role clarity and responsibilities and outcomes of care. We propose that it is timely to investigate models of care that nurture and sustain inter-provider and inter-team relationships to plan and coordinate care for MSK conditions, within the CFHS, and its extended referral networks. Rather than considering professions as an intervention with competing interests, consider their full scope of practice and differing views as complementary instead of exclusionary to be applied for the benefit of patient care.

Our findings emphasize the significance of professional cultures as barriers to effective IPC. We are reminded of the pioneering work of Hall (2005) who addressed

the increasing specialization of healthcare professions.⁴⁹ This has led to the “further immersion of learners into the knowledge and culture of their own professional group.” We have seen through our work that constantly defining and redefining professional roles and/or boundaries vis-à-vis MSK conditions, increases the risks inherent in one professional group excluding or forcing out their rivals – often with the propensity of describing rival groups as “frauds, amateurs, or incompetents” (p. 189).⁴⁹ Given the unique environment of the CFHS, coupled with other distinguishing characteristics of military culture anchored in rules, norms, values and traditions⁵⁰, there may be a danger in ‘insiders’ seeking scapegoats from within its external referral networks when faced with complex patient care challenges. According to Hall (2005), this can exempt members of a group from taking full responsibility for the consequences of their work (p. 189).⁴⁹ The notion of interprofessional cultural competence is especially important when healthcare teams are involved in internships and work placements, charged with ensuring that students have the requisite knowledge and skills to collaborate effectively in the real world.⁵¹

An examination of factors that foster or prevent interprofessional teamworking in primary and community care concluded that team structure (team premises) and team process were key considerations.^{6,52} For example, shared team premises may enhance information transaction, facilitate communication, and increase personal familiarity. In contrast, members with separate bases or work settings were less integrated with the team, which may limit team functioning and effectiveness.⁵³ The stability of the team was also deemed important in fostering IPC. Our findings suggest that from the perspectives of off-base contractors, workplace isolation and the dynamic composition of CFHS healthcare teams, due to military transfers, deployment and other internal factors, are contributing to IPC barriers. In addition, evidence suggests that the vast majority of providers outside of military facilities do not demonstrate military cultural competency, which impacts not only patient care but impedes effective communication and formation of alliances.⁵⁴ Thus, ensuring military cultural competence of civilian healthcare providers through appropriately structured IPE and ensuring its implementation into practice is another essential component successful IPC.

In summary, our findings illuminate a central ques-

tion for the CFHS that has yet to be addressed: “Is there any reason to send anybody for chiropractic care?” Although stakeholders (CFHS policymakers, practitioners, and off-base service providers) articulate a common goal, that is, achieving and maintaining healthy spines in CAF members, our findings suggest that they construct their professional roles, scopes of practice and work cultures very differently. Where the edges of their scopes or “territories” meet, the underlying conditions become “boundary objects” that must be negotiated.⁵⁵ We posit that the CFHS and its extended MSK referral networks, offers an information-rich “case” to explicate promising practices in IPC, with the potential to bring down the walls imposed by professional silos, for the benefits of policymakers, managers, healthcare professionals, educators, society, but most importantly CAF patient members.

Limitations

In presenting results in this manuscript we focus on one of six IPC domains (i.e., role clarity). To further explore issues central to this work, additional publications should include an in-depth examination of other IPC competency domains relative to key patterns or over-arching themes. Our efforts to obtain detailed documentation related to CFHS referrals to chiropractors and physiotherapist located off-base (e.g., numbers, location, diagnoses, etc.) , were not successful during the time that data was being analyzed and final reports prepared.

Our study consisted of military personnel, public servants and contractors of the Canadian Armed Forces and civilians. Participants were from different CAF bases, healthcare services, and geographic regions across Canada. Military personnel were of different ranks and military experience. It is possible that individuals who were not invited to participate may have expressed different views. We also did not explore patients’ perspectives of care delivered within the CFHS nor their experiences when requesting or being referred for chiropractic services.

Conclusions and recommendations

Our study provides the first qualitative analysis of barriers and opportunities for the collaboration of chiropractic within the unique CFHS environment. This manuscript, exploring IPC relative to MSK conditions in the CFHS, elucidated barriers and opportunities to potentially inform

a series of next steps involving key stakeholders. Further, findings reinforce the importance of bringing CAF members' voices to this important work.

Based upon our qualitative analysis, the research team posits the following recommendations gleaned from the over-arching experiences, perceptions, meanings and interpretations shared by key informants, together with reflexivity of the researchers, and an in-depth description and interpretation of the research problem. Our recommendations are:

1. Given the prevalence of MSK conditions in the CAF, and demonstrated interest in exploring cost-effective, evidence-based and sustainable changes to the delivery of care, design a pilot project to explore the interdependencies between the role of the physiotherapist and those of other professionals to optimize each members' scope.
2. In collaboration with academic partners and funding agencies, carry out research to increase understandings of the CAF members' experiences in seeking treatment for MSK conditions, both on-and-off the military base. This could include information-rich case studies, evaluative studies and quality care initiatives.
3. In partnership with educational partners, develop a suite of interactive IPE tools and resources, including military cultural competence and simulations, to depict the complexities associated with IPC in the treatment of MSK conditions and how best to mitigate these barriers in the real world of military healthcare.
4. Within the CFHS, expand continuing education sessions, and other knowledge dissemination and training activities focused on MSK conditions, to include, where feasible, broad representation of professionals from across the continuum of care, and respectful of the unique military culture and its environment.
5. MSK service providers must ensure that practices are professional, evidence-based, carried out with competence, with emphasis on clear and respectful communication strategies to strengthen care, coordination, collaboration and common understandings of care.

Box 1.

Interprofessional care.

Adapted from Centre for Interprofessional Education, Toronto Academic Health Science Network, 2017

Interprofessional Care* (IPC) occurs “when multiple health workers from different professional backgrounds provide comprehensive health services by working with clients/patients, their families, carers and communities to deliver the highest quality of care across settings”⁵⁶. [p.3.]

The Interprofessional Care Competency Framework includes six competency domains: Patient/Client/Family/Community Centred Care; Communication; Role Clarity; Conflict; Team Functioning and Collaborative Leadership⁵⁶.

Role Clarity. The provider/team understand their own role and the roles of those of other providers and inter-sectoral teams, using this knowledge to establish and achieve quality care as well as advance the health of populations. Enabling competencies include:

Understand own role and roles of those in other professions;

Explore the interdependencies between own role and roles of others to optimize each members' scope;

Facilitate access to understanding of roles and access to health and social services⁵⁶.

Acknowledgments

We thank the men and women of the Canadian Forces Health Services for their contributions to this study and to the Canadian and Ontario Chiropractic Associations for funding.

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Appendix A.
Interview Guide

1. Can you share an example of a positive collaborative experience that you have experienced, or have observed? This can be related to musculoskeletal pain, but not necessarily so...
Probe: What are the observed benefits of collaboration in the example that you provided?
2. In a collaborative setting within the CAF, for example, if a patient walks in with back pain can you describe what would happen?
Probe: How is choice of treatment determined? What role does the patient play? Which providers are accessed? When and why?
Probe: Collaborative practice within the CAF is evolving. How does staff mobility, e.g. posting changes, affect the establishment of collaborative practice?
3. We understand that chiropractic services are included in the CAF spectrum of care. How would you describe the military spectrum of care?
Probe: How would you describe the chiropractic spectrum of care within the CAF? How do CAF patients access chiropractic services? How does the process work, e.g. direct referral from base health care provider; patient requested; only after limited treatment response, etc.
4. For what conditions would you see chiropractic care being accessed? Is there a need in the CAF?
Probe: nature of condition; duration of condition (acute vs chronic)
5. What are your suggestions for the research team as we explore the issue of chiropractic care collaborations within the CAF health care system?
Probe: Can you elaborate on chiropractic care on-base? Off-base? Current challenges and opportunities of such access? Impact on patient care? If collaboration with chiropractic care in the CAF health care system is not necessary, why is it not necessary?
6. What is nature of communication between chiropractors and CAF health care providers?
Probe: does communication exist, in what form? How can it improve, if so how?
7. What criteria would you use to assess the impact of collaborative practices in the CAF between medical, physiotherapy and chiropractic services?
Probe: what are the indicators? What are the outcomes?
8. Of everything we have spoken about today, what would be the key messages or key points you would use to summarize this discussion?
9. Who else, or which organization, do you recommend we speak to on this topic? Could you please provide us with the contact information? Can we use your name when we contact them?
Probe: Could you recommend a physician, physician assistant (PA), nurse, physiotherapist, chiropractor or others who we should speak to on this topic?

Adverse events from spinal manipulations in the pregnant and postpartum periods: a systematic review and update

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Background: *The purpose of this study is to update a previous critical review of adverse events in pregnant and postpartum populations.*

Methods: *The following databases were searched: PubMed, CINAHL, Index to Chiropractic Literature, Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials and MEDLINE. We included all study design types as it was determined a priori that there would not be enough high-quality research on spinal manipulative therapy (SMT) in these populations to make any determinations. The Scottish Intercollegiate Guidelines Network (SIGN) and CARE (CAse REport) checklists were used for quality rating.*

Results: *This update found one case study that demonstrated a serious adverse event in the cervical*

Manipulations vertébrales chez la femme enceinte et la femme en postpartum : mise à jour : mise à jour d'une étude sur les effets indésirables

Contexte : *La présente étude vise à mettre à jour les résultats d'un examen critique des effets défavorables des manipulations vertébrales chez la femme enceinte et la femme en postpartum.*

Méthodologie : *On a interrogé les bases de données suivantes : PubMed, CINAHL, Index to Chiropractic Literature, Cochrane Database of Systematic Reviews/ Cochrane Central Register of Controlled Trials et MEDLINE. On a retenu toutes les études parce qu'il avait été établi antérieurement que le nombre de recherches de bonne qualité sur les manipulations vertébrales (MV) chez la femme enceinte et la femme en postpartum était insuffisant pour trancher toute question. On s'est servi des listes de vérification Scottish Intercollegiate Guidelines Network (SIGN) et CARE (CAse REport) pour évaluer la qualité des études.*

Résultats : *Une étude de cas faisait état d'un grave effet indésirable à la colonne cervicale après des*

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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.

spine following SMT and a handful of minor and transient adverse events in the low back following SMT.

Conclusions: There was limited evidence of adverse events following SMT in these populations. Although we are calling for improved reporting of such events in future studies, it may be that such injuries are rare.

(JCCA. 2021;65(1):32-49)

KEY WORDS: chiropractic, spinal manipulative therapy, manual therapy, pregnancy, postpartum, adverse events

Introduction

Musculoskeletal pain is a frequent complaint during pregnancy and the postpartum period. Low back pain (LBP), pelvic girdle pain (PGP), carpal tunnel syndrome, and mid-back pain are common complaints in these groups, with LBP being the most common complaint among pregnant women. The prevalence of low back pain during pregnancy has been reported as up to 90% of pregnant women¹⁻⁶ and may continue into the postpartum period with up to 75% of women reporting symptoms six months following birth⁷⁻¹² and approximately 8-20% still suffering from pregnancy-related pain two to three years after giving birth¹³. Both pregnant and postpartum women have described the back pain as moderate, severe or disabling^{1, 7} and interfering with life in general; interrupting activities of daily living, sleep and child rearing^{1, 8, 13, 14}. Unfortunately, many primary health care providers consider pregnancy-related back pain to be a normal and unavoidable occurrence¹⁵⁻¹⁷ and patients often receive little or no treatment suggestions to manage their condition^{18,19}.

The etiology of pregnancy-related back pain is unknown.^{17, 20} It has been suggested that causation is multifactorial and some of the proposed mechanisms include, but are not limited to, maternal weight gain, biomechanical changes due to pregnancy^{17, 21}, changes in abdominal musculature to accommodate the growing fetus²²⁻²⁴ and/or increased circulating relaxin²⁵ producing ligamentous laxity²⁶. In general, women are more susceptible to increases in joint laxity than men.^{27, 28} It has been suggested that hormonal changes may be responsible for these differences.²⁹⁻³¹ By the twelfth week of pregnancy produc-

MV et d'une poignée d'effets indésirables mineurs et transitoires à la colonne lombaire.

Conclusions : Il existe peu de preuves que les MV ont des effets indésirables chez les populations à l'étude. Il faudrait plus de données. Mais il est permis d'affirmer que ces effets indésirables sont rares.

(JACC. 2021;65(1):32-49)

MOTS CLÉS : chiropratique, manipulations vertébrales, grossesse, postpartum, effets indésirable

tion of the hormone relaxin is increased and “relaxes” the joints and ligaments for labour and delivery of the baby through the vaginal canal.^{32,33} This change in hormonal milieu does not dissipate upon delivery and it is suggested that women immediately postpartum may continue to experience hormone-mediated ligament laxity. It is important to note that this increase in ligament laxity is not targeted just at the pelvis³⁴ thereby making these women more susceptible to various musculoskeletal injuries during this time.

Low back pain (LBP)³⁵, neck pain³⁶⁻³⁸ and headaches³⁹ are significant causes of pain and disability in the non-pregnant population. Approximately 80% of the population experience at least one episode of LBP in their lifetime³⁵, 30-50% experience neck pain in a given year⁴⁰ and approximately 50% of people will experience a headache within the last year⁴¹. One effective treatment option for patients experiencing any of these pains includes spinal manipulative therapy (SMT)⁴²⁻⁴⁷; whereby a localized force of high velocity and low amplitude (HVLA) is applied in the direction of the spinal segment. In the non-pregnant population, severe adverse events following SMT are rare⁴⁸⁻⁵³ with most events being reported in lower level of evidence studies such as case reports or case series^{54, 55}. It is noteworthy that there are published case reports describing vertebral artery dissection and stroke following manipulation in the non-pregnant population.⁵² However, most cases of extracranial vertebral artery dissections are thought to occur spontaneously in individuals with other risk factors such as connective tissue disorders, migraine, hypertension or vessel abnormalities.⁵² At this

time, the current evidence does not find excess risk for vertebral artery dissection from individuals seeking care from chiropractors compared to primary care.^{52, 56}

Effective treatment options for pregnancy or postpartum related-back pain are not well known.⁵⁷⁻⁵⁹ There are few well designed randomized controlled trials⁶⁰⁻⁶² (RCTs) investigating chiropractic care on pregnancy and postpartum-related spine pain, with most of the current evidence for this population being case studies. Although chiropractors report seeing pregnant and postpartum patients regularly^{59, 63}, the lack of evidence for these two populations is surprising given the impact pain can have on a woman's life during these time periods. Similarly, there is little information regarding the safety of treatment options, such as SMT, in these populations. Given the coagulability status^{64, 65} of these women and the plethora of hormonal and biomechanical changes that occur as a result of pregnancy and into the postpartum period, it is possible that some treatment options, such as SMT, may be contraindicated in these populations.

Our 2012 critical review of the literature identified four case reports^{50, 51, 66, 67} and one prospective observational cohort study⁶⁸ reporting adverse events in seven individuals (five pregnant and two postpartum) following SMT⁶⁹. Events ranged from minor pain following treatment, to fracture, stroke and epidural hematoma. This is an update of that previous paper and our aim is to systematically review the literature for any reported cases of iatrogenic injuries following SMT and other manual treatments.

Methods

Similar to our first review⁶⁹, in this updated review we determined *a priori* that limiting our review to systematic reviews (SR) and RCTs would exclude valuable information regarding adverse events, so cohort and case reports were included. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews (PRISMA) and was registered with PROSPERO (no. CRD42019048918).

Literature search parameters

A literature search strategy (Appendix 1) was developed in collaboration with a health sciences librarian (KM). The following items were considered in developing the strategy:

Participants/Population

Women who were either pregnant or postpartum (up to 6 weeks after birth) with spine and/or pelvic girdle musculoskeletal complaints.

Intervention

The interventions examined included spinal SMT and any other manual therapies performed by chiropractors, osteopaths and physiotherapists; as the latter two can deliver similar treatment plans to pregnant women, these terms were also included.^{57, 58, 70}

Comparators

There were no restrictions for the comparison group which may include: active treatments (such as exercise), placebos/shams, usual obstetric care (UOBC) or no treatments.

Outcomes

The presence of adverse events/iatrogenic injuries.

Search strategy

The following databases were used in the search strategy: PubMed, CINAHL, Index to Chiropractic Literature, Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials and MEDLINE. Search terms consisted of subject headings specific to each database (i.e. MeSH in MEDLINE) and free text words relevant to pregnancy, postpartum, low back pain, pelvic girdle pain, chiropractic, etc. Publications in the search were restricted to the English language and from the date of our last review (October 2011) until November 2018. An additional search strategy was employed when reviewing systematic reviews (SR). Similar to Hawk *et al.*⁷¹ and others⁴⁶, two investigators (CAW and SW) searched each included SR for eligible studies not identified through the formal search. Any that were deemed potentially acceptable were added to the list of studies to be analyzed.

Screening

Titles were screened independently by two reviewers (SW and CAW). Disagreements on eligibility were resolved by discussion. The same two investigators reviewed the abstracts and articles. If there was disagreement between the reviewers, a third investigator also reviewed (KS) either

Inclusion	Exclusion
Studies that address adverse events including: Randomized control trials Cohort Studies Any other clinical trials Case studies Case reports	Studies that do not address adverse events Non-peer reviewed publications Commentaries/editorials/ letters No treatment outcomes Non-clinical studies A score of "unacceptable" by the SIGN criteria for SRs, RCTs and cohort studies

Figure 1.
Inclusion and exclusion criteria

the abstract or full-text article and the majority rating was used following a group discussion. Studies of unacceptable quality were excluded from the evidence tables.

Eligibility criteria

The eligibility criteria for articles in the search can be found in Figure 1.

Evaluation of risk of bias

As previously performed by Hawk *et al.*⁷¹ and others^{57, 58} the Scottish Intercollegiate Guideline Network (SIGN) checklists were used to evaluate systematic reviews/meta-analyses⁷² (both abbreviated as "SR") and cohort studies⁷³ and a modified SIGN checklist was used to review

Item		Yes/No ^a
1.1	The research question is clearly defined, and the inclusion/exclusion criteria must be listed in the paper.	
1.2	A comprehensive literature search is carried out.	
1.3	At least 2 people should have selected studies.	
1.4	At least 2 people should have extracted data.	
1.5	The status of publication was not used as inclusion criteria.	
1.6	The excluded studies are listed.	
1.7	The relevant characteristics of the included studies are provided.	
1.8	The scientific quality of the included studies was assessed and reported.	
1.9	Was the scientific quality of the included studies used appropriately?	
1.10	Appropriate methods are used to combine the individual findings.	
1.11	The likelihood of publication bias was assessed appropriately.	
1.12	Conflict of interests are declared.	
	Total score ^b	

Figure 2.
SIGN checklist for systematic review⁷²

SIGN – Scottish Intercollegiate Guideline Network

^aRating: "Yes" = 1, "No" or unable to tell from the article = 0

^bScoring: Sum of items - >9 high quality, low risk of bias; 6-9 acceptable quality, moderate risk of bias; <6 low quality, high risk of bias; if 1 and/or 3 are "no" Unacceptable quality (reject)

Item		Yes/No ^a
1.1	The study addresses an appropriate and clearly focused question.	
1.2	The assignment of subjects to treatment groups is randomized.	
1.3	An adequate concealment method is used.	
1.4	The design keeps subjects and investigators "blind" about treatment allocation.	
1.5	The treatment and control groups are similar at the start of the trial.	
1.6	The only difference between groups is the treatment under investigation.	
1.7	All relevant outcomes are measured in a standard, valid and reliable way.	
1.8	What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?	
1.9	All the subjects are analyzed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).	
1.10	Where the study is carried out at more than one site, the results are comparable for all sites.	
	Total score ^b	

Figure 3.
Modified SIGN Randomized controlled trial checklist⁷⁴

SIGN – Scottish Intercollegiate Guideline Network

^aRating: "Yes" = 1, "No" or unable to tell from the article = 0

^bScoring: Sum of items - 9-10 high quality, low risk of bias; 6-8 acceptable quality, moderate risk of bias; 3-5 low quality, high risk of bias; 0-2 or if item 1 and/or 3 are "no" unacceptable quality (reject)

Item		Yes/No ^a
1.1	The study addresses appropriate and clearly focused question	
1.2	The two groups being studied are selected from source populations that are comparable other than the factor under investigation. Only when there is a comparison group.	
1.3	The study indicates how many of the people asked to take part did so, in each of the groups being studied. Only in prospective, multiple cohort studies.	
1.4	The likelihood that some eligible subjects might have outcome at the time of enrolment is assessed and taken into account in the analysis	
1.5	It was revealed what percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed. In prospective studies.	
1.6	A comparison is made between full participants and those lost to follow-up, by exposure status. Only in prospective, multiple cohort studies.	
1.7	The outcomes are clearly defined.	
1.8	The assessment of outcome is made blind to exposure status. In studies with more than one group.	
1.9	Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome.	
1.10	The measure of assessment of exposure is reliable	
1.11	Evidence from other sources is used to demonstrate that the method of outcome is valid and reliable. Whenever any kind of subjective measure is used.	
1.12	Exposure level or prognostic factor is assessed more than once. Prospective studies only.	
1.13	The main potential confounders are identified and taken into account adequately in the design and analysis.	
1.14	Confidence intervals are provided.	
	Total score ^b	

Figure 4.
SIGN Cohort study checklist⁷³

SIGN – Scottish Intercollegiate Guideline Network

^aRating: “Yes” = 1, “No” or unable to tell from the article = 0

^bScoring: Sum of items – 12-14 high quality, low risk of bias; 9-11 acceptable, moderate risk of bias; 6-8 low quality, high risk of bias; <6 unacceptable quality.

RCTs^{71, 74}. The modified SIGN RCT checklist combined information from the original checklist about concealment and blinding of the investigators, and it added three other items including patient blinding, sample size justification and if the required sample size was reached (items 3, 4, 5 and 9). Unlike the original SIGN RCT checklist⁷⁴, the modified one did not take into consideration drop-outs or compare results from different sites⁷¹. Two of the original The SIGN checklists score each article as “high quality, low risk of bias”, “acceptable quality, moderate risk of bias”, “low quality, high risk of bias” or “unacceptable” quality. Any studies that were scored as “unacceptable” quality were removed from further analysis. Each level was defined by scoring the checklists and assigning a value of “1” for each “yes” response. Figures 2, 3 and 4 list the items in each checklist and explain the scoring system used to determine quality rating.

For case reports, the CARE (CASE REport) checklist for case reports was employed.⁷⁵ The CARE checklist evaluates 13 main areas over 30 specific items (Figure 5). Although there is no scoring system for this checklist, we decided *a priori* that each item would be worth “1” and a high score would indicate a more robust case report. A consensus-based decision between reviewers on whether the internal validity of the case reports was acceptable for inclusion in the current review.

Two investigators (CAW and SW) evaluated each article. If there was a disagreement between the two reviewers, a third investigator (KS) was asked to review. The majority rating was used after discussion among reviewers.

Data extraction

Variables for data extraction was determined *a priori* and completed by two investigators (CAW and SW) and the third author (KS) verified all of the data presented in the tables. All information extracted was entered into a Microsoft Word table.

Systematic Reviews (SRs)

Information extracted from SRs included: citation (first author and year of publication) and quality assessment, type of treatment/intervention, number of studies included, number of participants and type of studies included, results of that assessment and overall conclusions of the review.

Randomized Controlled Trials (RCTs)

Information extracted from RCTs included: study identification by citation (first author and year of publication) and quality assessment, patient population information, mean age and mean symptom duration, treatment/intervention, comparison group, dosage, adverse events reported and overall study conclusions.

Cohort studies

Information extracted from cohort studies included: study

identification by citation (first author and year of publication) and quality assessment, patient population information, mean age and mean symptom duration, intervention, dosage, adverse events reported and overall study conclusions.

Case reports

Data extracted from the case reports included: study identification by citation (first author and year of publication), case presentation, treatment, and adverse events reported.

Item	Description	
1	Title	The area of focus and “case report” should appear in the title
2	Key words	Two to five key words that identify topics in the case report
3	Abstract	a. Introduction – What is unique and why is it important?
		b. The patient’s main concerns and important critical findings
		c. The main diagnoses, interventions and outcomes
		d. Conclusion – What are one or more “takeaway” lessons
4	Introduction	Briefly summarize why this case is unique with medical literature references
5	Patient Information	a. De-identified demographic and other patient information
		b. Main concerns and symptoms of the patient
		c. Medical, family and psychosocial history including genetic information
		d. Relevant past interventions and their outcomes
6	Clinical findings	Relevant physical examination (PE) and other clinical findings
7	Timeline	Relevant data from this episode of care organized as a timeline (figure or table)
8	Diagnostic Assessment	a. Diagnostic methods (PE, laboratory testing, imaging, surveys)
		b. Diagnostic challenges
		c. Diagnostic reasoning including differential diagnosis
		d. Prognostic characteristics when applicable
9	Therapeutic Interventions	a. Types of intervention (pharmacological, surgical, preventative)
		b. Administration of intervention (dosage, strength, duration)
		c. Changes in the intervention with explanations
10	Follow-up and Outcomes	a. Clinician and patient-assessed outcomes when appropriate.
		b. Important follow-up diagnostic and other test results
		c. Intervention adherence and tolerability (how this was assessed)
		d. Adverse and unanticipated events
11	Discussion	a. Strength and limitations in your approach to this case
		b. Discussion of the relevant medical literature
		c. The rationale for your conclusions
		d. The primary “take-away” lessons from this case report
12	Patient perspective	The patient can share their perspective on their case
13	Informed Consent	The patient should give informed consent

Figure 5. *Case REport (CARE) Checklist*⁷⁵

Table 1.
Risk of bias assessment of included SRs with the SIGN checklist.

First author and year published	Items on SIGN checklist ^a												Total	Quality ^b
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12		
Liddle, 2015 ⁷⁶	1	1	1	1	0	1	1	1	1	1	1	1	11	H
Franke, 2017 ⁷⁸	1	1	1	1	0	1	1	1	1	1	1	1	11	H
Ruffini, 2013 ⁷⁷	1	1	1	1	0	1	1	1	1	1	1	1	11	H
Hall, 2016 ¹⁸	1	1	1	1	1	1	1	1	1	1	1	1	12	H
Gutke, 2015 ⁷⁰	1	1	0	1	0	1	1	1	1	0	1	1	9	A
Sharma, 2014 ⁷⁹	1	1	1	1	0	0	1	1	1	0	0	0	8	A
Majchrzyki, 2015 ⁸⁰	0	0	0	0	0	0	0	0	0	0	0	0	0	U
Posadaski, 2011 ⁸¹	0	0	0	0	0	0	0	0	0	0	0	0	0	U

SIGN = Scottish Intercollegiate Guideline Network

^{a,b}See Figure 2 for Quality assessment SIGN checklist items^a and scoring^b for SRs

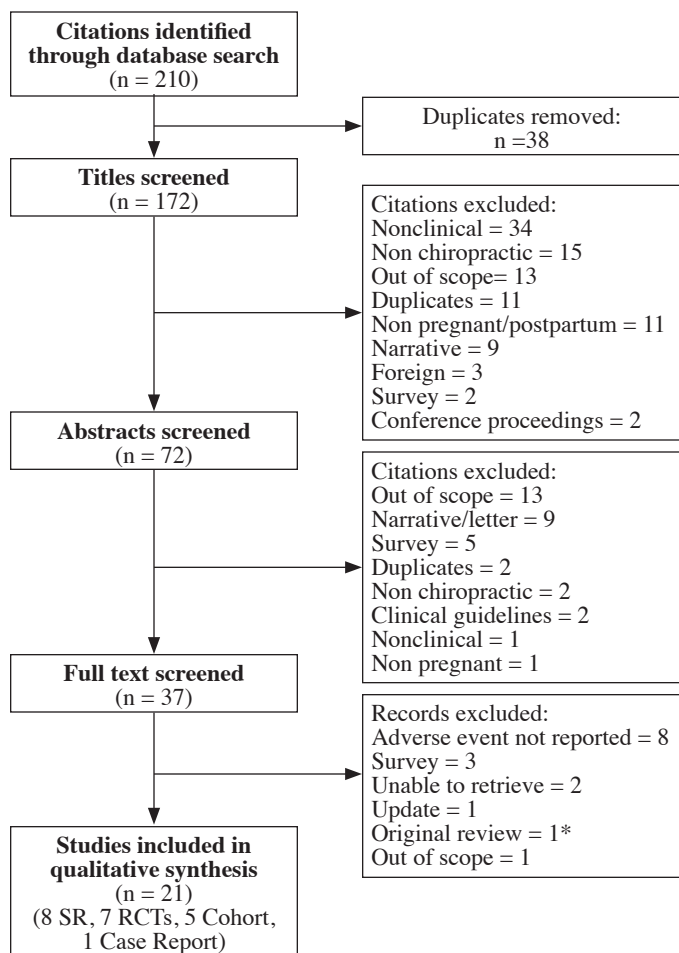


Figure 6.

Preferred reporting items for systematic reviews and meta-analysis (PRISMA) flow diagram.

*Stuber et al. (2012) not included in this analysis

Results

The initial database searches yielded 210 manuscripts (172 after duplicates removed). Of these, 21 were included in the review (8 SRs, 7 RCTs, 5 cohort, and 1 case study); see Figure 6 for the study flow diagram. Reasons for exclusion included: adverse events not reported, outside of the scope of the review, commentary/letter/narrative review, no outcomes reported, not a clinical study, non-chiropractic, abstract/conference proceeding, non-English, and not reported in a peer-reviewed journal. Excluded studies are listed in Appendix 2.

Systematic reviews

Table 1 lists each item on the Risk of Bias assessment instrument of included SRs. Of the eight SRs included, four were of “high quality”^{18, 76-78}, two were of “acceptable quality”^{70, 79}, and two were of “unacceptable quality”^{80, 81} and removed from analysis. Overall, only a qualitative analysis could be completed because of the lack of homogeneity between the trials (specifically regarding SMT) and limited methodological quality, as well as variation between individual studies (i.e., gestational age, number of participants, types of intervention, duration and frequency of intervention, outcome measures, and condition diagnosis). Table 2 summarizes the included SRs. One of the SRs examined a variety of treatment options⁷⁶ for the pregnant patient experiencing back pain, two examined osteopathic manipulative therapy (OMT)^{77, 78}, one assessed complementary and alternative medicine (CAM)¹⁸ as a treatment option, one examined modalities⁷⁰ and the final SR looked at physical therapy⁷⁹ in general. The four “high quality” SRs recorded adverse events of which

Table 2.
Evidence table for SRs including treatment/intervention, quality rating, number and type of studies and overall study conclusions.

Citation and quality*	Treatment/intervention	Number of studies and participants and type of studies	Adverse events reported	Overall study conclusion
Liddle 2015 ⁶⁶ High	Multimodal	34 studies (n=5,121): pertaining to: LBP 16 RCTs	The adverse event that were reported were considered transient and minor and mostly experienced by those who received acupuncture. LBP Overall, there were no serious adverse events to mother or fetus to report. <i>Exercise</i> (Group or individual): Studies reported no adverse events as a result of the intervention <i>Support devices</i> : No adverse events reported <i>Manual therapy</i> : One trial reported no adverse events; 1 trial reported that adverse events were similar amongst the groups, but no further details were given; 1 did not report on adverse events; 1 trial reported post-treatment soreness but no adverse effects as a result of the treatment <i>TENS</i> : No adverse event to report <i>Taping</i> : No adverse event reported	Overall, there is simply not good enough quality evidence to make confident decisions about treatments for these complaints. When reported, there were no lasting side effects on any of the studies. LBP There is low quality evidence that exercise improves pain and disability for women with LBP. Exercise interventions (from five to 20 weeks duration) improved the level of LBP and disability than women who just received regular prenatal care.
		PGP 6 RCTs	PGP Overall, no long-lasting adverse effects were reported. <i>Acupuncture</i> : Data not provided on adverse events, but some issues with needles (pain, bleeding, fainting). <i>Exercise + Education</i> : No adverse events reported <i>Belts</i> : Adverse effects not measured <i>Craniosacral Therapy</i> : some discomfort with belt, drowsiness and temporary increase in PGP	PGP In general, there is less evidence on treatment for pelvic pain. There is evidence from single studies that suggesting that acupuncture or craniosacral therapy improved PGP more than usual prenatal care.
		Both LBP and PGP 12 RCTs	Both LBP & PGP Overall, adverse events were minor and transient, when reported by subjects or investigators. There were no reported problems with any of the deliveries and neonates. <i>Acupuncture</i> : minor and transient adverse effects including bruising, local pain, nausea, weakness, heat or sweating <i>Physiotherapy</i> : some adverse effects, such as preterm uterine contractions, pre-eclampsia but unlikely to have been caused by physiotherapy	Both LBP & PGP There is moderate quality evidence that exercise results in less sick leave and fewer women reporting pain. Although the results are variable, exercise (eight to 12 weeks duration) reduced the number of women who reported back pain and land-based exercises reduced sick leave in 2 studies. However, 2 other studies suggested that sick leave was no better at preventing LBP or PGP than usual care. In addition, there is evidence from low quality studies that multimodal care (manual therapy, exercise and education) reduced pain and functional disability, but not sick leave.
Franko 2017 ⁷⁸ High	OMT	8 RCTs* Pregnancy : 5 RCT Postpartum : 3 RCT *5 of 8 were grey literature	Only 1 of the studies reported on adverse events and they suggested that they were minor in nature; occasionally patients reported they were tired following treatment. In personal communication, authors of 2 other studies, they reported no adverse event occurred.	Clinically relevant effects of OMT were found for reducing pain and improving functional status in pregnant and postpartum (3 months posttreatment) women experiencing LBP.
Ruffini 2016 ⁷⁷ High	OMT	24 studies total but those pertaining to: Pregnancy 8 studies (n=914) 4 RCTs, 2 case controls, 1 observational study and 1 case-series	Overall, adverse events were not sufficiently described; only 3 studies mentioned adverse events. Researchers suggested a more systematic reporting of adverse events in order to obtain solid and generalizable results. Pregnancy <i>Craniosacral Therapy</i> : Minor events listed in the intervention group including increased PGP, elastic belt discomfort and drowsiness. Minor events listed in the control group including elastic belt discomfort and increases in PGP	OMT can be considered effective on pregnancy-related back pain.
		Labour and delivery 4 studies (n=597): 1 RCT, 2 case-series and 1 observational study	Labour and delivery Only reported adverse events in 2 studies and determined that OMT was well tolerated	
Hall 2016 High ¹⁸	CAM	11 full text articles on 10 RCTs (n=1,198)	Researchers stated that their findings are similar to others in that very few adverse events have been reported in the literature and suggest complementary manual therapies are a safe option compared to no treatment at all.	There is limited evidence to support the use of complementary manual therapies as an option for managing LBP and PGP during pregnancy.
Gutke 2015 ⁷⁰ Acceptable	Modalities	34 RCTs; 8 CCTs; 3 long-term follow ups; 2 observational studies 4 observational retrospective studies; 1 experimental case study; 1 case series; and 3 pilot studies	No specific adverse events were recorded for any intervention (acupuncture, exercise, pelvic belt, physiotherapy, massage).	There was evidence for the positive effects of acupuncture and pelvic belts but weak for specific exercises.
Sharma, 2014 ⁷⁹ Acceptable	Physical therapy	9 RCTs; 1 cohort; 3 CS	No specific adverse events were recorded for any interventions (exercise, pelvic/sacroiliac belt, muscle energy techniques, soft tissue mobilization, postural alignment).	These authors recommend a combination of specific stabilizing exercises, nonelastic sacroiliac belt in the high position and ergonomic education as the most beneficial interventions in the management of sacroiliac dysfunction/PGP for pregnant individuals experiencing this pain.

Note: Majchrzycki (2015)⁸⁰ and Posadaski (2011)⁸¹ were deemed unacceptable and removed from the data extraction table.

*Scottish Intercollegiate Guideline Network (SIGN) Quality rating: >9=high quality, low risk of bias (H); 6-9=acceptable quality, moderate risk of bias (A); <6=low quality, high risk of bias (L)
CAM = complementary alternative medicine; CCT = controlled clinical trials; CS = case series; LBP = low back pain; OMT = osteopathic manipulative therapy; PGP = pelvic girdle pain;

Table 3.
Risk of bias assessment of included RCTs.

First author and year published	Items on Modified SIGN checklist ^a										Total	Quality ^b
	1	2	3	4	5	6	7	8	9	10		
Gausel, 2017	1	1	0	1	0	0	1	1	0	1	6	A
Schwerla, 2015 ⁸⁶	1	1	1	1	0	1	0	1	1	1	8	A
Hensel, 2016 ⁸⁷	1	1	0	1	1	0	1	1	0	0	6	A
Peterson, 2012 ⁶⁰	1	1	0	1	0	0	1	1	1	1	7	A
Licciardone, 2010 ⁸³	1	1	1	1	0	0	0	1	0	1	6	A
Licciardone, 2013 ⁸⁴	1	1	1	1	0	1	1	1	1	1	9	A
Hensel, 2016 ⁸⁵	1	1	0	0	0	1	1	1	0	0	5	L

RCTs = randomized controlled trials; SIGN = Scottish Intercollegiate Guideline Network

^aSee Figure 3 for Quality assessment SIGN checklist items^a and scoring^b for randomized controlled trials

almost all were considered transient and minor.^{18, 76-78} In addition, one of the SRs stated that there were no issues related to any of the deliveries or neonates⁷⁶ and another suggested that CAM, such as chiropractic, was a safe option compared to no treatment at all for pregnancy-related back pain.¹⁸ The two “acceptable quality” SRs^{70, 79} did not record specific adverse events for any intervention they examined.

Randomized controlled trials

Table 3 lists each item on the Risk of Bias assessment instrument of included RCTs. Of the seven RCTs identified, six were of “acceptable quality”^{60, 82-86} and one was of “low quality”.⁸⁷ Table 4 shows the data extraction of each RCT. There were five studies involving OMT⁸³⁻⁸⁷ as the intervention, one study examining SMT⁶⁰, and one study which provided multimodal treatment⁸². Of the five studies that examined OMT, four were compared to sham or placebo ultrasound and/or usual obstetric care (UOBC)^{83-85, 87} and one did not have a comparison group⁸⁶. All of the studies that applied an OMT protocol to pregnant women in the third trimester did not report any specific adverse events with respect to worsening their back pain and/or an increase in poor labour and delivery outcomes.^{83-85, 87} One study that examined the effects of OMT in women experiencing postpartum-related back pain did state that there were no serious adverse events reported, however occasionally participants did complain of being tired following the intervention.⁸⁶

Two RCTs included SMT in their study design; one compared a multimodal approach including SMT to UOBC⁸² and the other compared SMT and exercise to

neuroemotional technique (NET) and a control group consisting of individual home exercises and information. Both of these studies asked patients to recall any negative reactions to treatment at the follow up visit. Both studies did not have any serious adverse or long-lasting events to report. However, the study involving SMT and exercise compared with NET did state that 6% and 18% of participants experienced soreness, respectively.

Cohort Studies

Table 5 lists each item on the Risk of Bias assessment instrument of included cohort studies. Of the cohort studies included two were of “acceptable quality”^{88, 89}, one was of “low quality”⁹⁰ and two were considered “unacceptable quality”^{91, 92}. The two “unacceptable quality” studies were removed. Table 6 shows the data extraction of each cohort study. In the first “acceptable quality” cohort study, it was determined that following a high velocity thrust technique (HVTT) for a maximum of two attempts per symptomatic side, 80% of participants reported an improvement of 50% or more within the first 24 to 72 hours following the intervention.⁸⁸ In this cohort study, no subject was determined to have greater disability or pain after the intervention.⁸⁸ The second “acceptable quality” cohort study examined chiropractic treatment (unspecified method or frequency, left up to the treating clinician) on pregnant women with LBP and/or PGP at one, three, six and 12 months following the start of treatment.⁸⁹ A large proportion of women undergoing chiropractic treatment reported clinically relevant improvements in their symptoms at all time points. Eighty-five percent of the participants were “very happy” or “happy” with their

Table 4.

Evidence table for RCTs including quality rating, patient information, intervention and comparison group, dosage, adverse events reported and study conclusions.

Citation and quality*	Patient population, mean age, mean symptom duration	Intervention	Comparison group(s)	Dosage	Adverse event reported	Conclusion
Gausel 2017 ⁸² Acceptable	N=56, pregnant women, less than 29 wks, with 1-sided PGP Age (Mean yrs): TG: 28.9 CG: 29.9 GA (mean wks): 23.1 Onset: Prior to 18-29 wks	TG: SMT, mobs, STT, exercises and advice chosen by the chiropractor	CG: UOBC	TG: Number of treatments individualized by the chiropractor	Reported: At follow-up appts, women were asked to recall any negative reactions. No serious or long-lasting adverse events were reported. Although adverse events following SMT during pregnancy are rare, treatments should not be performed over a long period of time unless there is a positive response. Future studies should track possible adverse events throughout the study.	There were no statistically significant differences between the treatment group and control group with respect to sick leave, pain, disability or general health status.
Schwerla 2015 ⁸⁶ Acceptable	n=80, postpartum women with nonspecific LBP or PGP; at least 3mo and 5/10 on VAS Age (Mean yrs): TG=33.9 CG=33.3 GA: TG= postpartum CG= postpartum Onset: Within the past 3 to 15 mo Duration: TG: 9.8 mo CG: 9.7 mo	TG: OMT could include direct and indirect visceral and cranial techniques	CG: No tx but told they were put on a wait list to be scheduled 2 mo later	8 wks 4 txs 40-60 min	Reported: No serious adverse events were recorded during the study period. Occasionally, participants complained of being tired following the intervention.	OMT applied 4 times to postpartum women led to clinically relevant positive changes in pain intensity and functional disability.
Licciardone 2010 ⁸³ Acceptable	n=146, pregnant women, third trimester with or without LBP Age (Mean yrs) TG=23.8 CG1=23.7 CG2=23.8 GA: Enrolled 28-30 wks Onset: Not stated. Duration: Not stated.	TG: UOBC + OMT: Standardized OMT protocol during 3 rd trimester	CG1: UOBC + SUT CG2: UOBC	Up to 7 treatment in conjunction with OB appointments at 30, 32, 34, 36, 37, 38 and 39 wks gestation 30 min	No specific adverse events reported. But the authors stated that the study demonstrated important clinical benefits without any appreciable harms in back-specific functioning when OMT is provided as complementary therapy in the third trimester.	OMT does halt or lessen back pain during the third trimester of pregnancy; however the possibility of minimally important harms cannot be ruled out.
Hensel 2016 ⁸⁷ Acceptable	n=400, pregnant women, 3 rd trimester Age (Mean yrs): TG=24.0 CG1=24.1 CG2=24.7 GA: Enrolled at 30 wks Onset: Not stated Duration: Not stated	TG: OMT= Usual care + standardized OMT protocol	CG1: PUT CG2: UOBC	OMT and PUT groups provided 7 visits within 24 hours of OB visit 20 min over 9 wks	No specific adverse events reported. The authors did state that the OMT protocol did not increase the risk of precipitous labour, conversion to cesarean delivery or meconium-stained amniotic fluid Although the OMT group experienced longer labour, there was no increased incidence of complications during delivery including perineal laceration, episiotomy or need for forceps or vacuum	Those who received OMT protocol in addition to usual care had a slower rate of deterioration of their pain and back-specific functioning during the third trimester. The OMT protocol appears to be a safe and effective way to manage back pain and function during pregnancy.
Hensel 2016 ⁸⁵ Low	n=400, pregnant women, 3 rd trimester Age (Mean yrs): TG=24.1 CG1=24.1 CG2=24.8	TG: OMT= Usual care + standardized OMT protocol	CG1: PUT CG2: UOBC	OMT and PUT groups provided 7 visits within 24 hours of OB visit 20 min over 9 wks	No specific adverse events reported. When using high-risk status and labour and delivery outcomes as an index for safety, no greater risk in the OMT group was found.	The OMT protocol applied in the third trimester of pregnancy, is a safe intervention with respect to labour and delivery outcomes.
Peterson 2012 ⁶⁰ Acceptable	n = 57, pregnant women with LBP and/or PGP reproducible by palpation Age: TG1= 31.1 TG2=29.7 CG= 28.7 GA: TG1= 25.7 TG2= 27.0 CG=23.7 Onset: TG1=16.1 TG2=13.9 CG=11.6 Duration: During pregnancy	TG1: SMT= HVLA for L/S and SI JT; blocks used to adjust Sacro Occipital Technique Category II pelvis; activator to adjust pelvis TG 2: NET= chiropractic mind-body technique; combines desensitization procedures with 5 element Chinese medicine + chiropractic adjustment	CG: Individualized home exercises + Information	All TGs: Paralleled prenatal care schedule; 1x/mo until 28 wks; 2x/mo until 36 wks; 1x/wk thereafter CG: 5 x/wk 15 min	Reported: Participants were asked at each assessment if they experienced any adverse events as a result of the intervention. No adverse events were reported but the study participants in any group. However, 6% of SMT and exercise and 18% of NET participants produced soreness	All 3 interventions appear to provide clinically meaningful improvements in function and pain intensity.
Licciardone 2013 ⁸⁴ Acceptable	N= 144, pregnant women in 3 rd trimester with or without LBP Age: TG: 23.8 CG1: 23.7 CG2: 23.8 GA: enrolled between 28 -30 wks Onset: not stated Duration: not stated	TG: OMT + UOBC	CG1: SUT + UOBC CG2: UOBC	Up to 7 treatment in conjunction with OB appointments at 30, 32, 34, 36, 37, 38 and 39 wks gestation 30 min	No adverse events specifically reported. The authors did state that there was no SS between study groups in the rates of development of high-risk obstetric conditions or delivery prior to wk 39	OMT has medium to large treatment effects in preventing progressive back-specific dysfunction during the 3 rd trimester.

*Modified Scottish Intercollegiate Guideline Network (SIGN) Quality RCT rating: 9-10 high quality, low risk of bias; 6-8 acceptable quality, moderate risk of bias; 3-5 low quality, high risk of bias; 0-2 or if item 1 and/or 3 are "no unacceptable quality (reject)
CG – control group; GA – gestational age; HVLA – high velocity low amplitude; LBP – low back pain; L/S – lumbar spine; min – minute; mo – month; mobs – mobilization; NET = neuroemotional technique; OB – obstetrician; OMT – osteopathic manipulative therapy; PUT – placebo ultrasound therapy; SI JT – sacroiliac joint; SMT – spinal manipulative therapy; SS = statistical significance; STT – soft tissue therapy; SUT – sham ultrasound therapy; TG – treatment group; tx – treatment; txs – treatments; UOBC – usual obstetric care; wk – week; wks – weeks; x/ – times per; yrs – years

Table 5.
Risk of bias assessment of included cohort studies.

First author and published year	Items on SIGN checklist														Total	Quality ^b
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Al-Sayegh, 2010 ⁸⁸	1	1	1	0	1	0	1	0	0	1	1	0	0	1	8	A
Peterson, 2014 ⁸⁹	1	0	0	0	1	0	1	0	1	1	1	1	1	0	8	A
Hastings, 2016 ⁹⁰	1	0	1	0	0	0	1	0	1	1	1	0	1	0	7	L
Skarica, 2018 ⁹²	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	U
Haavik, 2016 ⁹¹	1	0	0	0	0	0	1	1	0	0	0	0	1	0	4	U

SIGN, Scottish Intercollegiate Guideline Network

^{a,b}See Figure 4 for Quality assessment SIGN checklist items^a and scoring^b for cohort studies

Table 6.
Evidence table for cohort studies including quality rating, patient information, intervention, dosage, adverse events reported and study conclusions.

Citation and quality*	Patient population, mean age, mean symptom duration	Intervention	Dosage	Adverse event reported	Overall study conclusion
Al-Sayegh 2010 ⁸⁸ Acceptable	n=69, postpartum women with LBP and/or PGP Age (Mean yrs): All: 31 TG1: 30 TG2: 34 GA: Postpartum Onset: Anytime during pregnancy or postpartum Duration: All: 28.9 wks TG1: 28.8 wks TG2: 29.9 wks	All subjects HVTT + forward rocking G1: HVTT success G2: HVTT non-success	2 attempts at each visit	Reported: In no case was a subject determined to have greater disability or pain after the intervention.	The pretest probability of success (80%) is enough to reassure the clinician about the decision to use HVTT lumbopelvic region in postpartum women experiencing LBP and/or PGP
Peterson 2014 ⁸⁹ Acceptable	n=143, pregnant women with LBP, PGP or both Age (mean yrs): 32.96 GA (mean wks): 26.21	Chiropractic treatment (unspecified)	Was left to the discretion of the treating clinician	Reported: No adverse events were reported and 85% of patients were happy or very happy with their chiropractic treatment.	A large proportion of patients with LBP or PGP undergoing chiropractic treatment reported clinically relevant improvements in their symptoms at all time points up to 1 yr.
Hastings 2016 ⁹⁰ Low	n= 75-80 pts approached, women who delivered within 48 hrs Age: not reported GA: postpartum	OMT – based on somatic dysfunction;	Was left to the discretion of the treating clinician; 20-30 min; most commonly used myofascial release, balanced ligamentous tension and facilitated positional release	Reported: Slight increase in tenderness and sharpness immediately following OMT, although not SS, is consistent with what is already reported in the literature. It is believed to result from minor and temporary tissue irritation	Most postpartum patients undergoing chiropractic treatment reported clinically relevant improvements at all time points.

Note: Skarica (2018)⁹² and Haavik (2016)⁹¹ were deemed unacceptable and removed from the data extraction table.

*Scottish Intercollegiate Guideline Network (SIGN) Quality rating: 12-14 high quality, low risk of bias; 9-11 acceptable, moderate risk of bias; 6-8 low quality, high risk of bias; <6 unacceptable quality
G = group; GA = gestational age; hrs = hours; HVTT = high velocity thrust technique; LBP = low back pain; min = minute; OMT = osteopathic manipulative therapy; PGP = pelvic girdle pain; pts = patients; SS = statistically significant; TG = target group; wks = weeks; yr = year

Table 7. CARE Case studies

		Morton, 2012 ⁹³
1.	Title	1
2.	Key Words	1
3.	Abstract	
a.	Introduction	1
b.	Patient's main concerns and important clinical findings.	1
c.	The main diagnoses, intervention and outcomes.	1
d.	Conclusion – what are the “take away” lessons?	1
4	Introduction	1
5	Patient information	
a.	De-identified demographic and other patient information.	1
b.	Main concerns of the symptoms of the patient.	1
c.	Medical, family and psychosocial history including genetic information.	1
d.	Relevant past interventions and their outcomes.	0
6.	Clinical findings	0
7.	Timeline	0
8.	Diagnostic Assessment	
a.	Diagnostic methods (PE, laboratory testing, imaging, surveys)	0
b.	Diagnostic challenges	N/A
c.	Diagnostic reasoning including differential diagnosis	N/A
d.	Prognostic characteristics when applicable	N/A
9.	Therapeutic Intervention	
a.	Types of intervention (pharmacologic, surgical, preventive)	0
b.	Administration of intervention (dosage, strength, duration)	0
c.	Changes in the intervention with explanations	N/A
10.	Follow up and Outcomes	
a.	Clinician and patient-assessed outcomes when appropriate.	0
b.	Important follow-up diagnostic and other test results.	1
c.	Intervention adherence and tolerability (how was this assessed).	N/A
d.	Adverse and unanticipated events.	1
11	Discussion	
a.	Strengths and limitations in your approach to the case.	0
b.	Discussion of the relevant medical literature.	1
c.	The rationale for your conclusion.	1
d.	Primary “take-away” lessons from this case report.	1
12	Patient perspective	0
13.	Informed consent	1
	Total	16
	Adverse events Reported	Yes

treatment and the authors reported that no adverse events had occurred.⁸⁹ The final cohort study of “low quality” determined the effects of a 20 to 30 minute OMT treatment on women who delivered within 48 hours. Although their preliminary results suggested that OMT is efficacious for postpartum pain management, 18.6% of participants experienced a slight increase in tenderness and sharpness immediately following their treatment.⁹⁰

Case studies

Table 7 lists each item on the CARE checklist.⁷⁵ Only one case study⁹³ reported a serious adverse event following SMT on the cervical spine in a 16 week pregnant woman (Table 8). Immediately following a cervical SMT treatment the patient experienced right-sided anterior neck pain and developed ipsilateral Horner’s syndrome as a result of a dissection of the right internal carotid artery. Four days following the treatment, the patient miscarried. The patient was admitted to the ICU and treated accordingly. One year later, the Horner’s symptoms still persisted.

Discussion

This systematic review provides an update of the literature regarding SMT during pregnancy and the postpartum period, as well as a review of any adverse events associated with the reported studies. With the exception of one case study, all studies reported only minor and transient events. The case study demonstrated an adverse event following cervical spinal manipulation. When added to the results of our 2012 review (four events following cervical SMT and three events following lumbar SMT) adverse events following SMT in these populations still appear to be scarce.

Table 8.

Evidence tables for case studies including citation, case presentation and treatment and reported adverse events.

Citation	Case Presentation	Treatment and Adverse Event reported
Morton, 2012	A 31-yr old woman presented to the chiropractor at 16-wks GA with occipital HA. She has a 17-yr previous history of monthly, intermittent, bilateral occipital muscle tension HA that are unchanged with pregnancy. In addition, she had a history of migraine characterized by unilateral frontal HA, the last episode which had been 6-wks earlier. Patient was diagnosed with SLE 12 yrs earlier, complicated by renal involvement treated with azathioprine and prednisone, hypertension managed with labetalol and episodes of DVT and PE. She was heterozygous for prothrombin gene mutation but did not have lupus anticoagulant or anticardiolipin antibody.	Immediately following chiropractic treatment (not specified but based on description, SMT was suggested), the subject reported severe right-sided anterior neck pain and developed ipsilateral Horner’s syndrome. MRI revealed dissection of the right internal carotid artery. It extended 5 cm distal to the carotid bulb to the horizontal intrapetrous segment. SLE flared up. 4 days after the onset of neurological symptoms, intrauterine fetal demise occurred. Tx: reported to ICU and treated with intravenous heparin and subsequently low-molecular weight heparin. Patient was placed on warfarin for 6 months. A follow-up MRI revealed a focal false aneurysm on the right internal carotid artery. One year later, Horner’s syndrome persists.

cm – centimetre; DVT – deep vein thrombosis GA – gestational age; HA – headache; ICU – intensive care unit; MRI – magnetic resonance imaging; PE – pulmonary embolism; SLE – systemic lupus erythematosus; SMT – spinal manipulative therapy; Tx - treatment; yrs – years;

One important revelation in this review is the lack of adverse events being reported, which was also highlighted in a few of the studies included in this review.^{77,82} Tracking of adverse events was not common practice in higher quality studies, such as RCTs, until the CONSORT guidelines^{94, 95} were developed and changed over the years to encourage researchers to do so. Unfortunately, the reporting of adverse events is a missing component of research papers. In the current paper, the fact that very few adverse events were reported, does not mean that others did not happen. There has to be a greater effort made by researchers to report not only adverse events associated with studies but also to clearly state that no adverse events occurred when that is the case. Future research should not only focus on reporting the presence or absence of adverse events,⁷⁶ but also determining the adverse events that occur at each of the different pain locations experienced by pregnant and postpartum patients. Recently, there has been a greater emphasis on delineating the various pain locations (lumbar spine LBP versus PGP versus combined pain) experienced by pregnant and postpartum patients.^{57,58,76,96,97} Robust trials on the effectiveness of SMT for cervical and thoracic spine in these populations are required to help inform decisions regarding care. By utilizing all of this information, future studies can be designed and ultimately determine possible prevention and effective management strategies for these populations.

Chiropractors are well versed in treating pregnant and postpartum patients.⁵⁹ However, the evidence with respect to safe and effective treatment options, including SMT, in these patients is limited. Two recent SRs regarding pregnancy⁵⁸ and postpartum-related back pain⁵⁷ have suggested that SMT should be considered as a possible modality to treat these two populations. Although the strength for SMT in these two SRs was inconclusive, it has been suggested that a trial of care may be warranted to see if it produces symptomatic relief for patients.^{4, 57, 58} Determining conclusive evidence in these populations may be difficult simply because of the rarity of these events.⁹³ In one RCT examining the effects of a multimodal program including SMT on LBP the authors suggest that although adverse events during pregnancy are rare, treatments should not be performed unless there is a positive response within a trial of care period.⁸² Unfortunately, there is even less evidence with respect to the safe-

ty and suggested treatment strategies for neck pain during the pregnant and postpartum period.

We continue to support the suggestions from our previous review:⁶⁹ (1) that contraindications to SMT are evident during a careful history and physical exam; (2) clinicians treating these two populations should consider prothrombotic and joint laxity risk factors when determining their treatment plan and attempt to minimize the risk of potentially dangerous and neurological complications; and (3) pregnant and postpartum women at higher risk for complications, such as those in a post-thrombotic state or possible joint laxity, should be treated with additional caution. These patients should be counselled with respect to the risks of SMT and educated as to the signs and symptoms of possible neurovascular complications.⁶⁹ In addition, we believe that future studies should include the presence or absence adverse events. Reporting this information will help to inform stakeholders of the actual possible adverse events that may occur in these populations.

Strengths and limitations

A key strength of this review is that a thorough search of the literature was conducted by a health science librarian, multiple electronic databases were searched, and we employed a number of broad search terms. Another strength for this review is that we expanded our search to include all forms of literature including SRs and meta-analyses, RCTs, cohort and case studies. In general, the information garnered in this paper should provide practicing chiropractors, chiropractic educators, chiropractic patients and other allied health professionals a reasonable and evidence-based rationale to the safety of SMT in these two populations.

There are a few limitations associated with this review. The first is the number of studies available and the hierarchy of available evidence. Similar to our 2012 review, the majority of the papers identifying serious adverse events were case studies, and they are considered lower levels of evidence because of their high risk of bias. The second limitation is the reporting of adverse events, or lack thereof in clinical trials. In most of the papers included in this review there was no mention of whether or not an adverse event occurred following treatment. Similar to the limitations of our previous review, we suggest that given the lower levels of evidence and the lack of reporting

of adverse events, the possibility of risk to pregnant and postpartum undergoing SMT cannot be measure or stated definitively. In addition, it cannot be determined if any such risk level is higher or lower than in non-pregnant or postpartum populations. There is a need to execute more robust high-quality studies, such as the SafetyNET active surveillance reporting system,^{98,99} to rigorously track adverse events and potentially develop mitigation strategies in these populations. The third limitation is the time frame since the current search was completed. Although it has been two years since the last search, similar to what we found between the original study and the current one, we do not anticipate any major changes with respect to the reporting of adverse events. However, a future update will be completed in a more expedient manner. The final limitation is the restriction of our postpartum timeline of six weeks. The hormonal changes that occur with pregnancy do not automatically revert back to a pre-pregnancy state with birth of a child. Therefore, we maybe limiting the number of studies that could have been retrieved and the adverse events associated with them. Extending the postpartum timeline should be considered for a future update.

Conclusions

High quality studies, such as RCTs, regarding SMT for pregnancy- and postpartum-related spinal pain are lacking. This update of our previous review found one case study⁹³ that demonstrated a serious adverse event following SMT in the cervical spine and a handful of minor and transient adverse events in the low back^{18, 60, 76, 77, 86}. Although we are calling for improved reporting of such events in all papers going forward, it appears these events are rare. Future research should focus on the proper reporting of all adverse events while assessing efficacy of appropriate treatment options for these populations.

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Appendix 1.
Search strategy terms

MEDLINE

1. MH “Long Term Adverse Effects”
2. adverse event*
3. adverse reaction*
4. adverse effect*
5. side effect*
6. TI harm* or AB harm*
7. (increas* n2 pain*) or (incident* n2 pain*)
8. hematoma*
9. sprain* or strain*
10. (disc n2 herniat*) or (disk* n2 herniat*)
11. (disc n2 bulg*) or (disk* n2 bulg*)
12. thrombophil* or thrombosis* or hypercoag*
13. dissection*
14. stroke*
15. fractur*
16. MH Chiropractic
17. MH Manipulation, Spinal
18. MH Musculoskeletal Manipulations
19. MH Manipulation, Chiropractic
20. chiroprac*
21. spinal* n2 manip*
22. spinal* n2 adjust*
23. musculoskeletal n2 manip*
24. musculoskeletal* n2 adjust*
25. manual n2 therap*
26. manual* n2 adjust*
27. hvla
28. high velocity low amplitude* or high-velocity low-amplitude* or high velocity thrust* or high-velocity thrust*
29. audibl* n2 releas*
30. subluxat*
31. MH Pregnancy
32. MH Pregnant Women
33. MH Pregnancy Outcome
34. MH Pregnancy Complications
35. MH Prenatal Care
36. MH Postpartum Period
37. MH Parturition
38. pregnan*
39. childbirth*
40. antenatal* OR ante natal* OR ante-natal*
41. prenatal* OR pre natal* OR pre-natal*
42. postnatal* OR post natal* OR post-natal*
43. postpartum* OR post partum* OR post-partum*
44. perinatal* or peri natal* or peri-natal*
45. peirpartum* or peri-partum*
46. 1-15/ OR
47. 16-30/ OR
48. 31-45/ OR
49. 46 AND 47 AND 48
50. LIMIT English
51. LIMIT January 1 2010-Nov 1 2018

Physical activity throughout pregnancy: guideline critical appraisal and implementation tool

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Objective: *The 2019 Canadian guideline for physical activity throughout pregnancy provides evidence-based recommendations to promote maternal, fetal, and neonatal health. We aimed to 1) critically appraise the 2019 Canadian guideline for physical activity throughout pregnancy; and 2) develop a guideline summary for clinicians to facilitate the uptake of recommendations into practice.*

Methods: *We used the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument to critically appraise the quality and reporting of this guideline. Four reviewers independently scored between*

Activité physique durant la grossesse: examen critique des lignes directrices et outil de mise en œuvre
Objectif : *L'édition de 2019 des Directives canadiennes en matière d'exercice physique pendant la grossesse fournit des recommandations fondées sur des données probantes visant à favoriser la santé de la mère, du fœtus et du nouveau-né. Notre objectif était 1) d'examiner d'une façon critique l'édition de 2019 de ces lignes directrices; et 2) de faire un résumé à l'intention des cliniciens pour faciliter leur adoption dans l'exercice.*

Méthodologie : *On a utilisé la grille Appraisal of Guidelines for Research and Evaluation II (AGREE II) pour évaluer la qualité et le contenu des lignes directrices. Quatre examinateurs indépendants ont attribué une cote allant de 1 (fortement en désaccord) et*

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Conflicts of Interest: None

Funding: Funding from the Canadian Chiropractic Research Foundation

1 (strongly disagree) to 7 (strongly agree) for 23 items organized into six quality domains.

Results: AGREE II quality domain scores ranged from 47%-64% and the overall quality of the guideline was rated as 83% (high quality).

Conclusion: Based on its methodological quality, we recommend the use of this guideline. Our guideline summary includes six recommendations and other safety precautions that are relevant for clinicians in Canada.

(JCCA. 2021;65(1):50-58)

KEY WORDS: physical activity, exercise, pregnancy, practice guideline, implementation science

Introduction

Physical activity recommendations for pregnant women have evolved over the years. Concerns regarding the fetal response to exercise and strenuous exercise was once thought to compromise fetal well-being.¹⁻³ As a result of evolving research, concerns regarding the potential and theoretical harmful effects of exercising while pregnant have been unsubstantiated. In fact, the Society of Obstetricians and Gynecologists of Canada, encourage women who are experiencing healthy, uncomplicated pregnancies to exercise.^{4,5} The benefits of exercising during pregnancy may include: decreasing pregnancy-related back pain, reducing nausea, reducing depression, fewer newborn complications, decreased risk of pre-eclampsia, and prevention of excessive maternal obesity.⁵⁻¹¹

The 2019 Canadian guideline for physical activity throughout pregnancy provides six recommendations.¹¹ Recommendations were developed by a guideline consensus panel and informed by systematic reviews, prenatal expert opinion, methodological experts, exercise professionals and patient consultation. Recommendations are reported by strength indicating whether the recommendation best serves all pregnant women (“strong”) or, if not all pregnant women benefit from the recommendation (“weak”). Additionally, recommendations are reported by the quality of evidence ranging from “very low” to “high” based on the guideline consensus panel’s con-

7 (fortement d'accord) à 23 éléments répartis dans six groupes d'aspects de la qualité.

Résultats : Les cotes attribuées aux aspects de qualité de la grille AGREE II ont varié de 47 à 64 %. La cote attribuée à la qualité globale des lignes directrices s'est élevée à 83 % (grande qualité).

Conclusion : Compte tenu de la qualité de la méthode avec laquelle elles ont été élaborées, on recommande l'adoption de ces lignes directrices. Nous résumons six recommandations et des consignes de sécurité pertinentes pour les cliniciens canadiens.

(JACC. 2021;65(1):50-58)

MOTS CLÉS : activité physique, grossesse, lignes directrices de pratique, science de la mise en œuvre

fidence in the estimated effect on the health outcome. All recommendations considered concepts regarding feasibility, acceptability, costs, and equity.

While the evidence for exercise throughout pregnancy is growing, not all healthcare professionals routinely counsel their pregnant patients regarding exercise.¹²⁻¹⁴ Some healthcare professionals have reported that they lack knowledge of exercise during pregnancy, lack awareness regarding the existence of guidelines, or they feel that there is a disconnect translating this knowledge into practice.^{12,13,15} Pregnant patients with musculoskeletal complaints may consult with clinicians, including rehabilitation professionals such as chiropractors or physiotherapists. They have opportunities to offer exercise prescription, manual therapies, education, and self-management strategies for pregnant patients experiencing musculoskeletal pain.¹⁶⁻¹⁹ A proportion of clinicians report not having the appropriate knowledge or comfort level in treating this patient population.²⁰ A lack of formal training, institutional variability, and awareness of current research can be challenging and may explain the deficit in knowledge.^{15,20} The 2019 Canadian guideline for physical activity throughout pregnancy provides a series of recommendations regarding physical activity throughout pregnancy in the promotion of maternal, fetal and neonatal health.¹¹

Guideline implementation (GI) tools can be used to

Maximum possible score = 7 (strongly agree) x 3 (items) x 4 (appraisers)
 Minimum possible score = 1 (strongly disagree) x 3 (items) x 4 (appraisers)

$$\text{Scaled domain score} = \frac{\text{Obtained score} - \text{Minimum possible score}}{\text{Maximum possible score} - \text{Minimum possible score}} \times 100$$

Figure 1.
 AGREE II scaled domain score formula

assist healthcare providers to understand and integrate clinical practice guidelines into practice by supporting GI implementation tools may include evidence summaries for clinicians, patient handouts, or indicators for performance measurement.²¹⁻²⁴ Disseminating GI tools may improve guideline uptake and adherence by healthcare providers.^{21,25} GI tools present evidence in concise and user-friendly formats to meet the needs of the user and aim to go beyond just what recommendations to apply by guiding how to apply them. In a systematic review by Gagliardi and Brouwers in 2015, 137 guidelines published between 2008-2013 were evaluated using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument and demonstrated low applicability scores.²⁶ Among included studies, the applicability domain scored lower compared to all other AGREE domains.²⁶ The pattern of low applicability scores among guidelines indicates a need for implementation tools. The purpose of this study was to critically appraise the methodological quality of this guideline and to develop a guideline summary for clinicians to improve the applicability recommendations in practice.

Methods

The AGREE II instrument was used to assess this clinical practice guideline.²⁷ The AGREE II instrument is a valid and reliable measure of quality of reporting and guideline development.^{28,29} Four independent reviewers were trained in the use of the AGREE II instrument with an online module and previous practice appraisals, independently provided scoring between 1 (strongly disagree) to 7 (strongly agree) for 23 items organized into six quality domains (Scope and purpose, Stakeholder involvement, Rigour of development, Clarity of presentation, Applicability and Editorial independence). The reviewers met after independent appraisal to reach consensus through discussion. Reviewers considered each item independ-

ently for biases and determined the impact the bias might have on the overall quality of the guideline. Scaled domain scores were calculated according the AGREE II User Manual formula (Figure 1).²⁷ The combination of the scaled domain scores and consensus discussion informed the overall quality rating of the guideline. Data was extracted by three reviewers (CAW, HH, and KN) and double checked by another (LV). All authors were involved with the interpretation and reporting of key recommendations.

Results

Individual AGREE II item scores were used to evaluate the overall quality of the guideline. AGREE II domain scores ranged from 47%-64% (Table 1). The overall quality of this guideline was 83% and the reviewers recommended this guideline for use.

Table 1.
 AGREE II scaled scores

Domain	Scaled domain score (%)*
▶ Scope and purpose	60
▶ Stakeholder involvement	62
▶ Rigour of development	57
▶ Clarity of presentation	64
▶ Applicability	47
▶ Editorial independence	48
▶ Overall guideline assessment	83
▶ Overall guideline recommendation	Yes

* A quality score was calculated for each domain according to the AGREE II formula and were reported as percentages.

Discussion

In our appraisal of the 2019 Canadian guideline for physical activity throughout pregnancy, the lowest domain score was regarding applicability and as such, we have designed a GI tool for clinicians. Low applicability scores arise when a guideline is not supported with tools or advice for implementation or when barriers to applying recommendations have not been adequately considered.²⁷ The overall rating could have been improved with a more clearly defined research question, robust details describing the recommendation development process and specific information on the monitoring or auditing criteria. The following recommendations are the result of the 12 systematic reviews conducted by the consensus guideline panel to describe the effects of physical activity throughout pregnancy.

Recommendations

[Strength of recommendation | Quality of evidence]

Recommendation 1:

All women without contraindications should be encouraged to be physically active throughout pregnancy. [Strong | Moderate]

- This recommendation includes women who were previously inactive, women diagnosed with gestational diabetes mellitus, and women who are categorized as overweight or obese (pre-pregnancy body mass index ≥ 25 kg/m²).
- No recommendation was provided for pregnant women over the age of 35 as there were no studies exclusively evaluating this subgroup.

Recommendation 2:

Pregnant women should accumulate at least 150 minutes of moderate-intensity physical activity each week to achieve meaningful health benefits and reductions in pregnancy complications. [Strong | Moderate]

- Moderate-intensity is described as tasks that result in light sweating and/or a slight to moderate increase in breathing or heart rate.^{30,31} As the term “talk test” implies, the woman is at a comfortable intensity if she is able to maintain a conversation during physical activity and should reduce the intensity if this is not possible.^{4,30} Examples include brisk walking, water aerobics, stationary cycling, and resistance training.
- Moderate-intensity heart rate ranges (beats/min) for

pregnant women aged <29 years are 125-146 and for those aged 30-35 years are 121-141.¹¹

- Although accumulating greater amounts of physical activity over the week is associated with greater benefit, physical activity below the recommendations also incurs some benefits. Therefore, pregnant women should be encouraged to be physically active, even if the recommendations are not able to be met.

Recommendation 3:

Physical activity should be accumulated over a minimum of 3 days per week; however daily activity should be encouraged. [Strong | Moderate]

- Ensuring that at least 150 minutes of moderate intensity physical activity accrues over a minimum of 3 days allows for a consistent accumulation of activity in manageable bouts and result in maternal and fetal benefit.
- There may be times when the recommendations cannot be met due to fatigue and/or discomforts of pregnancy; women are encouraged to do what they can and return to recommendations when possible.¹¹

Recommendation 4:

Pregnant women should incorporate a variety of aerobic exercise and resistance training activities to achieve greater benefits. The addition of yoga and/or gentle stretching may also be beneficial. [Strong | High]

- Physical activities should meet the needs and abilities of pregnant women. Different types of exercise can be performed alone or in combination. However, combining aerobic and resistance training during pregnancy has been more effective at improving health outcomes than interventions that focused on aerobic exercise alone. In addition, exercise has been shown to reduce the severity of low back pain, pelvic girdle pain, and lumbopelvic pain during pregnancy.³²

Recommendation 5:

Pelvic floor muscle training (PFMT) (e.g., Kegels) may be performed daily to reduce the risk of urinary incontinence. To achieve optimal benefit, instructions on the proper technique is recommended. [Weak | Low]

- Urinary incontinence (UI) is a common complaint of pregnancy and, as a result of the altered hormonal status that occurs during pregnancy, increased

weight of the uterus on the pelvic floor and the possible trauma to the pelvic floor muscles as a result of labour, UI may impact the postpartum period.^{11,33}

Recommendation 6:

Pregnant women who experience light-headedness, nausea or feel unwell when they exercise flat on their back should modify their exercise position. [Weak | Very Low]

- Although the exercise interventions that included supine exercises were not associated with adverse pregnancy outcomes, there was insufficient, high-quality evidenced to determine whether or not this should be avoided during pregnancy.^{11,34} Therefore, the panel suggested that pregnant women experiencing adverse events (nausea, light-headedness, etc.) while in this position should modify their position or avoid it altogether.¹¹

How can clinicians help?

Clinicians can promote healthy lifestyle behaviours with their pregnant patients by providing education and prescribing physical activity programs. The uptake and adherence to physical activity can be facilitated by clinicians choosing to take a proactive role with their patients.³⁵ Clinicians can implement a personalized approach to exercise prescription by considering a patient's environmental context, available resources, personalized education, and providing reassurance of a patient's exercise capability.³⁵ All pregnant women without contraindications (Figure 2) should be encouraged to follow the recommended physical activity guidelines. If pregnant women were not physically active before pregnancy, they should be advised to commence a graduated program. Programs may include strength training exercises, aerobic conditioning, stretching, and relaxation techniques, and clinicians can help determine the appropriate frequency, intensity, and timing of physical activities. Clinicians can discuss physical activity and exercise options with patients in consideration of their abilities, preferences, other personal and environmental factors, and perceived barriers to participating in physical activity. Clinicians should assess and address barriers to exercise, whether personal (fear-avoidance) or environmental (social or physical). For example, for patients living in smaller spaces, clinicians can suggest activities that require minimal space or equipment such as walking or bodyweight exercises (e.g., push-ups, squats).

Given that moderate-intensity physical activity is recommended, clinicians should educate pregnant patients on the use of heart rate zones^{36,37} or the “talk test” for monitoring intensity^{4,30}. Pregnant patients who wish to maintain high-intensity physical activity, such as elite athletes, should be referred for co-managing and monitoring by an obstetrics care provider.^{11,38} Clinicians can provide instruction on proper form and technique for all prescribed exercises. PFMT exercises alone or in combination with other forms of exercises may be prescribed to reduce the odds and severity of UI during pregnancy and the postpartum period.³³ If exercising in a supine position results in any light-headedness, nausea, or feeling unwell, alternative exercise positions should be recommended.³⁴ Clinicians should familiarize themselves with exercises performed in alternative positions, such as side-lying, seated, or standing.

As many as three quarters of pregnant women experience low back (LBP), pelvic girdle pain (PGP), or a combination of both during their pregnancy.³⁹ Due to their uncertain etiology, pregnancy-related LBP and PGP are complex in nature as well as unpredictable, involving variable levels of pain throughout the course of pregnancy and sometimes even throughout the course of a day.^{40,41} This has historically made it difficult to research the effects of exercise on the prevention and treatment of pregnancy-related LBP and PGP.⁴² A systematic review published in 2019 found that although exercise did not reduce the odds of pregnancy-related LBP or PGP, there was low to moderate evidence that prenatal exercise effectively decreased the severity of pregnancy-related LBP and PGP.⁴³ If clinicians choose to recommend exercise for women with pregnancy-related LBP and PGP, they should make sure to monitor for any possible exacerbations in symptoms and make modifications if necessary.

Pregnant patients should be regularly monitored for any development of diastasis recti.⁴⁴ If a midline separation between the two rectus abdominus muscles exists or seems to be developing, some exercises may need to be modified. For example, abdominal strengthening exercises such as abdominal curls should be avoided while aerobic exercise such as walking should be encouraged.¹¹

Finally, there are a number of biomechanical and physiological changes that may impact the pregnant patient's body and normal range of motion including a skewed centre of gravity and an increase in ligament laxity. As such, it

is recommended that all physical activities should include appropriate warm-up and cool-down periods to potentially minimize the risk of injury.^{30,44} Clinicians who feel unprepared to provide exercise instruction to their patients should make referrals to health or exercise professionals with experience in prenatal exercise programs.

Conclusions


The 2019 Canadian guideline for physical activity throughout pregnancy was deemed to have adequate methodological quality for use by clinicians. The guideline demonstrated a low applicability score amongst our reviewers, which led to the need to improve the implementation of guideline recommendations. We developed a GI tool for clinicians (Figure 2), which includes a safety checklist and recommendations to facilitate evidence-based patient care.

Author Contributions: GC drafted and revised the paper and approved the final draft. CAW, HH, KN, and LV drafted and revised the paper, critically appraised the guideline, and approved the final draft. CC conceived of the paper, assisted with the draft and revision of the paper and approved the final draft.


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Centre for Disability Prevention
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Canadian Chiropractic
Guideline Initiative



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Physical activity throughout pregnancy safety checklist and recommendations

For healthcare providers

Healthcare providers should:

✓ **Know the contraindications**

Absolute contraindications	Relative contraindications
<ul style="list-style-type: none"> ▪ Ruptured membranes, premature labour ▪ Unexplained persistent vaginal bleeding ▪ Placenta previa after 28 weeks' gestation ▪ Pre-eclampsia ▪ Incompetent cervix ▪ Intrauterine growth restriction ▪ High-order multiple pregnancy (eg. triplets) ▪ Uncontrolled type I diabetes, uncontrolled hypertension or uncontrolled thyroid disease ▪ Other serious cardiovascular, respiratory or systemic disorder 	<ul style="list-style-type: none"> ▪ Recurrent pregnancy loss ▪ History of spontaneous preterm birth ▪ Gestational hypertension ▪ Symptomatic anaemia ▪ Malnutrition ▪ Eating disorder ▪ Twin pregnancy after the 28th week ▪ Mild/moderate cardiovascular or respiratory disease ▪ Other significant medical conditions

✓ **Identify red flags**

Patients should stop their activity and call their healthcare provider if they experience:

- Persistent excessive shortness of breath that does not resolve on rest
- Severe chest pain
- Regular and painful uterine contractions
- Vaginal bleeding
- Persistent loss of fluid from the vagina indicating rupture of the membranes
- Persistent dizziness or faintness that does not resolve on rest

✓ **Remind patients of the safety precautions**

- ✓ Avoid physical activity in excessive heat, especially with high humidity
- ✓ Avoid activities which involve physical contact or danger of falling
- ✓ Avoid scuba diving
- ✓ Training at altitude:
 - Avoid training at altitude if they have never done so
 - If patients need to train at altitude, they should be monitored closely by their healthcare provider
- ✓ Those considering athletic competition or exercising significantly above the recommended guidelines should seek supervision from an obstetric care provider with knowledge of the impact of high-intensity physical activity on maternal and fetal outcomes
- ✓ Maintain adequate nutrition and hydration – drink water before, during and after physical activity

Adapted with permission from: Mottola MF, Davenport MH, Ruchat S, et al. 2019 Canadian guideline for physical activity throughout pregnancy. Br J Sports Med. 2018;52(21),1339-46.

Figure 2a.
Guideline Implementation tool.



Canadian Chiropractic
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Physical activity throughout pregnancy safety checklist and recommendations

For healthcare providers

Recommendations:



1. All women without contraindications should be encouraged to be physically active throughout pregnancy.
2. Pregnant women should accumulate at least 150 minutes of moderate-intensity physical activity each week to achieve meaningful health benefits and reductions in pregnancy complications.
3. Physical activity should be accumulated over a minimum of 3 days per week; however daily activity should be encouraged.
4. Pregnant women should incorporate a variety of aerobic exercise and resistance training activities to achieve greater benefits. The addition of yoga and/or gentle stretching may also be beneficial.
5. Pelvic floor muscle training (PFMT) (e.g., Kegels) may be performed daily to reduce the risk of urinary incontinence. To achieve optimal benefit, instructions on the proper technique is recommended.
6. Pregnant women who experience light-headedness, nausea or feel unwell when they exercise flat on their back should modify their exercise position.

How you can help:



- Develop a physical activity program in partnership with patient, instruct on proper technique and consider:
 - Frequency (minimum 3 days/week)
 - Intensity (know heart rate training zones)
 - Time (150 minutes/week of moderate-intensity physical activity)
 - Type (strength, cardiovascular, yoga/stretch)

Figure 2b.
Guideline Implementation tool.

The best aspects of being a chiropractor

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Objective: The aims of this study were to determine the best aspects of being a chiropractor from the practitioners' perspective and to determine job satisfaction among respondents.

Methods: An anonymous online survey was distributed to members of the chiropractic profession from August to September 2019. The survey included 25 statements regarded as being "a positive aspect of being a chiropractor."

Results: Three hundred and sixty-nine chiropractors responded. Respondents believe that the best aspects of being a chiropractor are that chiropractors can reduce pain, help move or build strength, flexibility, and power in patients. In addition, chiropractors 'being trained to diagnose' and 'being able to transform peoples' quality of life' were highly scored. Job satisfaction overall was rated as high (median score of 9/10). However, there are some aspects that are not highly regarded as best aspects by the profession such as the respect of the public and other health professionals.

(JCCA. 2021;65(1):59-65)

KEY WORDS: best aspects, job satisfaction, chiropractor, occupation, survey

Les meilleurs côtés de la profession de chiropraticien
Objectif : Cette étude visait connaître ce que les meilleurs côtés de la profession de chiropraticien du point de vue du praticien et d'établir le degré de satisfaction professionnelle chez les répondants.

Méthodologie : Un sondage anonyme auprès des membres de la profession a été en ligne entre août et septembre 2019. Le questionnaire comprenait 25 énoncés exprimant des aspects de la profession jugés positifs.

Résultats : Trois cent soixante-neuf chiropraticiens ont répondu au sondage. Ils estiment que le meilleur de ce que le chiropraticien peut apporter est le soulagement de la douleur, l'aide à la mobilité, l'augmentation de la force, de la souplesse et de la puissance. Les cotes attribuées aux énoncés « le chiropraticien est formé pour poser un diagnostic », et « le chiropraticien est capable de changer la qualité de vie du patient » sont très élevées. Le degré de satisfaction professionnelle globale est élevé (cote moyenne : 9/10). Certains aspects ne sont pas jugés les meilleurs aspects, comme le respect par le public et les professionnels de la santé.

(JACC. 2021;65(1):59-65)

MOTS CLÉS : les meilleurs aspects, satisfaction professionnelle, chiropraticien, profession, sondage

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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.

Introduction

Why does someone choose a specific profession? And why does someone choose to stay in that profession? There are attributes of an occupation that attract people to that profession. For many professions these attributes are unknown. Satisfaction at work is complex and multi-dimensional. There are different factors that can influence work satisfaction, including individual, cultural, social, managerial, and environmental factors.¹ Job satisfaction is a judgement of the job in its entirety, which can include aspects such as the work itself, income, co-workers, and supervision.² These aspects are likely to be different for each occupation.

As an example, many studies have been conducted regarding why students chose teaching as a career.³⁻⁵ Reasons included seeing teaching as meaningful, enjoying being with children and teenagers, being able to express creative abilities, an interest in teaching a subject, attractive working hours, and longer holidays.³⁻⁵ Also, factors have been identified in the teaching profession as to what is perceived to be important in teachers' decisions to remain within the profession including student involvement, professional challenge, and collegial support.⁶ In the case of accounting, it was chosen as a profession among some because of job security, the challenging and interesting nature of the work, and opportunities for advancement.⁷

Within health care, it has been found that nursing was chosen as a career due to a desire to care for others, believing that it is interesting work, and a personal desire for power and empowerment.^{8,9} Occupational therapy was chosen as a profession for reasons including wanting to help people with disabilities, the challenge and variety of the work, the ability to work in health setting, and the perception that many jobs are available.¹⁰ There were also factors that were likely to discourage people from becoming an occupational therapist including expense of education, not understanding what occupational therapy is, belief the training is too difficult, and being afraid of not being accepted.¹⁰

A few studies have considered the job satisfaction of chiropractors.¹¹⁻¹³ Overall, job satisfaction of chiropractors has been rated relatively high.^{11,12} Konrad *et al.*¹² found job satisfaction was related to relationships with patients, relationships with chiropractic colleagues, and satisfaction with compensation. Zhang *et al.*¹³ reported that chiropractors who were satisfied associated career success with

internal indicators including improving patients' health, practicing ethically, and accomplishing personal goals over external factors such as high income. However, more research is needed to further determine the best aspects of being a chiropractor. The development of a list of "best aspects" could identify motivations to choose the profession and also be used by chiropractic programs to recruit students. Therefore, the primary aim of this study was to determine the best aspects of being a chiropractor from the practitioners' perspective. The secondary aim was to determine job satisfaction level among responders.

Methods

Survey development

A draft survey of the 'best aspects' of being a chiropractor was constructed by two of the authors (BW and AB) using personal experience and exhausting logical possibilities. It was then assessed for face validity using a convenience sample of chiropractors and modified (described below). Hereafter, the survey was distributed to a proportion of the wider chiropractic profession to elicit opinions on the best aspects of being a chiropractor and job satisfaction using the improved pre-tested survey instrument.

Face validation of survey

The initial draft survey comprised of a 23-item questionnaire with additional spaces for other potential factors nominated by participants and a section at the end of the survey devoted to feedback from the clinicians. The questions were scored using a numerical rating Likert scale (0-10 option) with 0 representing strongly disagree and 10 strongly agree. Participants were also asked their sex and to rate their job satisfaction as a chiropractor. The survey was distributed via hard copy to a convenience sample of registered chiropractors in Perth in June 2019. Twenty registered chiropractors (12 male), all with at least three years' experience were invited to participate. Ultimately, ten responded (five males), all were anonymous. The survey took approximately 10-15 minutes to complete and once completed was returned by stamped self-addressed envelope. Ethics approval was attained for the face validity survey from Murdoch University Human Research Ethics Committee (Approval number: 2019/081).

Modifications were made to the survey based on the opinions of the chiropractors that participated in the face

validation of the survey. Two additional statements were added to the survey; “Chiropractors enjoy being able to communicate with patients on a day to day basis” and “Chiropractors are able to participate in research.” Also, one statement was modified from “Chiropractors are safe and trusted. People trust their chiropractor” to “Chiropractors are safe and trusted.”

Practitioner participants

Once face validity of the instrument was established the final survey was administered to a broader population of chiropractors more representative of the profession. This was in the form of an anonymous online survey (Qualtrics, Provo, UT). The survey was disseminated by Chiropractic Australia through email, and the “Evidence Based Chiropractors” private closed Facebook group based in Canada from August 12 to September 15, 2019. Although the “Evidence Based Chiropractors” Facebook group is based in Canada, it is an international community.

The survey included 25 statements regarded as “a positive aspect of being a chiropractor” based around their perceived ability to help patients, training, earning potential, workplace flexibility, public perception, and intra/extra professional relationships (Table 1). The questions were again scored using a numerical rating Likert scale (0-10) with 0 representing strongly disagree and 10 strongly agree. Participants were also asked to provide demographic information including sex and years in full-time practice (or full-time equivalent), and to rate their job satisfaction as a chiropractor. Ethics approval was attained from Murdoch University Human Research Ethics Committee (Approval number: 2019/143).

Analysis

Data were exported from Qualtrics version 1.3 (Provo, UT) to IBM SPSS version 24.0 (Armonk, NY) and checked for implausibility’s and cleaned. Analysis consisted of simple descriptive statistics providing a mean and standard deviation (SD) for each answer. Inferential statistics used parametric and non-parametric methods, depending on the type of data, to examine associations between years of practice, sex, job satisfaction, and the best aspects statements.

Sample size calculation

At the time of data collection there were approximately

900 Chiropractic Australia members from a pool of 5,522 registered chiropractors in Australia and 9700 online members in the “Evidence Based Chiropractors” Facebook “private closed” group. This provides a theoretical sample size of 10,600. In detail, with a population size of 10,600, we set an expected frequency of positive aspects response at a conservative 50%, confidence limits were set at 5%, one cluster design and a design effect of 1.0. Center for Disease Control (USA) Epi-Info StatCalc was then used to derive a sample size of 359.

Results

Three hundred and seventy-four responses were received. Of these five were excluded, four because they had missing data on the two key questions, namely “I am a registered or licensed chiropractor” and “I have been in full time practice... years.” This dual question missing data could have been because the respondent was not a chiropractor and therefore ineligible to participate. The fifth was a “recent graduate” who was not registered or licensed as a chiropractor and had no full-time practice experience. Therefore, 369 survey responses were included in the final analysis, of which 204 were male (55.3%), 159 were female (43.1%), and six nominated “other” (1.6%). The mean years of full-time practice (or full-time equivalent years) of the responders was 13.3 years (standard deviation (SD) 10.1) with a median of 11 years. There was no statistical difference in experience (years of practice) between males and females ($p=0.08$).

Best aspects of being a chiropractor

The rank of the 25 statements of the best aspects of being a chiropractor are shown in Table 1. Using the median in years of experience ($n=11$) we dichotomised the respondents into less and more experienced. The more experienced chiropractors ($n=179$) rated the statement “Chiropractors can have holidays/vacations and leave when it suits them” higher (mean [SD] = 6.54 [2.24]) than the less experienced chiropractors ($n=187$, mean [SD]= 5.92 (2.85), p -value 0.03). Additionally, the more experienced chiropractors also rated the statement “Chiropractors are highly respected by other health professionals” higher ($n=179$, mean [SD]= 4.60 [2.46]) than chiropractors with less experience ($n=187$, mean [SD]= 3.89 (2.24), p -value 0.004).

Mean scores on all 25 statements were compared be-

Table 1.
The best aspects of being a chiropractor.

Rank	Statement	Mean	SD
1	Chiropractors can reduce pain, help move or build strength, flexibility and power in patients.	9.24	1.64
2	Chiropractors are trained to diagnose. Because chiropractors can see people without a medical referral, they need to be able to differentially diagnose.	9.17	1.84
3	Chiropractors can transform people's lives. The ability to help people feel better and give them confidence to try something that they have not been able to do for a long time.	8.78	1.89
4	Chiropractors can work independently in their own businesses.	8.68	1.97
5	Chiropractors enjoy being able to communicate with patients on a day to day basis.	8.64	1.85
6	Chiropractors work with people, not just bodies. Chiropractors know that it is not enough to treat the body-as-a-machine.	8.46	2.06
7	Chiropractors physically touch people. This is a privilege i.e. to touch people for therapeutic reasons.	8.38	2.14
8	Chiropractors enjoy being first contact professionals. Few others, outside of medicine and dentistry, have this privilege.	8.22	2.28
9	With hard work chiropractors can earn a good income.	8.13	2.11
10	Chiropractors are constantly changing their posture at work and not sitting, standing or bending for too long.	7.89	2.12
11	Chiropractors have flexible working hours and days.	7.87	2.21
12	Chiropractors have variety in their work.	7.81	2.16
13	Chiropractors know people as social beings and take into consideration their personal values and circumstances	7.74	2.11
14	Chiropractors can readily keep up with science and modern evidence based practice advances.	7.68	2.34
15	Chiropractors provide employment for others.	7.61	2.25
16	There is a great work-life balance available to chiropractors.	7.61	2.23
17	Chiropractors are pragmatic, enthusiastic and motivated people who like to get things done.	7.60	2.26
18	Chiropractors are adaptable. No matter how difficult things seem right now, people will always want someone to use their hands in skilful, caring ways to heal them of their suffering.	7.56	2.3
19	Chiropractors are able to participate in research.	7.52	2.48
20	Chiropractors are safe and trusted.	7.17	2.50
21	Chiropractors enjoy collaborating with other health professionals.	7.14	2.51
22	Chiropractors can have holidays and leave when it suits them.	6.20	2.74
23	Chiropractors are powerful advocates for those less fortunate; advocating for people whose voices are not being heard.	5.43	2.83
24	Chiropractors are highly respected by the public.	5.33	2.41
25	Chiropractors are highly respected by other health professionals.	4.22	2.37

SD: standard deviation.

Statements scored using a numerical rating Likert scale with a 0-10 option. 0 represented strongly disagree and 10 strongly agree

Table 2.
Job satisfaction based on sex and years of experience

	N	Mean (0-10)	SD	P value
Overall	369	7.94	2.53	
Sex Female	159	8.49	2.07	0.001
Male	204	7.64	2.63	
Years of experience <11 years	187	7.96	2.31	0.94
11 and more	179	7.98	2.70	

SD: standard deviation.

Statement: "I am very satisfied with my choice of occupation being a chiropractor" scored with a 0-10 option. 0 represented strongly disagree and 10 strongly agree

tween males and females. Females rated the four statements; "Chiropractors are able to participate in research" (mean difference=0.81, p-value 0.001), "Chiropractors work with people, not just bodies. Chiropractors know that it is not enough to treat the body-as-a-machine" (mean difference=0.70, p-value 0.001), "Chiropractors are constantly changing their posture at work and not sitting, standing or bending for too long" (mean difference=0.63, p-value 0.004), and "Chiropractors have variety in their work" (mean difference=0.59, p-value 0.009) higher than males.

Job satisfaction

The overall mean satisfaction rating with choice of occupation as a chiropractor was 7.94/10 (SD 2.53) with a median score of 9/10 (Table 2). Years of experience did not alter opinion on job satisfaction. However, females were more satisfied with their choice of occupation as a chiropractor than males with a mean (SD) of 8.49 (2.07) and 7.64 (2.63) respectively (p-value 0.001).

Discussion

In summary, the results show that the highest scored 'best aspect' of being a chiropractor was being able to reduce pain, help move or build strength, flexibility, and power in patients. The second and third highest scored 'best aspect' related to the ability of chiropractors to diagnose conditions and that chiropractors transform peoples' quality of life respectively. Two statements ranked below the median score of five out of 10 and these were "chiropractors are respected by other health professionals" and "chiropractors are highly respected by the public." Job satisfac-

tion overall was rated as high with a median score of 9/10. So, what is the significance of these results?

Regarding reasons for choosing an occupation, a study of occupational therapists found the top reason was the desire to help people with disability.¹⁰ Additionally, two of the reasons that discouraged people from becoming an occupational therapist were being afraid of not being accepted, and a lack of respect.¹⁰ These views seem to be shared with chiropractors demonstrating that the chiropractic profession is not alone in these viewpoints.

The top three statements show that many chiropractors appear to be confident in their own abilities to diagnose conditions and achieve results with musculoskeletal conditions. A survey of chiropractors in the United States found that the majority of surveyed chiropractors considered themselves musculoskeletal specialists and were able to diagnosis a wide range of health conditions.¹⁴

The two lowest ranked statements demonstrate there may be a negative perception of the chiropractic profession amongst other health professionals and the public. Similarly, Mirtz *et al.*¹⁵, based on a survey of non-practicing chiropractors, found that 74% of respondents agreed with the statement 'chiropractic lacks cultural authority'. Although the chiropractic profession has existed for over 125 years, chiropractic has not been able to establish full respect within mainstream society.¹⁶ There are mixed responses regarding public perception about chiropractic. A survey of the general population within Australia (n=182) was conducted to identify the public perception of the profession.¹⁷ Nine percent (9%) of participants found chiropractic to be dangerous, 27% were unsure, and 64%

of participants perceived chiropractic as not dangerous. Additionally, the majority of participants (77%) believed that chiropractic should be part of the public health system, and 56% were interested to know more.¹⁷ Likewise, a survey conducted in the United States (N=5422) revealed that overall chiropractic was perceived as safe, and effective at treating neck and back pain.¹⁸ However, 24% of respondents believed that chiropractic care was dangerous.¹⁸ This mixed response could indicate that there may be a lack of knowledge about the profession, which may produce some negative views on chiropractic.¹⁷ In considering the opinions of medical, physiotherapy, occupational therapy, nursing, and pharmacy students about complementary and alternative medicine there was a correlation between educational exposure to complementary and alternative medicine, and the perceived usefulness of complementary and alternative medicine.¹⁹ Medical students, who had the lowest reported knowledge on complementary and alternative therapy, viewed complementary and alternative therapies as less useful.¹⁹ The student group that had the highest reported knowledge regarding a given therapy generally viewed that therapy more useful compared to students with less reported knowledge on that therapy.¹⁹ It is tempting to speculate that this is carried over into practice after graduation.

Years of experience

There were differences between chiropractors with 11 years or more of experience compared to chiropractors with less than 11 years of experience. Chiropractors with 11 years of more experience rated the statements “Chiropractors can have holidays and leave whenever it suits them,” and “Chiropractors are highly respected by other health professionals” higher than chiropractors with less than 11 years’ experience. We speculate this may be because chiropractors who have been in practice longer have higher levels of resources and seniority in the workplace and therefore may have more power over leave and time off. Additionally, they may have formed stronger relationships over time with other health professionals compared to chiropractors that have only been in practice for a relatively shorter period.

Sex differences

Females rated four ‘best aspect’ statements higher than males relating to the ability to participate in research,

working with people, constantly changing their posture, and having variety in their work. Indicating that females enjoy the variability of being a chiropractor, however the mean differences of all the statements between men and women were less than one point on the Likert scale demonstrating the difference between the groups were small. Overall, females were also more satisfied with their choice of occupation as a chiropractor than males. We are unable to find or surmise a reason for this difference.

Future direction

There are many positive aspects of being a chiropractor. However, there are some areas that are not as highly regarded as best aspects by the profession such as respect of the public and other health professionals. To improve these aspects, evidence-based information and research should be more easily available to the public to improve their knowledge on the profession. Additionally, it has been previously proposed within the literature that in order to overcome the low status amongst healthcare professions, the chiropractic profession could make changes in some key practice areas.¹⁶ This includes being more involved in public health initiatives, ensuring high quality education and research is being undertaken, and establishing a clear identity.¹⁶ Future research is needed to understand not only the perception of chiropractic amongst the public and other health professions but also why these views are held.

Future research could consider why students select chiropractic as a profession and if this correlates with what registered chiropractors perceived as the best aspects. Finally, future research could also consider the reasons for the differing opinions between chiropractors with more or less experience, and between male and female chiropractors.

Strengths and limitations

Strengths of this study included the ample sample size of 369 of participants which exceeded the target sample size of 359. As this survey could be completed online, it was easily outsourced worldwide so participation was not just regional or national.

There were limitations within this study such as the potential for selection bias and response bias. We used a convenience sample through dissemination by Chiropractic Australia and the “Evidence Based Chiropractors” private closed Facebook group in Canada. This could have led to

a subsample of chiropractors being asked to participate in the survey who have certain philosophical views which may have influenced the results. We did not ask participants their country of practice, and it is acknowledged that there may have been differences based on locations of the participants. Additionally, particular chiropractors, interested in volunteering, are more likely to complete the survey potentially leading to response bias. As this was an online anonymous survey we cannot guarantee all responders were registered and practicing chiropractors. However, we did screen the responders through the two key questions, asking if they are a registered chiropractor and then secondly asking how many years they have been in full time practice, and this resulted in five survey responses being excluded from the final analysis. For the face validation of the survey participants were recruited from Perth, Western Australia, while this gives an overall validation of the survey in terms of understandability, the results are unable to be generalised to other countries and are unable to account for cultural differences elsewhere.

Conclusions

There are many positive aspects of being a chiropractor. Chiropractors believe that the best aspects of being a chiropractor are that chiropractors can reduce pain, help move or build strength, flexibility, and power in patients. In addition, chiropractors being trained to diagnose and being able to transform peoples' quality of life were highly scored. However, there are some aspects that are not as highly regarded as best aspects by the profession such as respect by the public and other health professionals.

Acknowledgements

Blake Edwards, Rhys Sparks, Jayden Licastro, Reneigh Morley-Hart, Tom Vowles and Wesley Naidoo for their contribution in literature searches and assistance with data collection. Novia Minaee for her assistance with data analysis.

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The association between guideline adherent radiographic imaging by chiropractic students and the diagnostic yield of clinically significant findings

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Background: Radiographic guidelines aim to increase the diagnostic yield of clinically relevant imaging findings whilst minimising risk. This study assessed the appropriateness of radiographic referrals made by student chiropractors and explored the association between guideline appropriate imaging and clinically significant radiographic findings.

Methods: Radiographic referral and report findings (n=437) from 2018 were extracted from Macquarie University chiropractic clinics. Appropriateness of radiographic referrals was assessed according to current radiographic guidelines. Radiographic findings were assessed for clinical significance. The association between guideline appropriate radiographic referral and

Lien entre les demandes d'examen radiographiques conformes aux lignes directrices provenant d'étudiants en chiropratique et le rendement diagnostique des examens cliniquement pertinents

Contexte : Les lignes directrices relatives aux demandes d'examens radiographiques visent à accroître le rendement diagnostique des résultats des examens d'imagerie cliniquement pertinents tout en minimisant le risque. La présente étude a consisté à évaluer la pertinence des examens radiographiques demandés par des étudiants en chiropratique et à examiner le lien entre la pertinence des demandes d'examens d'imagerie et les résultats des examens radiographiques cliniquement pertinents.

Méthodologie : Des demandes d'examens radiographiques et des rapports d'examens (n = 437) en 2018 ont été extraits de dossiers de la clinique de chiropratique de la Macquarie University. La pertinence

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clinically significant radiographic findings was assessed using logistic regression analysis and odds ratios were estimated.

Results: The proportion of guideline appropriate imaging was 55.8% (95%CI: 51.2-60.4). An association between guideline appropriate radiographs and clinically significant findings was found (OR: 2.2; 95%CI: 1.3-4.1).

Conclusions: Approximately half of all radiographic referrals made by chiropractic students were guideline concordant. Guideline appropriate imaging was associated with an increase in clinically significant radiographic findings.

(JCCA. 2021;65(1):66-75)

KEY WORDS: chiropractic; radiographs; guidelines; diagnostic yield; appropriate use

Introduction

Radiographic imaging is used within chiropractic practice to diagnose serious pathology or trauma, determine appropriate treatment options, and detect contraindications to care.¹ Historically chiropractors also used radiographs to perform biomechanical analysis of the spine and inform technique selection and application.¹ In the last two decades however, radiographic guidelines for the chiropractic profession have discouraged routine radiographs for these reasons, due to the associated risks and lack of evidence of clinical benefit.²⁻⁴ In particular, radiographs commonly demonstrate pathoanatomical changes of limited clinical significance, such as isolated anatomical anomalies or degenerative findings.^{1,5,6} These radiographic findings may lead to overdiagnosis, increased down-

des demandes d'examens radiographiques a été évaluée en fonction des lignes directrices relatives aux demandes d'examens radiographiques en vigueur. La pertinence des résultats des examens radiographiques a été évaluée. On a examiné le lien entre les demandes d'examen radiographique conformes aux lignes directrices et les résultats d'examens radiographiques cliniquement importants à l'aide d'une méthode d'analyse par régression logistique et on a estimé les risques relatifs.

Résultats : La proportion de demandes d'examen d'imagerie qui étaient conformes aux lignes directrices s'est élevée à 55,8 % (IC à 95 % : 51,2-60,4). On a établi un lien entre les demandes d'examens radiographiques conformes aux lignes directrices et les résultats cliniquement pertinents (RR : 2,2; IC à 95 % : 1,3-4,1).

Conclusions : Environ la moitié de toutes les demandes d'examens radiographiques provenant d'étudiants en chiropratique étaient conformes aux lignes directrices. Les demandes d'examens d'imagerie conformes aux lignes ont été associées à une hausse de résultats d'examens cliniquement pertinents.

(JACC. 2021;65(1):66-75)

MOTS CLÉS : chiropratique, examens radiographiques; lignes directrices; rendement diagnostique; utilisation appropriée

stream healthcare utilisation, and create unnecessary patient concern.^{1,7,8} Amongst chiropractors, a high variance in radiographic imaging utilisation rates of between 8% to 84%¹ has been observed. A lack of knowledge and a lack of adherence to current radiographic guidelines has been noted amongst chiropractors, within both clinical and teaching environments⁹⁻¹¹, potentially driving higher imaging rates. Resistance to current radiographic guidelines amongst chiropractors is largely due to concerns that current guidelines do not account for the use of joint manipulative therapy, and that injury or sub-optimal treatment may result if radiographs are not used to screen patients for underlying pathology or anatomical variation prior to joint manipulative therapy.¹²⁻¹⁴

The purpose of radiographic guidelines are to inform

the appropriate use of imaging in clinical practice; that is to increase the diagnostic yield of clinically significant radiographic findings, whilst minimising associated risks.^{1,15} A clinically significant radiographic finding is one that will result in a change to the management of the patient, such as those that either indicate underlying pathology requiring medical referral or increase the likelihood of adverse events following joint manipulation.¹⁶ Clinically significant findings include those indicating underlying cancer, infection, fracture, inflammatory arthritis, joint instability, or osteopenia.^{1,16} Many other radiographic findings, including degenerative changes and isolated anatomical anomalies such as transitional segments and lumbar spondylolisthesis, have not shown clear association with patient symptoms or change to clinical management, making them of unlikely clinical significance.^{1,17,18} Although pathoanatomical changes are common on radiographs performed in chiropractic populations, the majority of changes are of uncertain clinical significance.^{5,6,19} Radiographic findings of known clinical significance are uncommon, with a diagnostic yield ranging from 0.1% to 6.6%.^{5,6,19} If radiographic guidelines are fit for purpose, radiographs taken in accordance with guidelines should be more likely to demonstrate clinically significant radiographic findings than those taken outside of guidelines. Although guideline appropriate imaging has been shown to have a low likelihood of missing pathology²⁰, to our knowledge, the association between guideline appropriate imaging and the diagnostic yield of clinically significant radiographic findings in a chiropractic population has not been assessed.

It is particularly important to ensure that student chiropractors are practicing within an evidence-based paradigm to the standards expected for chiropractic clinicians. Additional drivers of poor adherence to radiographic guidelines that may exist amongst student chiropractors include higher diagnostic uncertainty compared to clinicians and accreditation requirements to demonstrate competence in performing a minimum number of radiographs. There has only been one study that has investigated appropriate radiographic imaging use in the chiropractic student setting. Ammendolia *et al.*⁹, concluded that whilst only 10% of presenting patients were inappropriately referred for radiographs, this accounted for nearly half of all radiographic imaging referrals made; diagnostic yield and association with guideline adherence were not assessed.⁹

Therefore, the aims of this study are to determine (i) the proportion of guideline appropriate imaging performed by chiropractic students in their clinical internship year; (ii) the proportion of imaging performed that identified clinically significant pathology; and (iii) whether the use of guideline appropriate imaging referral is associated with an increased diagnostic yield of clinically significant findings on imaging.

Methods

Design and setting

A retrospective clinical record audit was conducted of all radiographic imaging referrals and reports from January to December 2018 at the Macquarie University chiropractic clinics. Macquarie University operates three chiropractic teaching clinics to provide supervised clinical placements for final year Master of Chiropractic students. The student clinicians are supervised by registered chiropractors to provide diagnosis (including radiographic imaging where indicated) and management for public patients. Ethical approval was provided by the Macquarie University Human Research Ethics Committee (Approval No.: 5201954218658) for this study.

Participants

All patients who were referred for radiographic imaging through the Macquarie University chiropractic clinics from January to December 2018 were included in this study. Patients were excluded if their imaging referral was from another health provider, the imaging was performed at an outside radiology centre, or they did not sign consent for their clinical data to be used for research purposes.

Data extraction

Radiographic referral forms and reports were downloaded from the OPAL-RAD PACs system and de-identified prior to data extraction, with unique identifying numbers allocated. Two researchers independently extracted data from the de-identified radiographic referral forms and reports into Microsoft excel. Referral form data extracted included: chiropractic teaching clinic where the radiographic imaging was performed, date of referral, date of birth, clinical reasons for the radiographic referral, and the radiographic series requested. Radiographic report data extracted included: date of the radiographic study, radio-

graphic series performed, and the radiographic findings. Extracted data were checked for consistency between the two data extractors and any discrepancies were corrected against the original record.

Data synthesis

Appropriateness of the radiographic imaging referral

Two researchers independently categorised the clinical information provided on the referral form as either appropriate or inappropriate compared to current radiographic guidelines for the chiropractic profession.²⁻⁴ Guideline appropriate reasons for radiographic imaging referral included suspicion of underlying serious pathology, history of trauma, suspicion of contraindications to spinal manipulative therapy, or non-response to care.²⁻⁴ Any discrepancies between the researchers were discussed to reach a consensus. If consensus could not be reached a third researcher was consulted. The strength of initial agreement in categorising the appropriateness of imaging between the two researchers was assessed using kappa statistics, and was categorised as slight (0-0.2), fair (0.21-0.4), moderate (0.41-0.6), substantial (0.61-0.8), and almost perfect (0.81-1.0).²¹

Clinically significant radiographic findings

Two researchers independently categorised the reported radiographic findings as clinically significant, possibly significant or clinically insignificant. Clinically significant findings were defined as those likely to change clinical practice or contraindicate the use of joint manipulation, including underlying serious pathology (e.g., osteoporosis, cancer, infection, inflammatory arthritis), fracture, or instability.¹⁶ Instability was assessed on radiograph when flexion and extension radiographs were performed. Possibly significant findings were defined as those that would not contraindicate joint manipulation, but have been reported by chiropractors to potentially inform clinician decisions related to the application of manual therapy.^{1,12,13} These included pathoanatomical changes such as degenerative joint disease, lumbar spondylolisthesis, transitional segments, and scoliosis. Radiographic findings of possible changes that needed clinical correlation or further investigation were also categorised as possibly significant (e.g. possible hypermobility, possible intervertebral foramen narrowing).

All other findings were categorised as clinically insignificant, this included isolated anatomical variances such as spina bifida occulta which are unlikely to have any clinical impact.¹⁹ Any discrepancies between the researchers were discussed to reach a consensus. If consensus could not be reached a third researcher was consulted. Initial agreement in categorising radiographic findings between the two researchers was assessed using kappa statistics.

Data analysis

Appropriateness of the radiographic imaging referral

The appropriateness of the radiographic imaging referral was analysed descriptively as the proportion of radiographic referrals determined as appropriate or inappropriate divided by the total number of radiographic referrals. Proportions of appropriate imaging were stratified by the clinic where the imaging referral was made, the anatomical region of imaging referral (e.g. lumbar, cervical etc.), and the age of patient (in decades) to observe for any trends across these categories.

Clinically relevant imaging

The proportion of clinically relevant imaging was analysed descriptively as the number of radiographs with clinically significant findings, possibly significant findings, or clinically insignificant findings divided by the total number of radiographs. The proportions of clinically relevant imaging were stratified by the clinic where the imaging referral was made, the anatomical region of imaging referral (e.g., lumbar, cervical etc.), and the age of patient (in decades).

Association between guideline appropriate imaging and clinically relevant imaging

Two models were created to assess the association between guideline appropriate imaging and clinically relevant imaging. In model one, the original criteria were applied and only imaging with clinically significant findings was considered clinically relevant. Any radiographic imaging with possibly significant or clinically insignificant findings were considered not clinically relevant. In model 2, adapted criteria were applied to reflect the uncertainty in clinical relevance of some radiographic findings. In

Table 1.

Age of patients, number of radiographic imaging series, and the number of radiographic imaging series per anatomical region, performed at each Macquarie University chiropractic clinic.

	Total	Clinic 1	Clinic 2	Clinic 3
Age range (yrs)	11 - 89	17 - 81	12 - 86	11 - 89
Mean age (SD)	41.8 (20.7)	40.5 (19.4)	44.0 (21.8)	41.8 (21.3)
Radiographic series (N)	437	150	83	157
Radiographic series per anatomical region (N)				
Cervical	98	32	19	34
Thoracic	81	26	13	35
Lumbar	145	46	33	50
Upper limb	48	22	6	17
Lower limb	65	24	12	21

model 2 the clinically significant findings and possibly significant findings were combined and considered as clinically relevant. For each model, two by two tables and logistic regression analysis (adjusted for patient age) were used to assess the association between guideline appropriate imaging and clinically relevant imaging. Odds ratios with 95% confidence intervals were calculated in SPSS (IBM SPSS Statistics v25).

Results

In the 2018 calendar year there were a total of 25,831 patient visits across the three Macquarie University chiropractic clinics. Of these, 4,500 patient visits were either new patients or a new presentation of an existing patient. In the same time period, 437 radiographic imaging referrals were requested. Therefore, radiographic referral proportions were 1.7% of all patient visits and 9.7% of new patients or presentations. The age range of the patients, mean age, number of radiographs performed in each clinic and the number of radiographic series performed per anatomical region are presented in Table 1. The clinic of referral was not recorded on 47 of the referral forms.

Appropriateness of the radiographic imaging referral

Guideline appropriate imaging referrals were made in

244/437 (55.8%; 95%CI: 51.2-60.4) of cases. The appropriateness of radiographic imaging referral stratified by clinic, anatomical region, and age is presented in Table 2. No clear trend in the proportion of guideline appropriate referrals is seen when stratified by clinic or age. An increase in guideline appropriate referrals is evident in the extremities (upper and lower limb) compared to the spine, with the lowest proportion of guideline appropriate referrals in the lumbar spine. Of the guideline appropriate reasons for radiographic imaging referral, the most common reasons were: no improvement after a course of treatment (38.1%, 93/244); history of trauma (37.7%, 92/244); suspicion of underlying pathology, including suspected contraindications to manipulation (13.1%, 32/244); assessment of neurological symptoms (6.6%, 16/244); and adolescent scoliosis (3.3%, 8/244). There was fair agreement²¹ in the initial categorisation of the appropriateness of radiographic imaging referral (kappa, 95%CI: 0.3, 0.2-0.4).

Clinically significant radiographic findings

The proportion of radiographs with clinically significant findings was 65/437 (14.9%; 95%CI: 11.8-18.5), and those with possibly significant findings was 190/437 (43.5%; 95%CI: 38.9-48.2). The proportion of clinically significant findings stratified by clinic, anatomical region,

and age is presented in Table 2. No clear trends in the proportion of clinically significant findings is seen when stratified by clinic or anatomical region. An increase in clinically significant findings is seen in patients over 60 years. Of the clinically significant radiographic findings, the most common findings were: fracture or trauma (30.8%, 20/65); underlying pathology, including inflammatory arthritis or DISH (27.7%, 18/65); osteopenia (24.6%, 16/65); instability (9.2%, 6/65); and congenital findings that would contraindicate manipulation (7.7%, 5/65). Findings that were categorised as possibly significant included: degenerative changes (54.7%, 104/190);

clinical correlation required or need for further investigation (19.5%, 37/190); congenital anomalies of possible significance (12.1%, 23/190); lumbar spondylolisthesis (10.5%, 20/190); intervertebral foramen or canal stenosis without neurological symptoms (2.1%, 4/190); and old fracture (1.1%, 2/190). There was moderate agreement²¹ in the initial categorisation of the clinically significant findings (kappa, 95%CI: 0.6, 0.5-0.6).

Association between guideline appropriate imaging and clinically relevant imaging

For model 1, the proportion of radiographs with clinic-

Table 2.
The proportions of appropriate radiographic imaging referrals and clinically significant findings, stratified by Macquarie University chiropractic clinic, anatomical region, and by age.

	Appropriate n (%; 95%CI)	Not appropriate n (%; 95%CI)	Clinically significant n (%; 95%CI)	Possibly significant n (%; 95%CI)	Clinically insignificant n (%; 95%CI)
Total (N=437)	244 (55.8; 51.2, 60.4)	193 (44.2; 39.6, 48.9)	65 (14.9; 11.8, 18.5)	190 (43.5; 38.9, 48.2)	182 (41.7; 37.1, 46.3)
Clinic					
1 (N=150)	83 (55.3; 47.3, 63.1)	67 (44.7; 36.9, 52.7)	19 (12.7; 8.3, 18.9)	55 (36.7; 29.4, 44.6)	76 (50.7; 42.8, 58.6)
2 (N=83)	52 (62.7; 51.9, 72.3)	31 (37.4; 27.7, 48.1)	15 (18.1; 11.3, 27.7)	41 (49.4; 38.9, 59.9)	27 (32.5; 23.4, 43.2)
3 (N=157)	80 (51.0; 43.2, 58.7)	77 (49.0; 41.3, 56.8)	23 (14.7; 10.0, 21.0)	71 (45.2; 37.6, 53.0)	63 (40.1; 32.8, 47.9)
Anatomical region					
Cervical (N=98)	58 (59.2; 49.3, 68.4)	40 (40.8; 31.6, 50.7)	13 (13.3; 7.9, 21.4)	52 (53.1; 43.3, 62.6)	33 (33.7; 25.1, 43.5)
Thoracic (N=81)	40 (49.4; 38.8, 60.1)	41 (50.6; 40.0, 61.2)	14 (17.3; 10.6, 27.0)	19 (23.5; 15.6, 33.8)	48 (59.3; 48.4, 69.3)
Lumbar (N=145)	62 (42.8; 35.0, 50.9)	83 (57.2; 49.1, 65.0)	19 (13.1; 8.6, 19.6)	82 (56.6; 48.4, 64.4)	44 (30.3; 23.5, 38.3)
Lower extremity (N=65)	44 (67.7; 55.6, 77.8)	21 (32.3; 22.2, 44.4)	9 (13.9; 7.5, 24.3)	23 (35.4; 24.9, 47.5)	33 (50.8; 38.9, 62.5)
Upper extremity (N=48)	40 (83.3; 70.4, 91.3)	8 (16.7; 8.7, 29.6)	10 (20.8; 11.7, 34.3)	14 (29.2; 18.2, 43.2)	24 (50.0; 36.4, 63.6)
Age range					
11-20 (N=33)	13 (39.4; 24.7, 56.3)	20 (60.6; 43.7, 75.3)	1 (3.0; 0.5, 15.3)	6 (18.2; 8.6, 34.4)	26 (78.8; 62.3, 89.3)
21-30 (N=140)	89 (63.6; 55.3, 71.1)	51 (36.4; 28.9, 44.7)	16 (11.4; 7.2, 17.8)	34 (24.3; 17.9, 32.0)	90 (64.3; 56.1, 71.7)
31-40 (N=46)	25 (54.4; 40.2, 67.9)	21 (45.7; 32.2, 59.8)	6 (13.0; 6.1, 25.7)	15 (32.6; 20.8, 47.0)	25 (54.4; 40.2, 67.9)
41-50 (N=14)	9 (64.3; 38.8, 83.7)	5 (35.7; 16.3, 61.2)	0.0 (0.0; 0.0, 2.2)	10 (71.4; 43.4, 88.3)	4 (28.6; 11.7, 54.7)
51-60 (N=54)	36 (66.7; 53.4, 77.8)	18 (33.3; 22.2, 46.6)	1 (1.9; 0.3, 9.8)	42 (77.8; 65.1, 86.8)	11 (20.4; 11.8, 32.9)
61-70 (N=44)	20 (45.5; 31.7, 59.9)	24 (54.6; 40.1, 68.3)	9 (20.5; 11.2, 34.5)	30 (68.2; 53.4, 80.0)	5 (11.4; 5.0, 24.0)
71-80 (N=45)	21 (46.7; 32.9, 60.9)	24 (53.3; 39.1, 67.1)	17 (37.8; 25.1, 52.4)	23 (51.1; 37.0, 65.0)	5 (11.1; 4.8, 23.5)
81-90 (N=10)	6 (60.0; 31.3, 83.2)	4 (40.0; 16.8, 68.7)	6 (60.0; 31.3, 83.2)	3 (30.0; 10.8, 60.3)	1 (10.0; 1.9, 67.8)

Table 3.

Association between guideline appropriate referrals and clinically relevant imaging.

Model 1: Original criteria for clinically relevant imaging*				
		Clinically relevant imaging		
		Yes	No	Total
Guideline appropriate referral	Yes	46	198	244
	No	19	174	193
	Total	65	372	437
Logistic regression analysis (OR, 95% CI): 2.2 (1.3, 4.1)				
Model 2: Adapted criteria for clinically relevant imaging#				
		Clinically relevant imaging		
		Yes	No	Total
Guideline appropriate referral	Yes	146	98	244
	No	109	84	193
	Total	255	182	437
Logistic regression analysis (OR, 95% CI): 1.2 (0.8, 1.9)				

*The original criteria only included clinically significant findings as clinically relevant imaging.

#The adapted criteria used the combination of clinically significant findings *and* possibly significant findings, as clinically relevant imaging

ally significant findings was 65/437 (14.9%; 95%CI: 11.8-18.5), and of these, the proportion that was guideline appropriate was 46/65 (70.8%; 95%CI: 58.8, 80.4), as presented in Table 3. Logistic regression analysis resulted in an odds ratio of 2.2 (95%CI: 1.3, 4.1), indicating that there is 95% confidence that odds of a clinically significant finding being present are between 1.3 to 4.1 times greater when the radiographic referral is guideline appropriate.

In model 2, the proportion of either clinically significant or possibly significant findings was 255/437 (58.4%; 95%CI: 53.7-62.9), and of these, the proportion that was guideline appropriate was 146/255 (57.83%; 95%CI: 51.1, 63.2) as presented in Table 3. Logistic regression analysis demonstrated that there was no statistically significant association between guideline appropriate referrals and the presence of either clinically significant or possibly significant radiographic findings. (OR; 95%CI: 1.2; 0.8, 1.9).

Discussion

This study demonstrated that although just over half of the radiographs performed by chiropractic students within the teaching clinics were considered guideline appropriate (55.8%; 95%CI: 50.2, 60.4), only 14.9% (95%CI: 11.8, 18.5) of radiographs demonstrated clinically significant findings. Of the remaining radiographs, 43.5% (95%CI: 38.9, 48.2) demonstrated possibly significant radiographic findings, of uncertain clinical relevance. The odds of finding a clinically significant radiographic finding on radiographic imaging are between 1.3 and 4.1 times greater when the imaging referral is guideline appropriate. A statistically significant association was not demonstrated between guideline appropriate imaging and the detection of either clinically significant or possibly significant radiographic findings (OR 1.2, 95%CI: 0.8, 1.9).

The diagnostic yield of clinically significant radiographic findings in this study was 14.9%, and included

reports of fracture, inflammatory arthritis, instability and osteopenia. This is similar to previously reported proportions of underlying pathology of approximately 12% in both medical²⁰ and chiropractic⁶ populations. In contrast to a previous study performed in a chiropractic teaching clinic, the proportion of possibly significant radiographic findings in our study was lower at 43.5% compared to approximately 55%.⁶ However, the previous study included some radiographic findings (such as anatomical variances like spina bifida occulta) that we considered of unlikely clinical significance.⁶ The proportion of clinically significant findings increased in patients greater than 60 years of age, which is consistent with research identifying age above 65 in females and 75 in males as possible risk factors for pathology.²⁵ Older guidelines suggest that age above 50 may be considered a risk factor of pathology.^{2,4} However, this was not identified in this study, with few patients in the 51-to-60-year age group having clinically significant radiographic findings.

To our knowledge, no other study has specifically looked at the association between guideline appropriate imaging and diagnostic yield. Here, an association between guideline appropriate imaging and imaging findings was present when clinically significant findings were considered alone, but was no longer apparent when possibly significant findings were added to the clinically significant group. This is consistent with current guidelines being designed to detect pathologies that will definitively impact clinical practice rather than those of less certain significance.^{1,15,22} Although an association between guideline appropriate imaging referral and clinically significant radiographic findings was observed, still nearly 30% of clinically significant radiographic findings were present on radiographs categorised as guideline inappropriate. This is in contrast to a Canadian study, where no serious pathology was identified in patients who were not indicated for imaging.²⁰ In the Canadian study, however, patients determined not to need imaging did not receive any, so the presence or absence of clinically significant imaging findings could not be performed. Instead, these patients were followed up at one-year for any subsequent diagnosis of pathology.²⁰ False positive imaging findings are common²³, and some of the clinically significant radiographic findings in the current study may in fact be determined as benign changes on further investigation. It is however, of clinical importance to acknowledge that referral for

radiographs in strict alignment with current radiographic guidelines, may not detect all clinically significant radiographic findings.

Just under half of all radiographic referrals by chiropractic students were considered guideline inappropriate. Depending on the anatomical region, the proportion of inappropriate imaging varied from 15.7% in the upper limb to 57.2% in the lumbar spine. This variation may reflect higher diagnostic uncertainty in the low back²⁴ and a lack of indicators for imaging with high diagnostic certainty²⁵. Certainly, low back pain is strongly associated with imaging overuse²⁶ and inconsistency between imaging referral and guideline recommendations²⁷. The proportion of inappropriate imaging in the lumbar spine in this study is similar to the small amount of available evidence from chiropractic teaching clinics, where, in Canada, up to 47.3% of radiographs did not conform to guidelines.⁹ These proportions of inappropriate imaging in student clinics are higher than the approximately one third of inappropriate imaging of the lumbar spine seen in clinical practice.²⁷ Higher proportions of non-indicated imaging amongst students may be due to a lack of knowledge, less certainty in their clinical decision-making process, or the need to meet radiographic imaging academic requirements. Concern has been raised over the diagnostic accuracy of many of the red flags that current radiographic guidelines are based on²⁵, potentially decreasing both clinician and student confidence in current guidelines. Strategies to increase clinical decision-making confidence, such as the development clinical decision-making frameworks^{28,29}, within both teaching and clinical environments need to be considered.

Strengths and limitations

The strengths of this study include the systematic approach to data collection and categorisation. All radiographic imaging referrals from a single calendar year across the three Macquarie University chiropractic clinics were collected. Categorisation of the data was performed by two independent researchers to a pre-determined rubric informed by current literature. All disagreements in categorisation were discussed between the research team to ensure final consistency between decisions and with published guidelines.

Limitations include the retrospective nature of the data collection and the level of agreement in categorisation

decisions. Data collection was limited to the information provided on the referral forms, which may not have included all relevant clinical details, and potentially may have impacted decisions regarding the appropriateness of the radiographic imaging referral. However, it is very likely that the strongest reasons for referring for imaging were listed on the forms, as students have to provide their clinical supervisors with appropriate justification for the radiographic imaging referral. Some reasons for referral, such as 'no improvement after a course of treatment' had limited clinical information but were categorised as concordant with guidelines for two reasons: 1) the phrasing is consistent with that used in the reference guidelines²⁻⁴; and 2) clinical supervisors would have been aware of the additional clinical information when approving the radiographic referral. Only fair agreement²¹ between the researchers was seen for the initial decisions regarding the appropriateness of imaging. Many of the radiographic referral forms reported reasons for referral that did not definitively align with radiographic guidelines, and a judgement call had to be made by the researchers. Further discussion between the research team was held to come to final and consistent decisions on the categorisation. Finally, it is possible that the proportion of appropriate imaging may be overestimated in this study due to the uncertainty around the diagnostic accuracy of red flag indicators of potential pathology²⁵ that were used to indicate appropriate imaging in this study.

Conclusion

Approximately half of all radiographic referrals made by Macquarie University student chiropractors were guideline appropriate. While guideline appropriate radiographic imaging was associated with an increase in clinically significant radiographic findings, demonstrating the utility of current guidelines, not all clinically significant findings were detected by guideline appropriate imaging. Radiographic guidelines are a useful tool to aid clinical decision-making regarding the need for radiographic imaging to detect clinically significant findings; however, clinician judgement is needed as some clinical scenarios indicating radiographic imaging referral may fall outside current guidelines.

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The nosological classification of whiplash-associated disorder: a narrative review

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Whiplash-associated disorder (WAD) is the most common complaint and purported cause of chronic disability associated with motor vehicle collisions in North America. However, its construct validity remains controversial. This narrative review of the literature summarises the evidence underlying the most commonly theorised biological and psychosocial mechanisms of WAD pathogenesis. While the face validity of WAD is good, empirical evidence supporting the various constructs suggesting a causal link between a trauma mechanism and the development of symptoms is poor. Because individual expectations of recovery are outcome-predictive, future research is necessary to develop a better understanding of how to enhance expectancies in order to help affected motorists gain a greater sense of control over their health and wellbeing.

(JCCA. 2021;65(1):76-93)

KEY WORDS: whiplash; injury; pathology; nosology; expectancies; chiropractic

Classification nosocomiale du traumatisme cervical en coup de fouet : revue narrative

Le traumatisme cervical en coup de fouet (whiplash cervical) constitue le symptôme le plus fréquent lié aux accidents de la route en Amérique du Nord. C'est aussi la cause prétendue de l'invalidité chronique résultant de ce type d'accidents. La validité conceptuelle de ce traumatisme soulève toutefois des controverses. La présente revue narrative de la littérature résume les preuves qui sous-tendent les mécanismes biologiques et psychologiques les plus théorisés de la pathogenèse du traumatisme cervical en coup de fouet. Alors que l'interprétation de ce traumatisme est juste en apparence, des preuves empiriques appuient diverses interprétations semblant indiquer que le lien de causalité entre le mécanisme de traumatisme et le développement de symptômes est faible. Comme les attentes individuelles d'un rétablissement constituent un élément prédictif de l'évolution, il faudrait mener d'autres recherches pour mieux comprendre la façon d'accroître les attentes pour aider les automobilistes à développer un sens plus aigu de la maîtrise sur leur santé et de leur bien-être.

(JACC. 2021;65(1):76-93)

MOTS CLÉS : traumatisme cervical en coup de fouet; atteinte; pathologie; nosologie; attentes; chiropratique

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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.

Introduction

Whiplash-associated disorder (WAD) is the most commonly reported clinical presentation by individuals involved in motor vehicle collisions (MVCs) with an annual incidence that has been estimated to be 300 per 100,000 people in North America.¹ The term “*whiplash*” was first introduced by Crowe in 1928 when he described the motion of sudden acceleration-deceleration of the cervical spine as the result of a collision.² Crowe did not intend for the expression to reflect the name of a new disease.³ In spite of this goal, clinicians, patients and lawyers have accepted whiplash as a clinical entity with a wide variety of sequelae, purportedly caused by trauma to the spine and its surrounding structures.

The *Quebec Task Force on Whiplash Associated Disorders* classifies WAD based upon the severity of a person’s symptoms and signs:⁴

- Grade 0: No complaints about neck pain. No physical signs.
- Grade I: Neck complaint of pain, stiffness or tenderness only. No physical signs.
- Grade II: Neck complaint and musculoskeletal signs including decreased range of motion and point tenderness.
- Grade III: Neck complaint, musculoskeletal signs and neurological signs including decreased or absent deep tendon reflexes, muscle weakness and sensory deficits.
- Grade IV: Neck complaint and fracture or dislocation.

The clinical presentation of WAD is highly variable. In one study of 6481 Saskatchewan residents who filed auto insurance claims, only 0.4% of respondent complaints were restricted to neck pain alone, with pain often extending into the head, shoulder girdle, upper, mid and lower back, and the upper and lower extremities.⁵ A variety of psychological symptoms may also be associated with WAD, including depression, anger, fear, anxiety, and hypochondriasis.⁶

Several kinematic studies have attempted to glean more information with respect to the forces applied to the body during a collision that may be helpful in understanding the etiology of WAD and inform its management. Suggested sites of tissue injury include the facet joint, capsule and its ligaments^{7,8}, intervertebral disc⁹, spinal ligaments¹⁰, and skeletal muscle¹¹. Evidence also exists

to suggest that central nervous system involvement¹², as well as psychosocial factors^{13,14} play a role in the development and persistence of WAD.

Given the pertinence of periodic review to revise our understanding of the scientific literature on the etiology of WAD, the aim of this narrative review is to summarise the evidence underlying the most commonly suggested mechanisms of WAD pathogenesis and to provide an updated appreciation of the subject matter in the 25 years since the last such review was performed by Stovner¹⁵ as part of a treatise on the etiopathology of WAD.

This review also considers whether a causal link between a trauma mechanism and the development of symptoms is reasonable. This is accomplished through the widely accepted guidelines for causation, established by Sir Austin Bradford Hill¹⁶, though not without controversy¹⁷⁻¹⁹, to discern the fundamental prerequisites and assessment criteria of the cause-effect relationship as it relates to WAD pathogenesis.

Methods

Search strategy

A MEDLINE/PubMed search was performed using the following search string “whiplash [Title/Abstract} AND injury [Title/Abstract} AND pathogenesis [Title/Abstract]” from January 1, 1994 to December 31, 2019, yielding 1237 entries, which were exported to EndNote X9 for reference management and tracking of the screening process.

Selection of studies

Studies were included if they met the following criteria: 1) published in English and in a peer-reviewed journal; 2) study designs included experimental (Randomised Clinical Trials) and observational (Cohort and Case-Control) studies; 3) study populations include adults (19+ years old); 4) study populations confined to traffic collisions; 5) studies that suggest damage or injury to, or aberration of, commonly suspected anatomical structures of the body including: the facet joint and/or capsule, skeletal muscle, and the central nervous system; 6) studies that suggest psychological factors associated with WAD such as psychological distress, catastrophisation, and patient expectancies, and 7) studies that consider compensation and its role in health outcomes. Because limited evidence exists to substantiate the notion that intervertebral disc²⁰⁻²²

Table 1.
Level of Evidence

A1	Systematic review of ≥ 2 A2-level studies
A2	Randomised, double-blinded clinical trial of good quality and adequate size
B	Comparative/controlled studies failing to satisfy criteria for A2
C	Non-comparative studies
D	Expert opinion

and spinal ligament^{23,24} involvement materially contribute to the development of WAD, summary regarding the validity of these particular structures as potential causes of WAD was not included in this review.

Studies concerning grade IV WAD, the pediatric population, esophageal, ocular, oropharyngeal, otologic, temporomandibular joint or vascular manifestations that may be associated with the condition, as well as cadaveric studies, kinematic studies, case reports, opinions, comments, letters to the editor, and articles without scientific data or a report of their methodology were excluded.

Level of evidence

A level of evidence rating was given to every study, based on the study design (Table 1), according to the 2005 classification system of the Dutch Institute for Healthcare Improvement CBO. Randomised double-blinded comparative clinical research of good quality and efficient size obtained a level of evidence A2, while cohort studies not meeting these criteria or case-control studies obtained a level of evidence B. Non-controlled trials obtained a level of evidence C. The level of evidence for each study is listed in the corresponding table of studies suggesting a cause of WAD, and the overall level of evidence for the cluster of studies represented in each table is listed under the respective table.

Strength of conclusion

Subsequently, the strength of conclusion (ranging from 1 to 4) was calculated for each cluster of studies reflecting one outcome parameter (Table 2) and is placed under the respective table representing a cluster of studies suggesting a cause of WAD. Strength of conclusion 1 was assigned for a study of level A1 or at least 2 independently conducted studies of level A2. Strength of conclusion 2

Table 2.
Strength of conclusion

Level	Conclusion based on
1	A1 study or ≥ 2 A2-level studies
2	One A2-level study or ≥ 2 independent B-level studies
3	One B-level or C-level study
4	Inconclusive or inconsistent results between various studies

was given when at least 2 independently conducted studies of evidence level B or one trial of evidence level A2 was included in the cluster, and strength of conclusion 3 was assigned if one study of evidence level B or C was present. Strength of conclusion 4 was given in case of inconclusive or inconsistent results between various studies.

The author reviewed all entries, of which, 43 duplicates were removed, and 1194 citations were screened by title and abstract. Two hundred and five full-text articles were screened. Of those, 39 articles met the inclusion criteria and were eligible for critical appraisal. Reasons for exclusion during the full-text screening phase were study design (n=30), research question (n=34), outcome of interest (n=94), and population of subjects (n=7) (Figure 1).

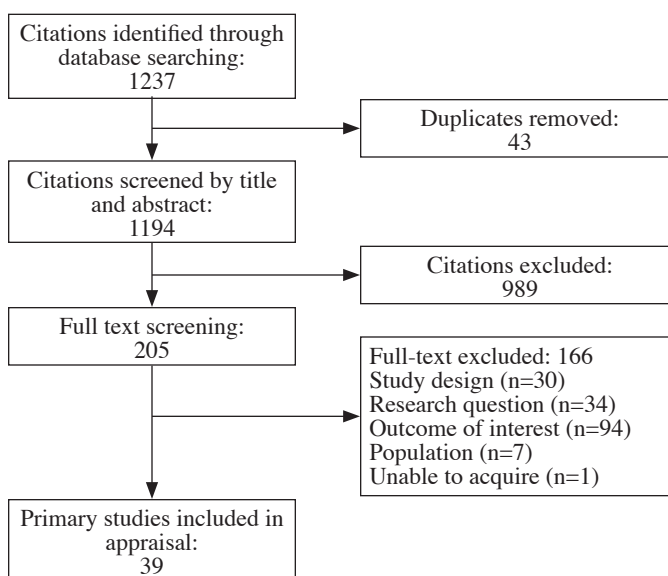


Figure 1.
Study selection process

Table 3.
Studies suggesting facet injury is a cause of WAD

First Author	Year Published	Treatment Administered	Study Design	Summary of Findings	Level of Evidence
Lord	1994	Anesthetic block	Double-blinded RCT	Complete HA relief in 13/55 patients Neck pain relief in 14/55 patients	A2
Barnsley	1995	Anesthetic block	Double-blinded RCT	Neck pain relief in 27/50 patients	A2
Lord	1996	Radiofrequency neurotomy	Double-blinded RCT	50% pain relief for mean of 263 in treatment group vs 8 days in control group	A2
Lord	1996	Anesthetic block	Placebo-controlled RCT	Neck pain relief in 31/52 patients	A2
McDonald	1999	Radiofrequency neurotomy	Cohort	Pain relief in 20/28 patients	C
Govind	2003	Radiofrequency neurotomy	Cohort	Complete pain relief at 90 days F/U in 43/48 patients	C
Barnsley	2005	Radiofrequency neurotomy	Cohort	Adequate pain relief in 36/45 patients for mean of 36 weeks	C
Smith	2014	Radiofrequency neurotomy	Cohort	Pain, disability, psychological distress & pain catastrophising ↓ at 1, 3 mo.	C

Level of evidence: A1; Strength of conclusion: 4; HA: Headache, F/U: Follow-Up

Table 4.
Studies suggesting change in muscle morphology is a cause of WAD

First Author	Year Published	Study Design	Summary of Findings	Level of Evidence
Elliott	2015	Prospective longitudinal cohort study	MFI values were significantly higher in the severe group when compared to the recovered/mild group at 2-weeks and 3-months	C
Karlsson	2016	X-sectional case-control	Participants with severe disability after a whiplash injury had higher MFI in the multifidus compared to controls and to those with mild/moderate disability secondary to WAD	B
Pedler	2018	X-sectional case-control	Global differences in MFI are not a feature of chronic WAD, with differences in MFI limited to the cervical spine musculature	B
Abbott	2018	X-sectional case-control	Increased MFI within cervical multifidus of WAD patients compared to controls	B

Level of evidence: B; Strength of conclusion: 4; MFI: Muscle fatty infiltrates, WAD: Whiplash-associated disorder

Table 5.
Studies suggesting central sensitisation is a cause of WAD

First Author	Year Published	Study Design	Summary of Findings	Level of Study
Borchgrevink	1997	X-sectional case-control	No significant alterations in CNS morphology identified	B
Radanov	1999	X-sectional cohort	No alterations in CNS perfusion by PET or SPECT scan	C
Freitag	2001	X-sectional case-control	Significant decrease in BOLD signal in symptomatic patients vs. asymptomatic patients and controls	B
Lorberboym	2002	X-sectional cohort	Regional CNS perfusion abnormalities by SPECT in 13/20 WAD patients	C
Sundstrom	2006	X-sectional case-control	No significant changes in WAD group, while non-traumatic neck pain group showed significant altered rCBF pattern compared to controls	B
Sturzenegger	2008	X-sectional case-control	No difference in ventricle-brain ratio between WAD patients and healthy controls	B
Obermann	2009	X-sectional case-control	Significant decreases in ACC and dorsolateral DLPFC at 3 mo.; resolved by 1 y	B
Linnman	2009	X-sectional case-control	Regional CNS perfusion increases & decreases by PET scan	B
Linnman	2010	X-sectional case-control	Availability of a pain processing (NK1) receptor was decreased in WAD patients	B
Bakhtadze	2012	X-sectional cohort	Parietal and frontal perfusion decreased with increased levels of pain	C

Level of evidence: B; Strength of conclusion: 4; CNS: Central Nervous System, PET: Positron Emission Tomography, SPECT: Single-Photon Emission Computed Tomography, BOLD: Blood-Oxygen-Level-Dependent imaging, rCBF: regional Cerebral Blood Flow, ACC: Anterior Cingulate Cortex, DLPFC: Dorsolateral Prefrontal Cortex, NK1: Neurokinin receptor 1, WAD: Whiplash-associated disorder

The studies selected for further analysis were clustered according to the following theorised mechanisms of WAD pathogenesis: 1) evidence of facet joint and/or capsule injury (Table 3); 2) evidence of change in skeletal muscle morphology (Table 4); 3) evidence of central nervous sys-

tem involvement (Table 5); 4) evidence of a role of psychological distress and patient expectancies (Table 6); and 5) evidence of the role of compensation resulting in poor health outcomes (Table 7).

Table 6.
Studies suggesting that pain catastrophising and expectancies impact WAD prognosis

First Author	Year Published	Treatment Administered	Study Design	Summary of Findings	Level of Study
Carroll	2009	Rehabilitation	Cohort	Patients who expected to recover soon recovered in 1/3 of the time	C
Ozegovic	2009	None	Cohort	Those who expected to recover experienced global recovery 42% faster	C
Ozegovic	2010	None	Population-based cohort	Depression, ↓ income, ↓ education & male gender associated with delayed RTW	C
Ferrari	2011	None	X-sectional cohort	High correlation between expectations and injury severity perception scores	C
Bostick	2013	Physiotherapy & Chiropractic	Longitudinal cohort	Expectations inversely correlated, catastrophising directly correlated with pain severity at 6 mo	C
Carriere	2015	Rehabilitation	Longitudinal cohort	Expectancies mediate the relationship between pain catastrophizing fear of movement & RTW	C
Chiarotto	2015	Manual therapy; motor & sensorimotor control training	Longitudinal Cohort	Baseline pain intensity & pain catastrophising predict response	C
Falla	2016	None	Longitudinal cohort	Female gender, unsettled insurance claims & financial status predict pain	C
Smith	2016	Radiofrequency neurotomy	Longitudinal cohort	Baseline pain catastrophising & disability predict response	C
Carriere	2017	Rehabilitation	Longitudinal cohort	Expectancies mediate the relationship between perceived injustice & RTW	C
Soderlund	2018	Multimodal therapy	Longitudinal cohort	Expectation of recovery, distracting & supportive feedback from significant others predict recovery outcome	C
De Pauw	2018	None	X-sectional case-control	Fear avoidance symptoms of central sensitisation, & pain predict motor impairment	B
Elphinston	2018	Rehabilitation	Longitudinal cohort	Expectations inversely correlated, catastrophising directly correlated with pain severity	C

Level of evidence: B; Strength of conclusion: 3; RTW: Return to Work

Table 7.
Studies suggesting that compensation impacts WAD prognosis

First Author	Year Published	Study Design	Summary of Findings	Level of Evidence
Schrader	1996	Retrospective cohort questionnaire	Expectation of disability, a family history, and attribution of pre-existing symptoms to the trauma may be more important determinants for the evolution of the late whiplash syndrome	C
Obelieniene	1999	Prospective controlled inception cohort study	Symptoms of acute whiplash injury are self-limiting	C
Cassidy	2000	Population-based cohort	The elimination of compensation for pain and suffering is associated with a decreased incidence and improved prognosis of whiplash injury	C
Rydman	2018	Cohort	Non-recovery rate was 51% in non-compensated group and 73% in compensated group	C

Level of evidence: C; Strength of conclusion: 3

Results

Facet joint and capsule injury

Of the various tissues in the cervical spine that may be injured during whiplash, the facet (zygapophysial) joint and facet capsule/ligament are the most extensively documented structures. A proposed mechanism of facet joint injury is undo strain upon the facet capsule, which has been documented in several *in vitro* biomechanical, and *in vivo* animal, studies.²⁵⁻³² Given that such studies are not possible in live humans, attempts to infer injury to the facet joint have been made by way of eight clinical trials documenting pain relief when the facet joint and capsule are specifically targeted via medial branch blocks or percutaneous radiofrequency neurotomy with some meaningful pain relief achieved. Of these studies, four were randomised clinical trials³³⁻³⁶; three involved anesthetic block³³⁻³⁵ and five radiofrequency neurotomy^{36,38-41}.

Two of the three RCTs involved WAD patients with headaches ± neck pain who underwent facet blocks. In two of these studies, patients were randomly assigned to receive an initial radiographically-guided block with either short-acting 2% lignocaine or longer-acting 0.5% bupivacaine.^{33,34} A positive diagnosis of cervical zygapophysial joint pain was made only if both blocks relieved a patient's pain and bupivacaine provided longer relief, which occurred in 13 of 55 patients with headache complaints and 14 of 55 patients with neck pain.³³ The second study saw 27 of 50 patients obtain neck pain relief based on a similar protocol.³⁴ In the third study, patients who presented with dominant headache and obtained relief following third occipital nerves blocks satisfied the authors' criteria for C2-C3 zygapophysial joint pain, and non-responders along with patients who presented with dominant neck pain underwent blocks of cervical zygapophysial joints at several levels below C2-C3.³⁵ Responders were then diagnosed with cervical zygapophysial joint pain at the respective level that offered them relief. The major limitation of the aforementioned studies, pertaining to the current discussion, was the outcome of interest (headache relief vs neck pain relief) coupled with the heterogeneous sample of patients, suggesting a significant risk of selection bias.

The only parallel-group RCT³⁶ involved 24 patients presenting with what the authors deemed to be cervical zygapophysial joint pain at levels C3-C7; confirmed with

the use of local anesthetic blocks. Patients with C2-C3 zygapophysial joint pain were excluded because a previous study³⁷ had shown that treatment at this level by radiofrequency neurotomy was technically difficult. Each subject received either active or mock radiofrequency neurotomy (n = 12 per group) and was followed by telephone interviews and clinic visits until they reported that their pain had returned to 50% of its preoperative level. The treatment protocol in the two arms was identical, except that the temperature of the electrode tip was raised to 80°C for 90 seconds in the active group and maintained at 37°C in the control group. Six patients in the control group and three in the active-treatment group had a return of their accustomed pain immediately following the procedure. At 27 weeks, one patient in the control group and seven in active-treatment group remained pain free with a median time of eight days and 263 days, respectively, before the return of at least 50% of their preoperative pain.³⁶ Notably, a higher proportion of patients involved in ongoing litigation were assigned to the control group. How this may have affected the study results remains unclear given the lack of information provided regarding these patients' circumstances.

The remaining four clinical trials employing radiofrequency neurotomy were uncontrolled.³⁸⁻⁴¹ The aforementioned studies operate on the following assumption: if we accept that a patient reported no pain prior to an MVC but reports pain thereafter, which is successfully treated with facet blocks or radiofrequency neurotomy, the inference is that the facet joint is the source of the patient's pain and, therefore, was injured or implicated in some way during the MVC. This is a common logical fallacy known as *post hoc ergo propter hoc* (from the Latin meaning: "with this, therefore because of this") – where credit is awarded to the treatment administered rather than considering a condition's natural history, regression to the mean, or the impact of narratives proffered to a patient, coupled with the power of the placebo effect and the contextual factors surrounding a patient's particular circumstances that work in concert to bring about recovery.

High-quality evidence demonstrates significant variability in the diagnostic utility of cervical facet joint nerve blocks in individuals with chronic spinal pain; with prevalence rates ranging between 36% to 67% and false-positive rates of 27% to 63%.⁴² Moreover, because studies of healthy and clinical populations find little difference in

the prevalence of anatomical impairment to warrant procedural intervention⁴³⁻⁴⁶, in turn, challenging the practice of assigning a structural cause for the perception of pain in the absence of detectable tissue pathology, an appreciation for the neurobiology of persistent pain is recommended⁴⁷.

In the context of WAD, it is noteworthy that the reporting of symptoms is not synonymous with the presence of injury, which refers to damage to the body produced by energy exchanges that have relatively sudden discernible effects.⁴⁸ Additionally, the perception of pain may arise from an emotional experience⁴⁹, as the correlation between pain and bodily damage is equivocal.

Although treatment interventions targeted at the facet joint have been shown to provide symptomatic relief for a small cohort of patients, the conclusion that injury to the facet joint is therefore the cause of WAD cannot be drawn *ipso facto*.

Muscle involvement

Muscle pain is a prevailing symptom reported by motorists involved in traffic crashes. Though, evidence of direct muscle injury as a cause of WAD remains inconclusive.⁵⁰ Several studies have documented findings in neck muscles by ultrasonography, including muscle deformation during real-time movement^{51,52}, muscle twitching⁵³, and the temporal development of fatty infiltration of the multifidus following MVC exposure⁵⁴⁻⁵⁷. In a single-center longitudinal cohort study by Elliot and colleagues⁵⁴, 36 people with acute WAD (≤ 1 week) were followed and assessed for temporal development of muscle fatty infiltrates (MFI) in the cervical multifidii and the findings were measured against self-reported pain and disability via the Neck Disability Index (NDI). Study subjects were dichotomised into two groups via NDI (0–28%, recovered/mild disability and 30–100%, moderate to severe disability). Mean percent MFI by group and time revealed little variation in the within group changes in the recovered group, the modest mean changes between one week and three months were statistically significant ($p=0.023$). In the moderate/severe disability group, mean percent MFI significantly increased across all time points ($p<0.002$). Comparing the recovered/mild to moderate/severe groups indicated no significant difference at 1 week ($p=0.31$) with significant differences at two weeks ($p=0.0009$) and at three months ($p<0.0001$). Although underpowered, this

study provides some evidential support for the differential development of MFI in participants with varying levels of functional recovery following whiplash. Similar findings are noted by Karlsson *et al.*⁵⁵ and Abbott *et al.*⁵⁶, when comparing 31 individuals with severe disability (chronic WAD lasting >6 months and <3 years) to healthy controls.

In a cross-sectional study by Pedler *et al.*⁵⁷ comparing 43 individuals with chronic WAD (>3 months and <10 years) and 16 healthy controls, the authors found no significant differences in MFI in the soleus muscle between people with chronic WAD and a demographically similar asymptomatic control group, despite between-group differences in MFI at the cervical multifidus – suggesting the potential of local mechanisms at the cervical spine contributing to the differences noted.

The mechanism behind how these aforementioned findings might contribute to the clinical presentation of WAD remains to be elucidated. Nevertheless, it is conceivable that disuse; as a consequence of fear-avoidance behaviour⁵⁸ and passive coping strategies⁵⁹, which has been shown to produce reductions in muscle volume as well as intramuscular fatty infiltration^{60,61}, may play a role in the development of the notable changes in muscle morphology.

Central sensitisation

Where peripheral sensitisation is often associated with acute WAD, increasing evidence exists to suggest that prolonged noxious input manifests as central sensitisation; the amplification of neural signaling within the central nervous system that results in pain hypersensitivity, and that these changes can remain long after nociceptive input has disappeared.⁶²⁻⁶³ The two hallmark characteristics of central sensitisation are the presence of allodynia (pain due to a stimulus that does not usually provoke pain) and hyperalgesia (increased pain from a stimulus that usually provokes pain). While the mechanism of central sensitisation is still not well understood, the processes involved in this phenomenon result in increased responsiveness to a variety of stimuli including mechanical pressure⁶⁴, chemical substances⁶⁵, cold temperature⁶⁶, heat temperature⁶⁷, and electrical stimuli^{64,68}. When the central nervous system is sensitised, tissue damage is not required to induce pain. This may explain the discrepancy between the absence of tissue damage and persistent pain complaints in chronic WAD patients.⁶⁹

It is unclear when the central nervous system starts sensitising and when general widespread hypersensitivity appears. Four studies suggest that central sensitisation occurs three to six months after the initial onset of WAD.^{66,70-72} At the same time, it is important to recognize that the chronic WAD population is heterogeneous and that central sensitisation is not present in all WAD patients.⁷³

As it relates to alterations in structural brain morphology, one study examining structural abnormalities shortly after MVC exposure (within two days), found no signs of edema or lesion in the acute WAD group when compared with healthy controls, nor could a prediction of symptom development be made.⁷⁴ Obermann *et al.*⁷⁵ conducted a cross-sectional case-control study that performed voxel-based morphometry in WAD patients with post-traumatic headache and neck pain within 14 days of MVC exposure. The authors found no structural brain alterations in the acute phase (initial 14 days). However, in those patients that developed chronic headache lasting longer than three months, decreased grey matter volume in the anterior cingulate cortex (ACC) and dorsolateral prefrontal cortex (DLPFC) was observed, and resolved after one year – coinciding with the cessation of headache symptoms. Another study analyzing the ventricle-brain ratio (VBR), found no difference in VBR between patients with chronic WAD and healthy controls.⁷⁶

As it relates to alterations in brain function, a cross-sectional case-control study conducted by Freitag *et al.*⁷⁷ examining 17 subjects; five symptomatic chronic WAD patients (duration 14 to 34 months), five asymptomatic WAD patients, and seven healthy volunteers, all with no evidence of structural brain damage, confirmed by T₂-weighted magnetic resonance imaging (MRI), found that chronic WAD patients showed a significantly decreased performance in psychophysical tasks of coherent motion detection and corresponding functional MRI (fMRI) activation in the middle temporal (MT) and middle superior temporal (MST) regions of the brain, which are known to be important cortical sites of visual motion processing, compared to asymptomatic patients and healthy volunteers. Linnman *et al.*⁷⁸ aimed to explore whether Neurokinin 1-receptor (NK1R) availability is altered in chronic pain patients as compared to healthy controls, and whether changes in NK1R expression are related to behavioural aspects of chronic pain.

The NK1R is a member of the tachykinin receptor

family that preferentially binds to Substance P (SP); the neuropeptide that regulates affective behaviour, emesis, and nociception⁷⁹, and both NK1 and SP have been implicated in locomotive activity⁸⁰ and in pain processing⁸¹.

The authors found a decrease of NK1R availability in chronic WAD patients, and observed a negative correlation between kinesiophobia and NK1R availability per patient scores on the self-reported Tampa Scale for Kinesiophobia (TSK) Questionnaire. That is to say, patients found to have decreased NK1R density also had higher TSK scores; reflecting increased pain-related fear and avoidance behaviour.

Five studies examined alterations in brain perfusion/metabolism through single-photon emission tomography (SPECT) and positron emission tomography (PET) imaging⁸²⁻⁸⁶, of which, only Radanov *et al.*⁸² found no indication for changes of brain perfusion. Sundström *et al.*⁸³ demonstrated that patients with chronic idiopathic neck pain showed decreased regional cerebral blood flow (rCBF) compared to healthy controls, which was most obvious in the parahippocampal and temporal regions, and the cerebellum. However, no such alterations could be observed in patients suffering from chronic WAD compared with healthy controls. Linnman *et al.*⁸⁴ found alterations in the left and right parahippocampal gyrus, left lingual gyrus, left and right posterior cingulate gyrus, right caudate nucleus and right pulvinar nucleus of the thalamus in chronic WAD patients. Bakhtadze *et al.*⁸⁵ found decreased perfusion of the parietal and frontal regions in patients with moderate to severe chronic idiopathic neck pain symptoms when compared to patients with only mild symptoms. Lastly, Lorberboym *et al.*⁸⁶ found regional CNS perfusion abnormalities by SPECT in 13/20 chronic WAD patients (range six months to five years).

However, these abnormalities were not equal for all patients. In 8 patients, perfusion abnormalities were observed in the temporal lobes, in three patients in the occipital lobes, in two patients in the frontal lobes, and another two patients in the basal ganglia.

Therefore, while some evidence exists demonstrating alterations in brain structure, function, perfusion and metabolism in individuals with chronic neck pain, the nature and location of these alterations is not entirely clear. Contradictory findings also exist, suggesting that multiple mechanisms may be responsible for the brain's neuroplasticity associated with the perception of pain.

The patient's psychological state

WAD patients may experience considerable psychological strain. In a meta-analysis of 24 studies, involving 4502 patients, elevated psychological distress was associated with WAD with a large effect size (Cohen's $d = 0.90$); appreciably larger than that observed amongst patients with spinal cord injuries ($d = 0.69$) or mild to moderate traumatic brain injury ($d = 0.23$).⁸⁷ Moreover, evidence exists suggesting that patients with persistent WAD are more likely to have had a pre-MVC history of psychiatric morbidity.⁸⁸

Pain catastrophising; a person's "tendency to magnify the threat value of pain stimulus and to feel helpless in the context of pain, and by a relative inability to inhibit pain-related thoughts in anticipation of, during or following a painful encounter,"⁸⁹ has been linked with poorer clinical outcomes in WAD patients⁹⁰⁻⁹⁵.

Extensive research has also been published on the impact of patient expectations with respect to recovery from WAD.⁹⁶⁻¹⁰⁶ Throughout these studies, the expectations most commonly studied were expectation of pain resolution and expectation of return to work; and in each study, patients' initial expectations of recovery were outcome-predictive.^{96-100,103,106} In one cohort study involving 6015 adults with WAD, those who expected to recover, recovered at more than three times the pace of those who did not anticipate recovery.⁹⁹ In another study, expectation of recovery was found to predict resumption of not just work, but also routine engagement in activities.¹⁰⁴ Expectation of recovery has also been shown to serve as a mediator of pain catastrophising and fear of movement.⁹⁷

Consequently, possessing higher levels of self-efficacy has been shown to be associated with enhanced physical functioning and health status, and lower pain intensity, perceived disability, depressive symptoms and fatigue in individuals with chronic musculoskeletal pain.¹⁰⁷

The impact of compensation

The legal concept of pain and suffering emerged from the origins of civil tort law in early England, and Western society has long recognized that compensation for a loss caused by another is an acceptable effort to make one whole.¹⁰⁸ Yet, it is hypothesised that observing WAD as a compensable phenomenon may result in worse health outcomes.¹⁰⁹ This understanding stems from the belief that fault-based compensation systems are harmful to

health because such systems require individuals to prove poor health and functional decline in an adversarial environment, which, in turn, is thought to negatively affect recovery.¹¹⁰ Moreover, the prospect of financial gain is presumed to motivate some individuals to exaggerate the severity of their symptoms or health status.¹¹¹

These views were corroborated by a population-based study of 7462 road traffic accident claimants, conducted by Cassidy *et al.*¹¹², that saw a 28% reduction in the incidence of whiplash claims along with a reduction in the median time to close claims by more than 200 days, despite increases in the number of vehicle-damage claims and the number of kilometers driven after the province of Saskatchewan switched to a no-fault insurance system from its previous fault-based system. Similar findings were reported in the state of Victoria, Australia, following the introduction of legislation limiting court actions and compensation for whiplash.¹¹³ In keeping with this theme, Cameron *et al.*¹¹⁴ conducted an interrupted time series to assess whether a change in legislation improved health status and quality of life for people with whiplash in New South Wales, Australia. The authors compared three independent groups at baseline (after injury and lodgement of the insurance claim) and two years later. The first group included whiplash claimants who were involved in a motor vehicle crash in the period July to September 1999, before the legislative change. The second group included whiplash claimants who were exposed to MVC during the period July to December 2001, approximately two years after the legislative change. The third group included whiplash claimants who were exposed to MVC between July 2003 and March 2004. Adjusted analysis for the three groups to control for additional factors such as age or gender, and other possible confounders revealed recovery rates of 37%, 52% and 49% in groups 1, 2, and 3, respectively. Reductions in pain intensity were also significantly improved ($p = 0.03$) in groups 2 and 3 compared to group 1, as were improvements in physical component scores ($p = 0.001$) and health status ($p = 0.01$), measured by SF-36 – demonstrating that health outcomes for people with whiplash were substantially improved after legislative change that restricted access to compensation for noneconomic loss, introduced clinical guidelines for the management of whiplash and provided earlier acceptance of compensation claims and greater provision of early treatment.

The notion that regional sociocultural factors may in-

fluence patterns of behaviour led Schrader and colleagues to study the natural evolution of WAD in Lithuania; a country where, at the time, most drivers did not have personal injury insurance, and with little public awareness, even among Lithuanian doctors, about whiplash and its potential to cause disability.¹¹⁵ The authors conducted a retrospective questionnaire-based cohort study of 202 individuals and found that the incidence of chronic neck pain was no higher among individuals involved in MVCs than those in the general population. While recall bias may account for the study findings, the data noted comports with the evidence that individual expectancies; which are not only influenced by one's hardiness, but also through social learning,¹¹⁶ duly predict outcomes. In a subsequent cohort study of 210 Lithuanian motorists involved in MVCs conducted by Obelieniene and colleagues, the authors found no significant differences between motorists involved in rear end collisions and the control group concerning frequency and intensity of neck pain, and headache symptoms after one year.¹¹⁷

Rydman *et al.*¹¹⁸ offer further support for the compensation hypothesis based on a longitudinal cohort study of 144 individuals reporting neck pain after being involved in a motor vehicle collision. The authors noted a higher non-recovery rate among individuals who filed insurance claims (73%) compared to those who did not (51%) over a period of two to four years. The authors further noted an overrepresentation of patients with elevated levels of mental distress at the time of the collision that may have influenced their compensation-seeking behaviour.

Other factors

In addition to the aforementioned negative risk factors associated with poor WAD prognosis, namely; catastrophisation, and compensation and legal factors, some evidence exists to suggest that post-MVC pain and disability¹¹⁹⁻¹²⁵, and early use of healthcare¹²¹ negatively affect WAD prognosis.

Interestingly, factors identified as not being associated with WAD prognosis include post-MVC MRI or radiologic findings^{121,126}, motor dysfunctions¹²⁷, and collision factors; such as the direction of impact, use of seatbelts or headrests, and the speed of the vehicle at the time of impact^{119,121,122,124}. The clinical presentation and prognosis of WAD are also not affected by pre-existing disc degeneration.²¹ This notion is further supported by a prospective

ten-year follow-up study that compared WAD patients and asymptomatic subjects using MRI. The study revealed that progressive decreases in the signal intensity of the intervertebral discs was observed more frequently among WAD patients than the healthy controls, while structural changes in the cervical spine, including posterior disc protrusion, disc space narrowing, and foraminal stenosis, progressed almost equally in both groups. Furthermore, the clinical symptoms observed in both the WAD patients and the healthy controls were not associated with any of the MRI findings. These findings suggest that, although some WAD patients may suffer from long-lasting clinical symptoms, whiplash exposure may not necessarily accelerate the symptomatic structural deterioration of the cervical spine. Instead, the progression of disc degeneration observed in the majority of WAD patients might be attributed to the normal ageing process, similar to the changes seen in the healthy controls.¹²⁸ Another prospective 11-year follow-up study that compared the incidence and prevalence of Modic changes in the cervical spines of WAD patients compared with healthy controls, found that Modic changes were not related to clinical symptoms. Instead, the development of new Modic changes was significantly associated with age, heavy labour, and pre-existing disc degeneration, but not with the details of the MVCs.¹²⁹

Discussion

Establishing a causal inference between a trauma mechanism and WAD

Where a disease denotes a condition characterised by functional impairment, structural change, and the presence of specific signs and symptoms, a disorder is defined by functional impairment without structural change.¹³⁰ Consequently, a diagnosis is the informed opinion of a clinician who provides a label to the patient advising them of their condition. A widely accepted definition of causation is that a specific occurrence serves as an antecedent event or condition that was necessary for the development of a specific condition or injury at the moment that it occurred, given that other circumstances are fixed.¹³¹ In order to ascertain the nosological classification of WAD, a causal relationship linking MVC exposure to symptom development that comports with detectable evidence of one or more of the aforementioned suggested mechan-

isms of WAD development must be constituted. This is achieved through consideration of the nine principles, proposed by Bradford Hill, in determining whether a causal inference is reasonable.¹⁶ The practical application of Hill's criteria is especially useful in determining the credibility of a cause-and-effect relationship in a forensic setting (in individuals evaluated for a legal matter) in order to answer two major forensic questions: "could the exposure have caused the injury or condition outcome in this case?" and "did the exposure cause the injury or condition outcome in this case?"

Herein, the application and interpretation of each of Hill's criteria, as they pertain to the etiology and pathology of WAD, is considered.

Strength of association refers to a strong statistical association for causality. Nolet *et al.* conducted a systematic review and meta-analysis to examine the association between MVC-related neck injury and future neck pain compared to the prevalence of neck pain in the general population, and calculated an unadjusted relative risk of future neck pain in the MVC-exposed population with neck injury of 2.3; reflecting a 57% attributable risk.¹³² At face value, this finding demonstrates a positive association between MVC-related neck injury and future neck pain. However, the broad operational definition of injury applied by the authors: "self-reported injury, primary care or emergency room physician diagnosed injury or an injury that had been filed with an automobile insurance company"¹³² raises the risk of overestimating injury incidence. If we were to apply the injury definition provided in this paper, a strong statistical association between MVC exposure and WAD would be less likely.

Consistency means that several studies involving various groups of patients produce the same conclusion. WAD has been described among distinct populations with significant differences in its incidence and prevalence.^{112-116,133,134} There is also considerable variation in the clinical presentation of WAD; owing to a lack of consistency.

Specificity refers to the degree to which an exposure derives a particular effect. For example; the most common mechanism of lateral ankle sprain is excessive inversion and internal rotation of the hindfoot while the leg is in external rotation, placing maximal strain on the lateral ankle ligaments.¹³⁵ Conversely, the descriptive validity of WAD; the degree to which it can be distinguished from

other similar conditions as a result of a specific cause, is inadequate.^{136,137}

Temporality, described as the obvious principle that cause must precede effect, is perhaps the sole universally agreed upon principle deemed essential for causal inference – where symptom development weeks after a collision would refute causation. At the same time, temporal subsequence does not necessarily imply consequence; as illustrated in an elaborately-designed study by Castro *et al.*, where 51 healthy adults underwent a mock collision that resulted in almost 20% of the subjects indicating "whiplash-like" symptoms within three days of exposure.¹³⁸ None of the test subjects raised any doubts about having been in a real collision after being exposed to 0.03 g-force; equivalent to four to five times less than the force applied when a person takes their first step to initiate walking. Yet, symptoms were reported and attributed to this exposure, which lacked the biomechanical potential to induce injury. In this example, where the timing of symptom development may adhere to the principle of temporality, the development of symptoms in the absence of trauma violates the principles of strength of association, consistency, specificity, biological gradient, biological plausibility, coherence, experiment and analogy.

Biological gradient (dose-response relationship) – Hill wrote that "if a dose response is seen, it is more likely that the association is causal."¹⁶ Meaning that greater exposure should generally lead to an increased incidence of the effect. Some authors suggest that a "limit of harmlessness" in low-velocity collisions (<15km/h) lies between 10-15km/h,¹³⁹ whereas Davis argues that although vehicle damage may not occur up until impacts reach speeds of 15km/h, 4km/h impacts can induce physical injury.¹⁴⁰ Giannoudis *et al.* conducted a retrospective study of 101 consecutive polytrauma patients at a Level I Trauma Centre, and found that the incidence of whiplash is relatively low (13%) following high-energy trauma; concluding that "there is no dose-response relationship between the magnitude of trauma severity and incidence of whiplash injury."¹⁴¹ In this study, whiplash injury was defined according to the Quebec Task Force guidelines as neck pain, stiffness, or headache following the original inciting event, and trauma severity was defined in the following ways: high-energy trauma; reflecting a fall from a height of more than two metres, high-velocity road traffic accidents; reflecting collisions occurring at speeds great-

er than 30km/h, and an Injury Severity Score (ISS) >16; reflecting major trauma.^{142,143}

Biological plausibility means that the association between cause and effect must appear reasonable based on our current biological knowledge. The primary concern regarding WAD pathogenesis is the lack of detectable tissue pathology to substantiate the notion that a traumatic mechanism accounts for the development of post-MVC symptoms. This understanding by no means discounts the patient's pain experience, but rather highlights the impact that psychosocial factors and expectancies associated with WAD can have on symptom chronicity and the patient's perception of disability and recovery.

Coherence is viewed as being similar to biological plausibility where "the cause-and-effect interpretation of our data should not seriously conflict with the generally known facts of the natural history and biology of the disease."¹⁶ The principle of coherence is not satisfied in the absence of gross, biochemical or histopathological evidence to substantiate a mechanistic construct for the development of WAD.

Experiment – Hill explained that evidence drawn from experimental manipulation may lead to the strongest support for causal inference. Implementation of this strategy has been attempted by way of several *in vitro* biomechanical, and *in vivo* animal studies demonstrating collagen fibre disorganisation and/or disruption and hyper-laxity²⁵⁻²⁸, in addition to axonal swelling changes, hyper-excitability, and permanent alterations in neuronal signaling within the spinal cord²⁹⁻³². However, the effects noted are generally imperceptible in live humans, negating this principle's utility in drawing a cause-and-effect relationship.

Analogy has been interpreted to mean that when one causal agent is known, the standards of evidence are lowered for a second causal agent that is similar in some way.¹⁴⁴ The cause-and-effect relationship between a trauma mechanism and the development of WAD is generally rejected, as this phenomenon violates the common traumatological and wound healing principles that inform our current understanding of hard and soft tissue injuries.¹⁴⁵⁻¹⁴⁷ In application; if we once again consider lateral ankle sprain – the primary tissue injury (anterior talofibular ligament and/or sometimes the calcaneofibular ligament) is easily detectable, the mechanism of injury is well-defined, there is a clear pathomechanical im-

pairment associated with the condition, and a significant improvement in mechanical stability is realised for the majority of individuals within a timeline that comports with the normative processes of wound healing.¹⁴⁸ If we attempt to infer a trauma mechanism for the development of WAD, and predict its prognosis using this principle of analogy, we fall short given our inability to 1) detect structural tissue damage and 2) correlate the persistence of symptoms with a narrative that supports the notion that physical injury accounts for the patient's condition. This line of reasoning is further corroborated by the findings noted in a retrospective survey investigating the occurrence of acute and chronic neck pain in demolition derby drivers. Of the 40 derby drivers surveyed, reporting exposure to a median of 1632 lifetime collisions, with mean and maximum collision speeds of 41.6 km/h and 72 km/h, respectively, only two reported their worst post-participation neck pain lasting more than three months, and for one it lasted more than a year. For the majority, the worst neck pain event lasted less than 21 days.¹⁴⁹ These findings suggest that motivational differences between derby drivers and people sustaining whiplash injuries in the general population may account for outcome differences. While this study is at risk of both recall and selection bias, as a group, the derbyists demonstrated that they were less likely to succumb to perceptions of victimhood or illness behaviour and symptom amplification – characteristics known to prolong recovery. Habituation; a form of non-associative learning that refers to any decrease in innate responsiveness to a repeated stimulus, may also play a role in the derbyists responses to collision exposures.^{150,151}

To this end, establishing a distinct cause-and-effect relationship between a trauma mechanism and the development of WAD via the aforementioned framework is untenable. As WAD is a disorder that is diagnosed clinically following a patient's report of symptoms that are commonly attributed to the temporality of MVC exposure in the absence of detectable tissue pathology, it may then be viewed, primarily, as a social construct that is significantly impacted by psychosocial factors, which may amplify otherwise benign bodily symptoms, or transform the possibility of a minor injury into one that is viewed as serious – in turn generating anxiety that sets in motion the phenomenon of symptom expectation and self-imposed functional disability. Those who may reject this inference might employ the *ad ignorantiam* argument by retorting

with the popular aphorism: “absence of evidence is not evidence of absence”. While there is some truth to this statement, absence of evidence may constitute evidence of absence when negative evidence has probative value to support a particular hypothesis over another, to the extent that negative evidence is more likely to draw a scientifically sound conclusion under the favoured hypothesis than under the alternative hypothesis.¹⁵²

Limitations

Although a comprehensive summary regarding the evidence underlying the most commonly theorised biological and psychosocial mechanisms of WAD pathogenesis was attempted, a primary limitation of this review includes finite access to data, hence the use of a single search database. The author is also cognisant that employing a narrow string of search terms may have unintentionally missed other published research studies pertaining to some aspect of WAD pathology.

Conclusion

A definitive etiopathological pathway displaying a causal relationship between MVC exposure and WAD development remains to be elucidated. While the face validity of WAD is good; as both clinicians and patients recognise the condition, the evidence supporting the various purported constructs suggesting a causal link between a trauma mechanism and the development of symptoms is inadequate. In the absence of a defined injury mechanism, a sophisticated understanding of the interconnected nature of biological, psychological, and social states and processes involved in the perception of pain is recommended. Therefore, future research is required to develop a better understanding of how to enhance individuals’ expectations and abilities to adapt and self-manage in the face of physical, emotional, and social challenges, as this appears to significantly impact recovery.

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Assessing the feasibility of using an electronic records database system in use in a group of private chiropractic clinics for practice-based research

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Objective: To explore the feasibility of collecting aggregated patient data from the electronic records of a group of private practices and to determine the suitability of the data for comparative effectiveness or other practice-based research (PBR).

Methods: Assess the type and quality of health-related variables contained in a commercially available electronic records system (Vitalogics) in use in consenting chiropractor's offices. Descriptively analyze baseline patient records to identify demographic variables, vital signs, case types and diagnoses.

Évaluation des possibilités d'utilisation d'une base de données sur les dossiers électroniques par un groupe de cliniques de chiropratique privées aux fins de recherches fondées sur la pratique

Objectif : Examiner la possibilité de recueillir des macrodonnées de patients dans les dossiers électroniques d'un groupe de cliniques privées et déterminer leur utilité pour mener une recherche comparative d'efficacité ou mener d'autres recherches fondées sur la pratique.

Méthodologie : Évaluer le type et la qualité des variables de santé contenus dans le logiciel de gestion de dossiers médicaux informatisés de Vitalogics en usage dans les cabinets des chiropraticiens consentants. Effectuer une analyse descriptive de dossiers de patients de référence pour trouver des variables démographiques, des signes vitaux, des cas types et des diagnostics.

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The study was supported in part with funds from the Health Missions foundation and approved by the Institutional Review Board of Life University in Marietta, GA, USA. The authors have no other disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript.

Results: *Of the 46,000 individual patient records that were analyzed, only a fraction had usable demographic data while more than half contained ICD-9 codes, including records for non-insurance case-types. None contained outcome variables.*

Conclusion: *We did not find that the electronic record system we examined had the types of demographic and outcomes variables that would be useful for comparative effectiveness research. The addition of special fields to code chief complaint and health status indicators not typically included in an electronic records system would be most useful.*

(JCCA. 2021;65(1):94-104)

KEY WORDS: chiropractic, database, effectiveness, health record, practice-based research

Résultats : *Des 46 000 dossiers de patients examinés, seule une partie contenaient des données démographiques utiles alors que moins de la moitié contenaient les codes de la classification ICD-9, et des données sur des cas types non assurés. Aucun ne contenait de variables de résultats.*

Conclusion : *À notre avis, le système de gestion de dossiers électroniques examinés ne fournit pas des types de variables démographiques et de variables de résultats qui seraient utiles pour mener une recherche comparative d'efficacité. L'ajout de champs spéciaux permettant de saisir le code du symptôme principal et des indicateurs de l'état de santé, ce qui d'habitude ne se trouve pas dans un logiciel de gestion de dossiers électroniques, s'avérerait très utile.*

(JACC. 2021;65(1):94-104)

MOTS CLÉS : chiropratique, base de données, efficacité, dossier médical, recherche fondée sur la pratique

Introduction

Health-services researchers and policymakers are continuously looking for ways to reduce costs of health-care in the USA while still making sure everyone has access to quality care. Chiropractic care is considered a healthcare option with similar efficacy for neck pain and low back pain as physical therapy or standard medical care. Current European and North American guidelines recommend a trial of chiropractic care, which includes spinal manipulative therapy (SMT) as well as other modalities such as strengthening and flexibility exercises, education and advice on self-management strategies; all within the scope of practice of chiropractors for both of these afflictions.¹⁻⁵

Current guidelines are mostly based on systematic reviews of randomized clinical trials (RCTs) of previous guidelines. While RCTs are generally considered to be the gold standard for studying the efficacy of health care interventions, many such studies are carried out in institutional settings which are unlike the typical chiropractor's office. Hence, clinical trial results don't necessarily reflect a true measure of the effectiveness of chiropractic

care nor do they provide a true picture of real-world outcomes and costs.^{6,7} Blanchette *et al.*, found only a limited number of studies of effectiveness or cost-effectiveness for chiropractic care for low back pain when they focused on 'pragmatic' studies (i.e. carried out in close to real-world settings) in 2016.⁷ They found conflicting evidence for the cost/benefit of chiropractic care compared to other types of non-invasive care, and indicated a need for more high-quality pragmatic studies.

Practice-based research (PBR) offers an alternative approach to studying the effectiveness of chiropractic care for a range of health conditions. By moving the locus of research to the offices of one or more chiropractors practicing in the field, it may be possible to amass very large volumes of data relating to problems, therapeutic modalities, costs and outcomes. PBR works well for what has been called Comparative Effectiveness Research (CER)^{8,9}; CER seeks to compare outcomes across many practices, with differing clinical approaches, to see what works best for what clinical presentations. The power of CER is that the results are immediately generalizable to the real-world practice, since data are gathered from that

milieu. Also, the sample size can be expansive and geographically diverse if enough practitioners are involved.

However, the collection of data directly from doctors' offices involves its own set of challenges, especially in terms of network development, staff training and buy-in and quality control.¹⁰ A recent article by Bussieres *et al.* points out the challenges of developing a PBR network (PBRN) in chiropractic, which stem from a lack of research infrastructure and research training by chiropractors.¹¹

Currently there are two PBRNs listed with the U.S. Agency for Healthcare Research and Quality (AHRQ): the International Chiropractic Pediatric Association (ICPA) PBRN and the ResearchLink Chiropractic Learning Healthcare Community.¹² The ICPA PBRN is perhaps the most productive of the currently operational PBRNs in chiropractic, with five recent publications.¹³⁻¹⁷

Traditional PBR projects have depended on paper forms for data collection, especially of health outcomes in the form of patient questionnaires or doctors' assessments.¹⁰ More recently, researchers are using online resources, including emails to contact patients, and online questionnaires.^{15,16,18}

It is also possible to collect PBR data from private and public databases such as those containing medical claims data. These databases contain claims data from a mixture of healthcare practitioners, including chiropractors, and have gone far to describe the economics of complementary and alternative medicine (CAM) healthcare consumption¹⁹⁻²³ as well as the distribution of Medicare utilization²⁴⁻²⁶.

Public and Insurance databases in the United States contain only claims-level data and some information about the patient's date of birth, and date of injury or disability as seen on the insurance claim. While diagnostic information is present, claims databases do not typically have information about patient health assessments or response to care.

Other government-sponsored health information databases, such as the Medical Expenditures Panel Survey (MEPS), combine health expenditure information, with employers' records and health interviews with representative samples of adult consumers. Analyses of these data have provided information about outcomes of care and comparisons of expenses between CAM practitioners and standard medical care.²⁷⁻³⁰

The present study approaches PBR from a relatively new and untested direction, namely using the practitioner's own Electronic Record System as the source of data. Since such systems are now mandated, the computerized data management systems presumably installed in all chiropractic offices in the US may be a rich source of information about patients, their progress under chiropractic care and the cost-effectiveness of the care. It may be possible to collect patient data retrospectively from the doctor's electronic files. The main benefit would be that no extra work is required from doctors or their staff to enter study-specific information.

It should be noted that the electronic records systems used in a particular doctor's office may be one of two types: an electronic medical record (EMR) or an electronic health record (EHR). An EMR is a single practice's digital version of a patient's chart. It contains the patient's medical history, diagnoses and treatments by a particular physician, nurse practitioner, specialist, dentist, surgeon or clinic. An EHR is also a digital version of a patient chart, but it is a more inclusive snapshot of the patient's medical history. EHRs are designed to be shared with other providers, so authorized users may instantly access a patient's data across different providers. A USF Medical School web page discusses the differences.³¹

Mior *et al.* used data from an electronic billing system to study the economics of chiropractors in private practice in Ontario, Canada.³² The study assessed summary data pertaining to numbers of patients and visits seen over time but did not look at patient outcomes or demographics. The use of EHR as a data source for retrospective studies of chiropractic patients has been carried out in institutional settings using college or hospital EHR systems. Peterson *et al.* used a hospital EHR in Switzerland to study the relative effectiveness of two treatments for low back pain.³³ Kaeser *et al.* used the EMR of a chiropractic college in the US to compare demographics and diagnoses of patients in the care of student interns to patients seen in private practice.³⁴ They determined that there were distinct differences between patients seen in the school clinics and those reported by practitioner surveys. Hence, there is a need for more information from general practitioners in the chiropractic field.

The present report describes our initial venture into the use of an office-based EMR for possible use in PBR studies. In what follows, we explore the issues encountered in

practitioner recruitment and buy-in, database access, data transmission, personal health information (PHI) de-identification and data analysis. In addition, we briefly discuss institutional review board approval as it relates to this type of work.

Methods

Study design

A retrospective cross-sectional descriptive analysis of a selected set of variables extracted from aggregated data samples contained in cloud-based backups of database files from practitioners using the Vitalogics records system.

Data source

We elected to utilize the commercial electronic records system marketed by Vitalogics Wellness Technologies [www.vitalogics.com, Peoria, IL, USA], largely because the owner of the company is a chiropractor who offered us access to his software engineers and to assist in recruiting clinics in return for our help in improving the software. The software, which was in use in hundreds of chiropractic offices, is an EMR system specifically designed for Chiropractic offices. Besides functionality specifically for practice management and billing, it features modules for healthcare management, outcome assessment, records management and SOAP notes. It is these latter features that we hoped to exploit for comparative effectiveness research.

The actual extraction of data and assembly of working files was performed by programmers employed by Vitalogics. Two cross-sectional data samples were extracted from records of consenting offices, one for all active patient with visits occurring in July 2014 and the other for January 2015. The records extracted contained only baseline data from the patient registration database and did not include information about services performed.

Participants

Participants were of two types: the doctors or practices providing the data and the patients whose records were part of the data sample. As regards the former, any doctor or practice using the Vitalogics software was eligible to participate. Doctors were required to sign a consent form agreeing to the data extraction. Our recruitment plan for

doctors using the software called for the software owner to make an initial request either through email or personal contact. As a further recruiting effort, the research team made a presentation to a regional meeting of software users to familiarize them with the project and enlist them in the study. Practitioners were able to voice their concerns about the project goals and possible outcomes. Practitioners were required to provide written consent before any data could be accessed. The study consent form described the goals of the research and the HIPAA compliant security and de-identification methods that would be used to guarantee data safety and anonymity.

Since our patient participants were 'virtual' and could not consent to participation in person, it was necessary to collaborate with our Institutional Review Board (IRB) to develop a study-specific ethics protocol appropriate to the parameters of this study. Following recent ethics discussions³⁵ and the U.S. federal regulations on human research protections³⁶, it was decided that patient consent would not be required for this project for two reasons: (1) the data were retrospective, implying that in many cases the care plan has been completed and it would be difficult to contact patients to gain consent, and (2) any personal health information (PHI) would be transformed using HIPAA safe harbor plus statistical de-identification methodologies.

Variables

We learned from the software engineers that the software contained several thousand variables, many of which were related to internal software processes. The software engineers provided an initial list of 62 variables focusing on patient demographics, vital statistics, the visit/service record, diagnosis codes and outcomes. Upon inspection, we found that many of these variables were numbers that could be used to identify individual patients, and we could not use them if confidentiality was to be maintained. Also, we had determined early on in the study plan not to include visit-specific data, but to focus on patient characteristics and health status.

We also developed a list of desirable outcome variables specific to comparative effectiveness research, including psychosocial factors, such as marital status, number of children and income level; and educational level which are known to contribute to health and availability of care.^{37,38} The variables we suggested are typically utilized in health services research databases.³⁹

The final list consisted of 34 variables, with 17 variables for record identification and patient demographics, two diagnosis variables, 13 health indicators and two related to referral source or the presence of outcomes (Table 1). The patient’s method of payment, whether cash or some form of third party payment was included as the variable ‘Case Type’. The software engineers matched our list to their data dictionary and identified 27 variables in the database that best matched our requested list. For the final data capture, the programmers developed specific database queries to amass a working dataset.

Data handling and analysis

According to pre-established protocols, the resulting datasets were conveyed through a secure server to a single researcher at our institution who performed initial data cleaning, including removal or transformation of any residual Protected Health Information (PHI). To facilitate this process, we developed protocols for data blinding and transfer based on best practices as well as federal research and HIPAA guidelines.⁴⁰ The Life University institutional review board (IRB) approved the data handling plan and the collection of data directly from the EMR database.

Using Microsoft Excel, a descriptive analysis was performed; to find the rate of utilization of each variable, we first simply counted the number of instances for each variable where data were found to determine the percentages present. Next, we evaluated the range of each numeric variable, such as age, to determine validity. Invalid values (e.g. dates in the wrong century) were removed from the database.

To assess the frequency of utilization of the various diagnosis codes, we constructed a subsidiary database whose records contained the diagnosis codes, case types and age variables. For grouping purposes, the dataset was augmented by the addition of a three-digit ICD ‘root’ code, and short descriptors matched to an ICD-9 code database downloaded from the US Centers for Medicare & Medicaid Services.⁴¹

Diagnosis codes were also compared to those presented in previous articles that used MEPS to study the use of chiropractic care in back pain patients. Traditionally, there is a limited set of ICD codes that are considered “Back Pain” by researchers.^{27,28} Smith used this same list, but augmented it with two codes (846 & 847) to include

Table 1.
Variable types and numbers requested, compared to the actual variable list received in both data slices combined.

Identification Codes	% present in sample
Clinic_ID	100.0%
Pt_ID	100.0%
Date at 1 st visit	100.0%
Creation Date	68.0%
Age at 1st visit	72.3%
Gender	65.8%
Marital Status	49.3%
Education level	Not in db
Number of children	Not in db
Family income	Not in db
Employment Status	32.7%
Occupation	14.0%
Case Type (Cash, Insurance, Medicare, WC)	63.5%
Residence ZIP Code (3 digits)	79.0%
Residence City	79.5%
Residence County	Not in db
Residence State	77.4%
Diagnosis	
ICD Code	51.1%
Date of Diagnosis	Not in db
Other	
Referral Source	17.4%
Outcomes (NDI, RMDQ, VAS, etc.)	Not in db
Vital Signs	
Height	Not in db
Weight	Not in db
Diastolic Pressure	Not in db
Systolic Pressure	Not in db
Pulse rate	Not in db
Activity level	Not in db
Family Medical History	Not in db
Reason for seeking care this case	Not in db
Duration of health issue	Not in db
Severity of health issue	Not in db
Fitness Rating	Not in db
Goal of care this case	Not in db
Status at last visit	Not in db

db = database

Sprains & Strains of the spine or sacroiliac region.^{29,30} We flagged the codes in our database that were used by Smith to indicate back pain as “used in MEPS” and marked them with an asterisk (*) in Table 2.

Results

Practitioners

The recruitment process yielded 40 clinics that signed consent forms and agreed to participate in the study. The clinics were located across the US with 15 located in the Midwest, 12 in the Pacific region, seven in the Southeast

Table 2.

Diagnosis Code breakdown by Case Type. Values are the number and percentage of patients of a certain case type that was given the diagnosis code type shown at each row. The diagnosis codes were reduced to just the 3-digit root code and the general description for each. Codes are sorted by frequency of use from most frequent at the top and only the most frequent 20 codes are shown. Counts and percentages of each case type are shown in the bottom row. ‘’ indicates a code recognized as ‘Back Pain’ in MEPS studies (n=22552)*

Diagnosis Code (3 digit) & Description	Major Medical	Cash	Medicare	Gratis	PI	Managed	Wellness	Workers Comp	Medicaid	Total number	Per-cent
739 Somatic dysfunction	57.4%	41.3%	50.8%	44.4%	45.9%	63.7%	50.7%	46.7%	46.1%	11614	51.5%
724 Other /unspecified disorders of back*	10.2%	17.1%	18.4%	7.6%	9.5%	20.0%	13.7%	19.4%	14.4%	2864	12.7%
723 Other disorders of cervical region*	7.3%	10.7%	9.4%	17.5%	9.4%	5.9%	6.9%	9.8%	6.7%	1985	8.8%
722 Intervertebral disk disorders*	9.8%	5.1%	3.3%	4.3%	2.4%	3.5%	1.1%	2.0%	0.4%	1646	7.3%
847 Sprains and strains of other and unspecified parts of back*	4.2%	4.4%	3.2%	4.3%	14.5%	0.6%	14.9%	6.5%	5.3%	1060	4.7%
839 Other, multiple, and ill-defined dislocations of spine*	1.4%	8.7%	4.2%	0.2%	9.4%	0.2%	0.2%	5.4%	2.5%	834	3.7%
729 Pain in Limb	2.1%	2.3%	2.5%	7.9%	1.3%	0.1%	4.5%	2.9%	12.0%	541	2.4%
728 Muscle weakness, spasm, ligament laxity	1.7%	1.3%	0.4%	11.3%	0.6%	0.1%	0.0%	1.3%	0.4%	406	1.8%
720 Ankylosing spondylitis and other inflammatory spondylopathies*	0.8%	2.0%	3.6%	0.3%	1.7%	0.1%	6.3%	0.7%	6.3%	316	1.4%
719 Joint Pain – upper limb, lower limb, Pelvis	1.2%	1.9%	1.3%	0.1%	0.9%	2.0%	0.3%	2.2%	2.8%	316	1.4%
784 Headache	0.6%	1.2%	0.8%	0.1%	1.3%	2.4%	0.3%	0.4%	1.4%	203	0.9%
840 Sprain of shoulder	1.1%	0.4%	0.0%	0.0%	0.9%	0.2%	0.0%	1.1%	0.0%	158	0.7%
721 Spondylosis and allied disorders*	0.6%	0.9%	0.6%	0.0%	0.5%	0.0%	0.0%	0.9%	0.0%	135	0.6%
737 Curvature of spine*	0.4%	0.7%	0.4%	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	113	0.5%
736 Unequal leg length	0.5%	0.1%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	68	0.3%
346 Migraine Headache	0.2%	0.5%	0.2%	0.0%	0.2%	0.6%	0.2%	0.0%	0.4%	68	0.3%
782 Edema	0.1%	0.5%	0.3%	0.0%	0.3%	0.0%	0.2%	0.2%	1.1%	68	0.3%
781 Abnormality of gait/posture	0.1%	0.6%	0.1%	0.1%	0.3%	0.1%	0.6%	0.2%	0.0%	45	0.2%
307 Tension Headache	0.2%	0.3%	0.2%	0.0%	0.3%	0.7%	0.0%	0.0%	0.4%	45	0.2%
846 Sprains and strains of sacroiliac region*	0.2%	0.1%	0.2%	0.5%	0.2%	0.0%	0.3%	0.2%	0.0%	45	0.2%
Total N	11998	6495	1105	970	925	496	361	113	90	22552	
% of patients by Case Type	53.2%	28.8%	4.9%	4.3%	4.1%	2.2%	1.6%	0.5%	0.4%		100%

Number of Patients within SCF

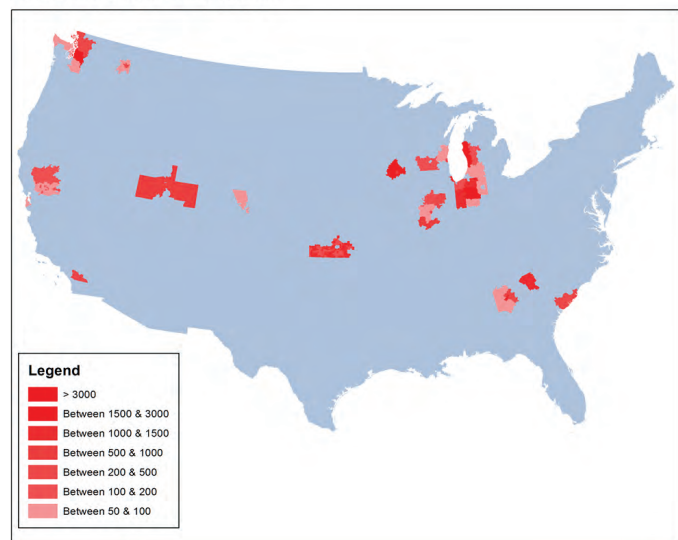


Figure 1.

Geographic distribution of patients in EMR sample.

and three each in the Mountain and Northeast regions (Figure 1).

Patient data

The July 2014 data consisted of 31,000 patient records and the January 2015 slice included 44,500 records. After removing duplicate records, there were 46,692 records. Table 1 shows the list of variables requested and the percent of records that contained usable information for each variable. Of 34 variables requested, 15 were found in the dataset, with several being present in less than half of the records. Age at first visit was present and valid in 72.3% of the records and ranged from 0 years to 93 (Mean 38.7 (SD 18.5)). Gender was present in 65.8% of records (F=60.4%, M=39.6%). Figure 2 shows the frequency distribution of ages, broken out by gender, when both variables were present for the same patient.

Marital Status was found in 49.3% of records — the most frequent being Married (53.2%) and Single (37.5%). There were no data available for education level, number of children or family income. Employment status and occupation were found in less than half of the records.

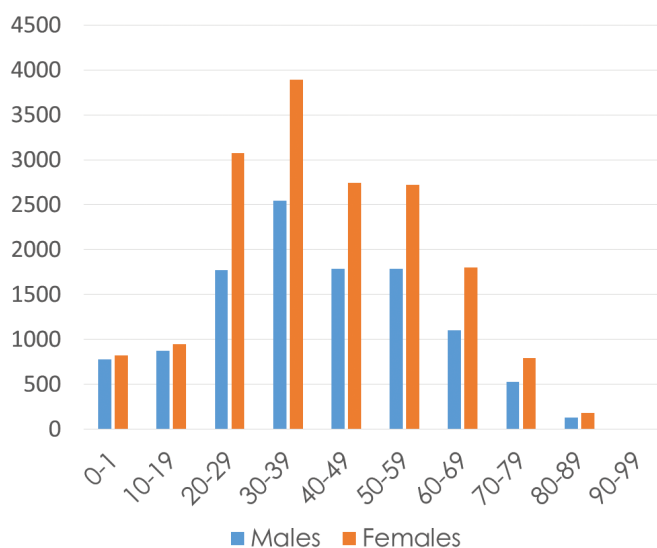


Figure 2.

Frequency distribution of ages, broken out by gender, when both variables were present for the same patient. Vertical axis is number of patients, horizontal axis is age in decades at the time of 1st visit.

No data were available on vital signs, medical history, or several other health- and fitness-related variables.

The Case Type variable was present in 63.5% of patient records. The variable was originally entered as an open-ended text field and yielded 80 different values. It was cleaned and grouped into 9 different case types, including: Major Medical, Cash, Medicare, Gratis, Personal Injury, Managed, Wellness, Workers Comp, & Medicaid. Major Medical and Cash were the most frequent with 53.2% and 28.8% respectively.

Diagnosis codes

Diagnosis codes were assigned by doctors at or near the first visit. The dataset included up to four ICD-9 diagnosis codes for each patient and 23,854 patients (51%) had at least one diagnosis. Of patients with diagnoses present, 82% had all four diagnosis codes assigned. In the original database, we found 88,900 codes across all patients, which were one of 366 unique ICD codes. We found 120 unique 3-digit root codes. The most frequent group of codes was 739 “Somatic Dysfunction” having been assigned to 51.5% of patients; of these, 29% were

for cervical region, 26% thoracic and 22% lumbar. The remainder were limbs or pelvis.

Because of the relative completeness of the diagnosis code data, we decided to look at it more closely. While there were 120 unique code groups when looking at the three-digit root code, 99% of those codes fell into only 20 unique groups. Table 2 shows the breakdown of those top 20 codes by case type (e.g., major medical, cash or gratis, etc). The frequency and percentage of each case type appears in the bottom two rows of the table, respectively. Major Medical was most frequent, followed by Cash, etc. [Note that ‘*’ after code descriptions indicates that the code is “in MEPS.”].

Comparing the frequency of diagnosis codes across the case types suggests that Cash patients were assigned codes in the 739 family (Somatic Dysfunction) less often than Major Medical patients and were assigned codes in the 724 (Other/unspecified disorders of the back) family more often.

We also looked at diagnosis code breakdowns with respect to each clinic. One clinic was omitted because it only contributed one patient to the dataset. The usage by clinic is quite varied, but there appear to be 4 major groups that can account for 34 of the 39 practices:

- 15 clinics use Somatic Dysfunction for the majority of their diagnoses (97%);
- 10 use Somatic Dysfunction most of time, but for less than 50% of their diagnoses. They tend to also use “Other and unspecified disorders of back*” and “Other disorders of cervical region*”;
- Six use “Other and unspecified disorders of back*” most often;
- Three use “Other, multiple, and ill-defined dislocations of spine*” for most of their diagnoses.

Discussion

In this study, we investigated the feasibility of collecting data from an EMR system for potential use in research. We could glean little from our data samples about the patients themselves. The most often populated fields were age (reduced to decade), and gender. Marital and employment status were included in the database, but not often completed. We found very little useful data in the database regarding other demographics, vital signs or the outcomes of care.

The patients in this study were more often females, as also found in a recent scoping review by Beliveau *et al.*⁴² and the NBCE 2015 survey of chiropractic practitioners⁴³. The median age of patients in our study (38.7) was slightly younger than the median reported across several studies surveyed by Beliveau *et al.* (43.4) but was within the interquartile range.

Diagnosis coding

As a major component of insurance billing systems, the diagnosis codes were completed for more than half of the patients. In general, there was a preponderance of musculoskeletal diagnoses, particularly in the neck, mid- and low back. We found a higher occurrence of neck complaints at 29% than did Beliveau *et al.* (22%).⁴²

A unique feature of this dataset is that we have diagnosis codes for a full range of 9 different case types, including five that might be considered insurance of one form or another. The ‘Cash’ case type was the second-most frequent type found, representing a significant portion (28.4%) of the patients. An interesting finding is that non-insurance case types (e.g. Cash, Gratis) have somewhat similar diagnostic profiles to insurance patients as seen in Table 2, but there is less reliance on somatic dysfunction codes. Medicare and insurance claims data would not contain records of patients that do not have insurance, so this is perhaps a new finding.

Another remarkable finding of the examination of diagnoses was the reliance on the 739 family of codes, which is a somatic dysfunction of the neck, back and upper and lower extremities. The large majority of these were in the neck, spine or pelvis. It was the most frequently used code, no matter which way we looked at the data: by case type, age or clinic. It is remarkable because this is not a code that would have been picked up by previous back pain researchers following the standard methodology to identify chiropractic care.²¹⁻³⁰

The Somatic Dysfunction code (739.xx) was often used in combination with other codes. In total, 78.9 % of patients were assigned at least one diagnosis code that we flagged as ‘In MEPS’, meaning they would have been classified as back or neck pain patients in previous studies. That means that 21.1% would have gone undetected if researchers relied solely on doctor assigned-diagnosis codes. It suggests the possibility that a fair number of patients in previous studies of chiropractic claims data may

have been misclassified, or not included in analyses of ‘back pain’.

Feasibility of using EMR data for practice-based research

We are not the first to suggest that chiropractic research could be based on EMR data from practitioners — Johnson recommended this action in 2010.⁹ Peterson *et al.* have been successful using EMR data in a hospital setting to compare SMT to nerve root injections for patients with lumbar disc herniation.³³ Uniquely, however, this is the first report on actual patient data extraction from a commercial EMR written specifically for chiropractors. While research to document chiropractic’s impact on the population is clearly a possibility, our efforts to date had mixed results. We were successful in collecting information directly from practitioners’ databases, but our success with gathering variables beyond those typically found in claims databases was limited.

Kukaftka *et al.* suggested that EHR systems should be designed from the ground up in such a way as to serve not only clinical goals but also efforts in public health.⁴⁴ Similarly, EMR systems such as the one we tested need to be augmented with additional modules to enable better harvesting of data for health services research.

The EMR system that we used for our study is equipped with a free-form text field for chief complaint; it is not coded in any way and hence cannot be easily correlated with ICD codes. Thus, due to the complexity of data extraction and reduction to a limited set of chief complaints, such a correlation has not been accomplished to date.

In addition to codified presenting complaints, EMR systems need the ability to track outcomes.⁴⁵ Doctors most certainly track improvement in patient’s subjective symptoms and use this information to guide care and for billing. If recorded electronically in the EMR, the information is mostly buried in the case notes as some form of SOAP (Subjective, Objective, Assessment, and Plan). The EMR we used does in fact contain SOAP notes in an uncoded form; however, our software engineers could not justify the effort it would have taken to extract the information. EMR systems could include modules to record outcome measures typically used in clinical trials (SF-12, Roland-Morris Disability Questionnaire, etc.). Indeed, the designers of the software we tested developed a module

for the SF-12, but we were not able to obtain any records in that domain to ascertain its frequency of use.

Early on in the implementation of EMRs, doctors were offered financial incentives to purchase “certified” software systems that included certain public health-related fields and modules. Having the ability to enter enhanced variables is the first step. In the end, the modules will only be useful if doctors begin to make use of them.

A major unresolved issue is what incentive(s) software developers might have to include new features in their systems. Software developers are challenged and even hesitant about adding functionality to a software system for the purpose of research because it typically does not enhance the economic value of the product to the clinician. However, the data collected on patient services and outcomes may provide valuable insight on how the software is being utilized. This utilization insight may inspire programmers to improve the functionality of the software which may provide the enhanced economic value the software company is looking for. Further complicating the issue is the fact that clinicians must regularly use the software enhancements for the research benefit to be realized. The clinician’s concern and the threat of non-engagement is going to be based on the efficiency of documentation. However, objective outcome assessments that provide data to support third party reimbursement will provide high value to the clinician and enhance their potential utilization of additional software functionality.

Limitations

This study only included a limited set of variables in one specific commercial electronic medical record system. We did not collect data on visits and services over time, so there is no perspective on process of care, outcomes, or cost. Assessing the type and quality of health-related variables from other databases might produce different results.

Conclusion

We were successful in gathering a large volume of data (more than 46,000 individual patient records) from the EMR software of practicing clinicians with the cooperation of the software designers. While we have looked at initial patient records only, and not the visit records, the cleanest and most complete data we found were in the diagnosis codes. Other variables important in healthcare

research such as patient demographics, clinical information, and outcomes of care were not found in the database. As such, the software at this stage was not particularly useful for comparative effectiveness research. We recommend that additional data fields be implemented to indicate the overall presenting profile of the patient including demographics and health indicators.

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Survey of students' perception of the jurisprudence, ethics and business management course at the Canadian Memorial Chiropractic College

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Introduction: The objective of this study was to survey 2018-2019 Year III students at the Canadian Memorial Chiropractic College in order to explore their perceptions of the components of the revised Jurisprudence, Ethics and Business Management course.

Methods: This study was approved by the Research Ethics Board. A paper survey was distributed to all enrolled students. Using a five-point Likert scale, students were asked if they perceived the course material as (i) well-presented and (ii) important for them to know as future chiropractors. Students were required to sign a consent form to participate.

Results: Survey response rate was 94%. Over 90% of respondents 'strongly agreed'/'agreed' lectures, small group session and course assignments were well

Sondage auprès des étudiants du Canadian Memorial Chiropractic College pour connaître leur opinion sur le cours de jurisprudence, d'éthique et de gestion des affaires

Introduction : La présente étude visait à sonder des étudiants de 3^e année au programme du Canadian Memorial Chiropractic College en 2018-2019 pour connaître leurs opinions sur la nouvelle version du cours de jurisprudence, d'éthique et de gestion d'un cabinet chiropratique.

Méthodologie : La présente étude a été approuvée par le comité d'éthique de la recherche. On a mené un sondage auprès de tous les étudiants inscrits. À l'aide d'une échelle de Likert de cinq points, on a demandé aux étudiants si la matière du cours était i) bien présentée et ii) importante pour eux comme futurs chiropraticiens. On a demandé aux étudiants de signer un consentement à la participation à l'étude.

Résultats : Le taux de participation au sondage a été de 94 %. Plus de 90 % des répondants étaient « tout fait d'accord » ou « d'accord » que le cours, les séances

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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.

presented and important for them to know as future chiropractors. Respondents were more critical of the online business modules (on average, 50% 'strongly agreed/agreed').

Conclusions: *The information from this survey will enable refinement of future versions of this course.*

(JCCA. 2021;65(1):105-120)

KEY WORDS: chiropractic business management, ethics, jurisprudence, student perceptions, survey

Introduction

The course that teaches students jurisprudence at the Canadian Memorial Chiropractic College (CMCC) was reconstructed in 2007 from its original format - a format that had not tangibly changed since its inception in the late 1970s.¹ Following a series of intradepartmental meetings in 2016, the course was completely redesigned. Specifically, the course changed from an only lecture-based format to a format that included lectures, small group sessions facilitated by faculty members (all practicing chiropractors) and an online business management program called Lean Canvas², developed in cooperation with Centennial College in Ontario, Canada. The course was retitled Jurisprudence, Ethics and Business Management (JEB) and launched during the 2017-18 academic year. The course description and its learning objectives as per the academic calendar are presented in Table 1.

The primary purpose of this study was to survey 2018-2019 Year III students at CMCC in order to explore their perceptions of modified teaching methods and content of a revised JEB course. This paper also describes changes made to this course as a result of the student survey results.

Methods

The Research Ethics Board of CMCC approved this project (Certificate #1904X01). In order to explore students' perception of the new course format, a unique 56-item paper survey was administered during their final open book multiple-choice question (MCQ) examination,

en petits groupes et les devoirs étaient bien présentés et avaient de l'importance pour eux comme futurs chiropraticiens. Les répondants se sont montrés plus critiques en ce qui concerne sur les modules en ligne sur la gestion d'un cabinet chiropratique (en moyenne, 50 % étaient tout à fait d'accord ou d'accord).

Conclusions : *Les résultats du présent sondage serviront à perfectionner ce cours.*

(JACC. 2021;65(1):105-120)

MOTS CLÉS : gestion d'un cabinet de chiropraticien, éthique, jurisprudence, opinion de l'étudiant, sondage

scheduled at the end of Year III. Since all over assignments for the course had already been submitted and graded, and since the final examination consisted of only MCQs (there were no essay questions that could be graded subjectively), it was thought this was the most appropriate time to distribute the survey because, not only was it anonymous (defined below), students knew there was no opportunity for the course coordinator (the Principle In-

Table 1.

JEB course description and learning objectives.

Course Description:

The modern principles of patient-centered chiropractic care in the evolving healthcare environment are examined. Relevant topics pertaining to professional identity, jurisprudence and ethics are explored. Learning will be applied within the context of social theory, social contract and social closure. The concepts of entrepreneurship are applied through E-learning modules utilizing Lean Canvas.

Learning Objectives:

1. Demonstrate professionalism as it relates to ethical issues, ethical dilemmas and grey zones.
2. Explain the progress in developing cultural authority within the chiropractic profession.
3. Discuss the importance of professional boundaries, how to establish boundaries in different situations and environments, and how to resolve conflict.
4. Explain regulations, acts, codes, standards of practice, guidelines, policies and consequences in a pan-Canadian perspective pertaining to the practice of chiropractic.
5. Apply leadership strategies within the context of social closure and social contract for professional challenge resolution.
6. Apply an entrepreneurial framework to the development of a chiropractic career.

vestigator (PI)) to (theoretically) enact any form of retribution if the feedback was negative. Moreover, this was the last opportunity for Year III students and the course coordinator to interact, since students were transitioning to their internship and the course coordinator only teaches in the undergraduate program. Because of these circumstances, it was theorized students could answer questions on the survey candidly and honestly.

Prior to the final examination, the PI (who is also the course coordinator) emailed students with instructions with respect to what they could bring in with them to the lecture hall where the exam was being administered, since the examination was open-book: In that same email, the PI informed students they would have an opportunity to complete a survey of the course as well. At the beginning of the exam, the author went over some administrative details (e.g., what to do if they did not understand a question) and reminded the students the survey which was on their desks and was available for them to complete if they chose to do so.

The cover sheet of the survey consisted of a consent form which explained the purpose of the survey. Participation in the survey was voluntary and no form of compensation was offered. Although students who wished to respond to the survey signed and dated the consent form it was separated by the examination invigilators (not the PI) and placed in a separate box from the survey itself. The survey had no identifiable marks on it, thus assuring respondent anonymity. Prior to data extraction, a manual count was made to ensure there were the same number of surveys as there were consent forms. Responses were extracted onto an Excel sheet for review.

In the survey, students were asked to comment on their perception of the lectures, facilitated small group sessions, online business modules and the four assignments in the course. The survey questions were the same ones used successfully in a previous study that assessed students' perception after the jurisprudence course was restructured in 2007.¹ Prior to distribution the survey was reviewed by the Vice-President Academic, two Education Directors (both chiropractors) and the Research Administrator, offering a degree of face validity.

With respect to the lectures, students were asked (i) if they perceived the content was 'well presented' and (ii) if they thought the topic was important for them to know as future chiropractors. Respondents were informed

'well presented' meant the lectures were 'well-organized, well-paced and understandable'. Using a five-point Likert scale, students could respond 'Strongly Agree' (5), "Agree" (4), "Undecided" (3), "Disagree" (2) or "Strongly Disagree" (1) to each question. Similarly, students were asked if they thought each of the four Lean Canvass online modules were (i) well-presented and (ii) important for them to know as future chiropractors.

Using the same Likert scale, students were asked (i) if they were actively engaged in the small group sessions and (ii) if they thought the topic was important for them to know as a chiropractor. It was theorized their level of engagement would reflect their interest in the topic.

Lastly, students were asked if they perceived the four assignments in the course were important for them to know as a future chiropractor. Students were able to provide written comments at the end of the survey.

Results

Of a class of 186 students, 175 completed surveys were submitted, representing a response rate of 94.1%. The same number of consent forms were also returned. The number of responses and corresponding percentages to each survey question are presented in Table 2.

Table 2.
JEB course survey results.

Topic #1: Who's Who and What's What, Tribalism and the Social Contract				Topic #5: Advertising, Marketing and Internal Office Promotion			
Q1: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=176)	Q9: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)
	Strongly Agree	45	25.6		Strongly Agree	55	31.4
	Agree	109	61.9		Agree	100	57.1
	Undecided	19	10.8		Undecided	14	8.0
	Disagree	3	1.7		Disagree	6	3.4
	Strongly Disagree	0	0		Strongly Disagree	0	0
Q2: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=177)	Q10: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	89	50.3		Strongly Agree	121	69.1
	Agree	80	45.2		Agree	51	29.1
	Undecided	8	4.5		Undecided	3	1.7
	Disagree	0	0		Disagree	0	0
	Strongly Disagree	0	0		Strongly Disagree	0	0
Topic #2: Professionalism, Ethics and Codes of Conduct				Topic #6: Scope of Chiropractic Practice			
Q3: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=172)	Q11: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)
	Strongly Agree	74	43.0		Strongly Agree	84	48.0
	Agree	86	50.0		Agree	80	45.7
	Undecided	11	6.3		Undecided	9	5.1
	Disagree	1	0.6		Disagree	2	1.1
	Strongly Disagree	0	0		Strongly Disagree	0	0
Q4: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=177)	Q12: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=176)
	Strongly Agree	128	72.3		Strongly Agree	140	80.0
	Agree	49	27.7		Agree	35	19.4
	Undecided	0	0		Undecided	1	0.6
	Disagree	0	0		Disagree	0	0
	Strongly Disagree	0	0		Strongly Disagree	0	0
Topic #3: Professional Misconduct Regulations				Topic #7: Prohibition Against Having Sex with a Patient			
Q5: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)	Q13: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)
	Strongly Agree	79	45.1		Strongly Agree	101	57.7
	Agree	78	44.6		Agree	56	32.0
	Undecided	15	8.6		Undecided	12	6.9
	Disagree	3	1.7		Disagree	6	3.4
	Strongly Disagree	0	0		Strongly Disagree	0	0
Q6: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=174)	Q14: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	128	72.3		Strongly Agree	127	72.3
	Agree	49	27.7		Agree	43	24.6
	Undecided	0	0		Undecided	4	2.3
	Disagree	0	0		Disagree	1	0.6
	Strongly Disagree	0	0		Strongly Disagree	0	0
Topic #4: Panel Discussion: What Should the Proposition Statement of the Chiropractic Profession Be?				Topic #8: Record Keeping, Special Reports			
Q7: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)	Q15: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=174)
	Strongly Agree	40	22.9		Strongly Agree	75	42.9
	Agree	81	46.3		Agree	73	41.7
	Undecided	46	26.3		Undecided	20	11.4
	Disagree	8	4.6		Disagree	5	2.9
	Strongly Disagree	0	0		Strongly Disagree	1	0.6
Q8: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)	Q16: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	64	36.6		Strongly Agree	134	76.6
	Agree	67	38.3		Agree	37	21.1
	Undecided	34	19.4		Undecided	3	1.7
	Disagree	10	5.7		Disagree	1	0.6
	Strongly Disagree	0	0		Strongly Disagree	0	0

Table 2.
JEB course survey results (continued)

<i>Topic #9: Career Options, Contracts, Banking and Dealing with the Media</i>			
Q17: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=174)
	Strongly Agree	43	24.7
	Agree	75	43.1
	Undecided	37	21.3
	Disagree	19	10.9
Strongly Disagree	0	0	
Q18: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	117	66.9
	Agree	50	28.6
	Undecided	6	3.4
	Disagree	2	1.1
Strongly Disagree	0	0	
<i>Topic #10: Complaints and Discipline</i>			
Q19: This topic was well presented (i.e. lectures were well organized, well-paced and presented in an understandable manner)	Response Option	Score	Percent (n=175)
	Strongly Agree	79	45.1
	Agree	82	46.9
	Undecided	12	6.9
	Disagree	2	1.1
Strongly Disagree	0	0	
Q20: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	122	69.7
	Agree	47	26.9
	Undecided	5	2.6
	Disagree	0	0
Strongly Disagree	1	0.6	
<i>Topic #11: Small Group Sessions – Rewriting the Chiropractic Oath</i>			
Q21: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	62	35.4
	Agree	65	37.1
	Undecided	28	16.0
	Disagree	14	8.0
Strongly Disagree	6	3.4	
Q22: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	33	18.9
	Agree	47	25.7
	Undecided	44	25.1
	Disagree	41	23.4
Strongly Disagree	10	5.7	
<i>Topic #12: Small Group Session – Resolving Ethical Dilemmas</i>			
Q23: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	81	46.3
	Agree	80	45.7
	Undecided	10	5.7
	Disagree	4	2.3
Strongly Disagree	0	0	
Q24: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	86	49.1
	Agree	72	41.1
	Undecided	14	8.0
	Disagree	2	1.1
Strongly Disagree	1	0.6	
<i>Topic #13: Small Group Session – Chiropractic Industry</i>			
Q25: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	63	36.0
	Agree	84	48.0
	Undecided	19	10.9
	Disagree	9	5.1
Strongly Disagree	0	0	
Q26: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	71	40.6
	Agree	78	44.6
	Undecided	21	12.0
	Disagree	5	2.9
Strongly Disagree	0	0	
<i>Topic #14: Small Group Session – Creating a Proposition Statement for the Chiropractic Profession</i>			
Q27: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	44	25.1
	Agree	78	44.6
	Undecided	31	17.7
	Disagree	18	10.3
Strongly Disagree	4	2.3	
Q28: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=174)
	Strongly Agree	37	21.1
	Agree	72	41.1
	Undecided	40	22.9
	Disagree	23	13.1
Strongly Disagree	2	1.1	
<i>Topic #15: Advertising non-NMSK conditions by individual chiropractors and/or professional organizations</i>			
Q29: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	96	54.9
	Agree	71	40.6
	Undecided	5	2.9
	Disagree	2	1.1
Strongly Disagree	1	0.6	
Q30: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	98	56.0
	Agree	66	37.7
	Undecided	9	5.1
	Disagree	2	1.1
Strongly Disagree	0	0	
<i>Topic #16: Expanding the Scope of Chiropractic Practice</i>			
Q31: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	84	48.0
	Agree	76	43.4
	Undecided	10	5.7
	Disagree	4	2.9
Strongly Disagree	1	0.6	
Q32: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	87	49.7
	Agree	76	43.4
	Undecided	11	6.3
	Disagree	1	0.6
Strongly Disagree	0	0	

Table 2.
JEB course survey results (continued)

Topic #17: Small Group Session – Chiropractors as Entrepreneurs				Topic #21: Small Group Session – Ethical Practice Activities			
Q33: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)	Q41: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	69	39.4		Strongly Agree	77	44.0
	Agree	77	44.0		Agree	74	42.3
	Undecided	18	10.3		Undecided	19	10.9
	Disagree	10	5.7		Disagree	3	1.7
	Strongly Disagree	1	0.6		Strongly Disagree	2	1.1
Q34: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)	Q42: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	85	48.9		Strongly Agree	90	51.4
	Agree	75	42.9		Agree	66	37.7
	Undecided	15	8.6		Undecided	16	9.1
	Disagree	0	0		Disagree	2	1.1
	Strongly Disagree	0	0		Strongly Disagree	1	0.6
Topic #18: Small Group Session – Prohibition Against Sex with a Patient – Treating a Spouse				Topic #22: Chiropractic as a Career			
Q35: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)	Q43: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)
	Strongly Agree	91	52.0		Strongly Agree	105	60.0
	Agree	72	41.1		Agree	56	32.0
	Undecided	7	4.0		Undecided	10	5.7
	Disagree	3	1.7		Disagree	3	1.7
	Strongly Disagree	2	1.1		Strongly Disagree	1	0.6
Q36: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)	Q44: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=174)
	Strongly Agree	105	60.0		Strongly Agree	109	62.6
	Agree	60	34.3		Agree	55	31.4
	Undecided	6	3.4		Undecided	8	4.6
	Disagree	4	2.3		Disagree	1	0.6
	Strongly Disagree	0	0		Strongly Disagree	1	0.6
Topic #19: Small Group Session – Boundary Crossing versus Boundary Violation				Topic #23: Lean Canvass Business Module – Foundations of Business Planning			
Q37: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)	Q45: I found the material in this Module was well presented	Response Option	Score	Percent (n=175)
	Strongly Agree	77	44.0		Strongly Agree	8	4.6
	Agree	74	42.3		Agree	30	17.1
	Undecided	19	10.9		Undecided	45	25.7
	Disagree	3	1.7		Disagree	57	32.6
	Strongly Disagree	2	1.1		Strongly Disagree	35	20.0
Q38: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=)	Q46: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	90	51.4		Strongly Agree	65	37.1
	Agree	66	37.7		Agree	61	34.9
	Undecided	16	9.1		Undecided	25	14.3
	Disagree	2	1.1		Disagree	14	8.0
	Strongly Disagree	1	0.6		Strongly Disagree	10	5.7
Topic #20: Small Group Session – Attending a Discipline Hearing: Lessons Learnt				Topic #24: Lean Canvass Business Module – Customer Segments/ Target Customers			
Q39: I was actively engaged during this small group session	Response Option	Score	Percent (n=175)	Q47: I found the material in this Module was well presented	Response Option	Score	Percent (n=174)
	Strongly Agree	105	60.0		Strongly Agree	12	6.9
	Agree	56	32.0		Agree	37	21.3
	Undecided	10	5.7		Undecided	42	24.1
	Disagree	3	1.7		Disagree	51	29.3
	Strongly Disagree	1	0.6		Strongly Disagree	32	18.3
Q40: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=174)	Q48: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	109	62.3		Strongly Agree	63	36.0
	Agree	55	31.6		Agree	63	36.0
	Undecided	8	4.6		Undecided	24	13.7
	Disagree	1	0.6		Disagree	11	6.3
	Strongly Disagree	1	0.6		Strongly Disagree	14	8.0

Table 2.
JEB course survey results (continued)

<i>Topic #25: Lean Canvass Business Module – Unique Value Proposition</i>				<i>Topic #27: Assignment – Proposition Statement for the Chiropractic Profession</i>			
Q49: I found the material in this Module was well presented	Response Option	Score	Percent (n=175)	Q53: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=173)
	Strongly Agree	16	9.1		Strongly Agree	25	14.3
	Agree	43	24.6		Agree	72	41.6
	Undecided	39	22.3		Undecided	37	21.4
	Disagree	50	28.6		Disagree	28	16.2
	Strongly Disagree	27	15.4	Strongly Disagree	11	6.3	
Q50: This topic is important for me to know as a future chiropractor				<i>Topic #28: Assignment – Advertising of non-NMSK conditions</i>			
	Response Option	Score	Percent (n=175)	Q54: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=174)
	Strongly Agree	65	37.1		Strongly Agree	75	43.1
	Agree	72	41.1		Agree	77	44.3
	Undecided	15	8.6		Undecided	10	5.7
	Disagree	12	6.9		Disagree	9	5.2
	Strongly Disagree	11	6.3	Strongly Disagree	3	1.7	
<i>Topic #26: Lean Canvass Business Module – Financial Management</i>				<i>Topic #29: Assignment- Discipline Hearing Report</i>			
Q51: I found the material in this Module was well presented	Response Option	Score	Percent (n=174)	Q55: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	13	7.5		Strongly Agree	81	46.3
	Agree	28	16.0		Agree	62	35.4
	Undecided	42	24.0		Undecided	24	13.7
	Disagree	51	29.3		Disagree	6	3.4
	Strongly Disagree	40	23.0	Strongly Disagree	2	1.1	
Q52: This topic is important for me to know as a future chiropractor				<i>Topic #30: Assignment – Chiro-Legal Report</i>			
	Response Option	Score	Percent (n=175)	Q56: This topic is important for me to know as a future chiropractor	Response Option	Score	Percent (n=175)
	Strongly Agree	100	57.1		Strongly Agree	82	46.9
	Agree	49	28.0		Agree	59	33.7
	Undecided	12	6.9		Undecided	27	15.4
	Disagree	7	4.0		Disagree	4	2.3
	Strongly Disagree	7	4.0	Strongly Disagree	3	1.7	

Table 3a.
Students' perceptions of lectures topics.

Lecture Topic	'Well-presented' % Strongly Agree/Agree	'Important to know' % Strongly Agree/Agree
Who's who, What's what, Tribalism and the Social Contract	87.5	95.7
Professionalism, Ethics and Codes of Contest	83.0	100
Professional Misconduct Regulations	89.7	98.3
Chiropractic Scope of Practice	93.7	99.4
Marketing, Advertising and Internal Office Promotion	88.5	98.2
Prohibition Against Sex with a Patient	89.7	96.9
Complaints and Discipline	92.0	96.9
Record Keeping and Special Reports	84.6	97.7
Career Options, Banking and Dealing with the Media	67.8	95.5
Panel Discussion: <i>What Should the Proposition Statement of the Chiropractic Profession Be?</i>	69.2	96.6

Lectures (Tables 3a and 3b)

With respect to the lectures on 'Who's Who and What's What, Tribalism and the Social Contract', 'Professionalism, Ethics and Codes of Conduct', 'Professional Misconduct Regulations, 'Chiropractic Scope of Practice', 'Advertising, Marketing and Internal Office Promotion', 'Prohibition Against Sex with a Patient' and 'Complaints and Discipline' approximately 90% of students either 'agreed' or 'strongly agreed' they were well presented and over 95% of them 'agreed' or 'strongly agreed' these topics were important for them to know as future chiropractors.

Over 95% of students 'agreed' or 'strongly agreed' the lectures on 'Record Keeping and Special Reports' and 'Career Options, Banking and Dealing with the Media' were important for them to know as future chiropractors. Approximately 84% of students 'agreed' or 'strongly agreed' the lecture on 'Record Keeping and Special Reports' but only 68% of students 'agreed' or 'strongly agreed' the lecture on 'Career Options, Banking and Dealing with the Media' were well presented.

One of the lecture sessions consisted of a panel presentation on 'What Should the Proposition Statement of the

Table 3(b).
Detailed description of topics in each lecture.

Lecture Title	Topics Discussed in Lecture
Who's who, what's what, tribalism and the social contract	<ul style="list-style-type: none"> • Discussion of various chiropractic organization and their mandates (e.g. regulatory bodies and their committees, advocacy groups, malpractice carrier, academic institutions, government agencies) • Discussion of difference between the Charter, Legislation, Acts, Standards of Practice, Guidelines, and Policies • Definition of a profession • Definition of professionalism • Defining the chiropractic profession • Challenges to the trustworthiness of the profession • Controversies within the profession • Social contract, social closure and socialization cycle as it applies to chiropractic
Professionalism, ethics and code of conduct	<ul style="list-style-type: none"> • Principles of beneficence • Definition of fiduciary duties • CCA code of ethics and conduct
Professional misconduct regulations	<ul style="list-style-type: none"> • Review of professional misconduct regulations in Ontario
Advertising, Marketing and Internal Office Promotion	<ul style="list-style-type: none"> • Definition of advertising, marketing and internal office promotion • Review of advertising standards of practice across Canada • Examples of controversial advertising across Canada and other jurisdictions • Caselaw examples
Scope of Chiropractic Practice	<ul style="list-style-type: none"> • Review of chiropractic scope of practice across Canada and other jurisdictions • Definition of controlled act versus activities in the public domain • Acupuncture • Animal chiropractic • Vaccination and immunization • Limited prescription rights • Requirements to use chiropractic technique system on patients • Caselaw examples
Prohibition against having sex with a patient	<ul style="list-style-type: none"> • History of Issue • Definition of patient • Differentiation between sexual harassment, sexual misconduct, sexual violation and sexual abuse across Canada • Spousal exemption • Mandatory reporting • Sexual harassment of doctors by their patient • Caselaw examples
Record keeping and special reports	<ul style="list-style-type: none"> • Record keeping requirements and Standards of Practice • Privacy and Confidentiality • Consent • Special reports • Caselaw examples
Career options, contracts, banking and dealing with the media	<ul style="list-style-type: none"> • Career options available to a chiropractor • Purchasing a practice • Operating costs • Capital expenditures • Speaking to the media • Examples from real-life
Complaints and discipline	<ul style="list-style-type: none"> • Understanding complaints process • Understanding discipline process • Caselaw examples

Chiropractic Profession Be?” (see description of assignment below). Panelists included representatives (typically the CEO) from the World Federation of Chiropractic, the Canadian Chiropractic Association, the Ontario Chiropractic Association and the Alliance for Chiropractic (previously the Chiropractic Awareness Council). Usually, a representative from the College of Chiropractors of Ontario (CCO) also participates; unfortunately, that was not the case during the 2018-19 academic year. When asked, 69.2% of students perceived the panel was ‘well presented’ and 74.9% ‘agreed’ or ‘strongly agreed’ this topic was important for them to know as future chiropractors. Table 4 provides details of the content of each of these lectures.

Small group facilitated sessions (Table 5)

Approximately 90% of students stated they were actively engaged in, and approximately 90% of students ‘agreed’ or ‘strongly agreed’ it was important for them to know as future chiropractors, the following small group session topics: ‘*Resolving Ethical Dilemmas*’; ‘*Advertising non-Neuromusculoskeletal (NMSK) conditions*’; ‘*Expanding the Chiropractic Scope of Practice*’; ‘*Prohibition Against Sex with Patient – Spousal Exemption*’; ‘*Boundary-Crossing vs Boundary Violation*’; ‘*Attending a Discipline Hearing – Lessons Learnt*’; ‘*Ethical Practice Activities*’ and ‘*Chiropractic as a Career*’.

A slightly lower percentage of students (83.4%) stated they were actively engaged during the ‘*Chiropractors as*

Table 4.
Detailed description of each small group session

Session Title	Session focus/structure
Rewriting the chiropractic oath	<ul style="list-style-type: none"> Students tasked with rewriting the Chiropractic Oath CMCC graduates take during convocation, originally written in the 1940s
Resolving Ethical Dilemmas	<ul style="list-style-type: none"> Students discuss how they handle various ethical dilemmas they found themselves in and whether or not they would have handled it any differently in hindsight
Chiropractic Industry	<ul style="list-style-type: none"> Students consider information that discusses chiropractic as an industry (e.g. utilization rates in different geographical locations, average incomes, job satisfaction rates)
Creating a Proposition Statement for the Chiropractic Profession	<ul style="list-style-type: none"> Students create a proposition statement for the chiropractic profession
Advertising non-NMSK conditions by individual chiropractors and/or professional organizations	<ul style="list-style-type: none"> Students debate whether or not individual chiropractors and/or chiropractic organizations ought to advertise potential benefits of chiropractic care for the management of non-NMSK conditions (e.g. colic, enuresis, asthma, gastro-esophageal reflux disorder, urinary incontinence)
Expanding the chiropractic scope of practice	<ul style="list-style-type: none"> Students discuss the political challenges, pros and cons of an expansion of the chiropractic scope of practice (e.g. ability to order advanced imaging tests, ability to order laboratory testing, ability to have limited prescription privileges)
Chiropractors as entrepreneurs	<ul style="list-style-type: none"> Tutors discuss their experiences with operating a chiropractic practice and students share their experiences of shadowing chiropractor in the field
Prohibition against having sex with patients – treating a spouse	<ul style="list-style-type: none"> Students discuss complexities of providing care for a healthcare provider’s spouse
Boundary crossing versus a boundary violation	<ul style="list-style-type: none"> Students consider when does a boundary crossing, during which a chiropractic may self-disclose personal information in order to develop a rapport with a patient, becomes a boundary violation
Attending a discipline hearing	<ul style="list-style-type: none"> Students share their experiences of attending a discipline hearing
Ethical practice activity	<ul style="list-style-type: none"> Students consider the ethical of various practice activities, including prepayment packages, open concept offices and the obligation of a potential patient to bring in their spouse or significant other during their report of findings
Chiropractic as a Career	<ul style="list-style-type: none"> Students consider the pros and cons of various career options available to them as a chiropractor

Table 5. Students' perception of small group facilitated sessions.

Small Group Facilitated Session	'Actively Engaged' % Strongly Agree / Agree	'Important to know' % Strongly Agree / Agree
Resolving Ethical Dilemma	92.0	92.2
Advertising non-NMSK conditions	95.5	93.7
Expanding Chiropractic Scope of Practice	91.4	93.1
Prohibition Against Sex with a Patient – Spousal Exemption	93.1	94.3
Boundary Crossing v Boundary Violation	86.3	89.1
Attending a Discipline Hearing – Lessons Learnt	92.0	93.9
Chiropractic as Entrepreneurs	83.4	91.8
Chiropractic Industry	84.0	85.2
Creating a Proposition Statement for the Chiropractic Profession	69.7	62.2
Rewriting the Chiropractic Oath	72.5	44.6

Entrepreneurs' small group session, although 91.8% of them 'agreed' or 'strongly agreed' it was important for them to know as future chiropractors. Likewise, 84% of students stated they were actively engaged during the small group session that discussed 'the Chiropractic Industry' and a similar percentage (85.2%) of them 'agreed' or 'strongly agreed' this topic was something that was important for them to know as future chiropractors.

Student responses were far less favorable for the small group session that tasked them with developing a 'Proposition Statement' for the chiropractic profession. Specifically, 69.7% of students stated they were actively engaged during this small group session and only 62.2% of students 'agreed' or 'strongly agreed' this topic was important for them to know as future chiropractors.

During the first small group session students were tasked with re-writing the Chiropractic Oath CMCC graduates take during convocation. This was a group assignment. When asked, 72.5% of students stated they were actively engaged in this small group session and only 44.6% 'agreed' or 'strongly' this project was important for them to know as future chiropractors. Table 5 provides details of the topics discussed during each small group session.

Table 6.

Students' perception of online business course (Lean Canvas)

Small Group Facilitated Session	'Well Presented' % Strongly Agree / Agree	'Important to know' % Strongly Agree / Agree
Foundation of Business Planning	52.6	72.0
Customer Segments/ Target Customer	47.6	72.0
Unique Value Proposition	44.0	78.2
Financial Management	52.3	85.1

Lean Canvas (Table 6)

In general, students had much less favorable perceptions toward the online Lean Canvas business modules. Roughly 50% of students 'disagreed' or 'strongly disagreed' the content of all four Lean Canvas sessions were well presented. Seventy two percent (72%) of students 'agreed' or 'strongly agreed' the Lean Canvas module on 'Foundation of Business Planning' and 'Custom Segments/ Target Customers' were important to know as future chiropractors. That number increased to 78.2% for the Module on the 'Unique Value Proposition' and increased still further to 85.1% for the Module on 'Financial Management'.

Table 7.

Students' perception of course assignments

Course Assignment	Important to Know % Strongly Agree / Agree
Proposition Statement	55.9
Attending a Discipline Hearing	81.9
Chiropractic Legal-Report	80.6
Advertising non-NMSK conditions	87.3

Course assignments (Table 7)

There were four course assignments submitted for grading by the small group facilitators for the JEB course. Students changed facilitators (tutors) four times during the course. A group assignment required students to create a proposition statement for the chiropractic profession. For the purpose of this assignment, the following

definition was used to define a proposition statement: 'A value proposition is a marketing statement that describes why a consumer should choose a particular product or service. To develop a value proposition, one must identify the need of the target demographic group, address the need and add value. For chiropractors to develop a value proposition appropriately, they must identify what is missing in the health care portfolio overall and whether they can consistently add value by meeting that need'.³ Examples of proposition statements over the years include 'Chiropractors as Spine Care Experts', 'Chiropractors as MSK Specialists' and 'Chiropractors as Wellness Experts'. The proposition statement had to be defended by appropriate references from peer-reviewed literature. Students were also required to create advertising material and an advertising strategy for their proposed statement (e.g. use of social media, use of print; radio or television commercials or; grass-roots communication with other healthcare providers such as medical doctors and so on).

Similar to their perception of the panel presentation and small group session on this topic, only 55.9% of students 'agreed' or 'strongly agreed' this assignment was important for them to know as chiropractors.

One of the requirements for this course was for students to attend a Discipline Hearing (DH) at a regulated health-care professional college. This has been a requirement for this course dating back to the 1980s. Students could fulfil this requirement in their home province during scheduled breaks in the academic year. Since DHs are - with very few exceptions - open to the public, regulatory bodies post the dates of upcoming DHs on their webpages. These notifications include the name of the member and the Notice of Hearing which lists the allegations against them. Over 81% of students reported they 'agreed' or 'strongly agreed' attending a DH was important for them to know as future chiropractors.

Students were required to prepare a Chiropractic Legal Report (CLR) for grading. For this course, the CLR was to be written from the perspective of a professional letter to a patient's lawyer subsequent to a motor vehicle accident or other similar injury resulting in litigation. Slightly over 80% of students 'agreed' or 'strongly agreed' this was important for them to know as future chiropractors.

Lastly, another group assignment required students to state whether or not individual chiropractors and/or the

profession writ large should be permitted to advertise the management of non-NMSK conditions. With respect to this topic, 87.3% of students 'agreed' or 'strongly agreed' it was important for them to know as future chiropractors.

Written comments

Students were given the opportunity to provide written comments. The responses fell into six broad categories: lecture presentation; business management content; Chiro-Legal Report (CLR); course outline; the open book examination and; small group sessions.

Comments on lecture presentation

There were 32 written comments provided by students pertaining to the lectures (see Table 8 for representative examples). In general, students were universally positive with respect to their feedback on the lecture material and presentation style. By far one of the teaching strategies students enjoyed the most was 'story-telling' - that is, when students were provided real-life examples of scenarios or caselaw illustrating the topic under discussion.

Comments on Business Management modules

Forty-six students provided comments pertaining to the

Table 8.

Written comments on lecture presentation

- Dr G knows his sh*t. He is the go to guy with regards to discipline, governing bodies, laws etc
- I liked the course! Great info! The timing of some of the due dates could have been better but that is being picky
- Course content was great, engaging, necessary and well delivered. Love the occasional swears because it really helps drive the point home. Try some F-bombs next time around ;)
- I thoroughly enjoyed the course. Dr G has great insight into important topics that we need to know as chiropractors. As a student thinking about the gray areas of practice can be frustrating. I enjoyed Dr G's takes on the topics. I feel mostly confident in processes that I need to do as a licensed DC. Thank :)
- Love your stories & enthusiasm Dr G!
- Loved the course, especially the labs! Very important info for us to know going into 4th year and beyond - Dr Gleberzon taught it well and made it fun/interesting. Thanks for a great course!

online business management modules (see Table 9 for representative examples). Not surprisingly, based on their responses provided in the survey itself, the comments were not favorable. Almost all students who provided comments wrote they held unfavorable opinions of the assignments associated with each online module. Many students suggested the online content be replaced by a lecture-based course that allowed a more interactive and fulsome discussion of business management concepts and strategies. Many students admitted to a general lack of financial literacy and they perceived this course did little or less to address that knowledge gap.

Comments on CLR, course outline, open book examination and small group sessions

Sixteen students commented that, although they perceived the CLR was a worthwhile assignment to do, not enough instruction was provided on how to do it. Thirteen students commented on the course outline suggesting the due dates for each assignment be made clearer. Nine students complained about the open-book examination, which allowed them to bring with them any written notes they wished to bring (e.g., copies of PowerPoint presentations, personal notes, Noteservice notes) [Author's Note: Noteservice is a student directed initiative where a student takes notes of lectures of different courses that are then printed and bundled together and distributed to the students who subscribe to the service].

Inexplicably, these nine students stated that having to print out the all the course material and then having to throw it all out was a waste of paper. Students did not mention that they were under no obligation to bring any notes with them, let alone required to throw them out after the exam.

Lastly, seven students commented on the small group sessions. The comments were generally personal observations, neither positive nor negative, although two students stated re-writing the chiropractic oath was a waste of their time.

Discussion

Adult education has generally moved away from an exclusive lecture-based 'sage-on-the-stage' format to a format that uses multiple teaching strategies, mostly notably small group sessions. Skinner *et al.*⁴ described how the use of small group learning opportunities enhanced

Table 9
Written comments on Business Management

- Was not a big fan of the business modules. They are important but poorly done
- The lean canvas assignments were frustrating to complete as they were largely the same as the assignments we had completed last year in our CP class. These modules focus heavily on entrepreneurship and business planning two topics which have already been extensively covered. I feel I would have benefitted more had the focus been more on how to practically operate a business once doors are open for business (ie financial management, bookkeeping, operating patient management software etc)
- The online business modules were very confusing and hard follow. What is required for this class is really unorganized and confusing. Mandatory in class step by step lectures on how to start a business, run a business and financial fees would be very beneficial
- The business modules are not helpful to someone who lacks business knowledge/experience. An intro course held in-class in first year would help introduce the subject better than having us try online on our own.
- We need a business course designed and taught by chiropractors! Online modules from Centennial College are useless. Giving online business modules to students who have NO business background is useless. I googled everything and essentially learned/obtained nothing (with the exception of UVP). Additionally these modules don't seem to be catered towards 'selling' a health service rather they feel more like selling a product which is not the same thing
- The business modules are poor. I love business and learning about it, but these assignments are tedious, annoying, and honestly provided almost no value or knowledge that I will take away moving forward. In-class would be better or even small group would be better
- The business section of this course needs to be taught at a lecture. Leaving 3rd year, I still know very little about operating a business and entrepreneurship. I am in no way ready or confident enough to start my own or take over a chiropractic office. Teach us business basics, the how-to's, definitions, banking info, etc.

interpersonal and communication skill development for physiotherapy students. They contend interpersonal skills entail effective communication, active listening, cultural competency and professionalism. These attributes, they wrote, are needed to enhance communication between a healthcare provider and their patient and family or carer, as well as between the healthcare provider and their colleagues, other healthcare providers, regulatory bodies and other professional organizations.⁴

In an article advocating that adult learning theories be applied to medical education, Abela⁵ describes various

tools that can create a dynamic learning environment, many of which were used in the JEB course including: emphasizing the relevance of what is being taught; use of small groups to tackle abstract or difficult subjects and; open discussion on current 'how topics'. Advocating for what is referred to as Transformative Learning - which stresses the importance of the teacher in facilitating learners to question and reflect on their own and others' assumptions - Abela opines small group work is especially useful to formulate ideas on a particular topic.⁵

At CMCC courses and course instructors are evaluated using an online platform such as SurveyMonkey (www.surveymonkey.com). The author of this study teaches 8 different courses and is very familiar with the survey instrument and content. Unfortunately, the questions asked in the survey are very generic, bordering on being anodyne. Examples of survey questions include "what did you find most helpful to your learning?" and "did the faculty member model professionalism?" with response options ranging from 'always' to 'hardly ever'. In addition to the lack of granularity of the survey questions, response rates have historically ranged from 8% to 22%, numbers that are non-representative of a class of 185 students and do not allow for any fulsome exploration of responses.

In order to address this problem, the author devised a specific paper survey with more precise questions, in hopes of not only yielding a higher response rate but also to better understand how its redesign was perceived by students. In a limited way, it would serve as a quality control measure of the success - or lack of success - of the various components of the course.

In this study, a paper survey distributed directly to students resulted in a very high response rate of over 94%. This is considerably higher than most surveys and runs counter to the observation that response rates in surveys tend to be declining overall.^{6,7} It may speak to the high motivation of students to share their opinions on this course.

With the few exception described above, the vast majority of students had favorable perceptions of the lectures, small group sessions and course assignments. In general students perceived the lectures were well presented and they were actively engaged in almost all of the small group sessions.

In their comments, many students specifically men-

tioned they found 'story-telling' to be one of the most effective teaching strategies used by the lecturer to illustrate the topic under discussion. This is consistent with recommendations offered by attendees at a workshop conducted during the 2018 WFC Education Conference held in London, UK (the workshop was facilitated by the author of this study).⁸ That workshops sought to standardize jurisprudence, ethics and business management courses taught at chiropractic programs worldwide and asked attendees to discuss which teaching strategies they found worked best in the classroom. Almost to a person they agreed story-telling by lecturers or small group facilitators was the best way to engage students.⁸

Students overwhelmingly perceived almost all the lectures, small group sessions and assignments were important things for them to know as future chiropractors, with one notable exception: The one topic that students had a poor perception of was the panel discussion, small group session and assignment pertaining to developing a proposition statement for the chiropractic profession. Despite the PI's best efforts, it is possible that chiropractic students do not appreciate how having a unifying proposition statement for the profession could advance it in the eyes of the public, other healthcare professions and the media.

Similarly, although they reported the content was important for them to know as future chiropractors, the majority of students had unfavorable perceptions of the online business management modules delivered by Lean Canvas. This is not entirely surprising. The content was not specific to establishing a chiropractic practice and there were many topics not covered, including: types of insurances either required or needed by chiropractors (e.g. malpractice, life, critical illness, disability, office liability); capital expenditures specific to chiropractic practice; issues related to hiring and training chiropractic health assistants (CHAs); how to read a financial statement; how to create an investment portfolio; how to appraise a practice for sale or purchase; associateship contracts and; basic financial literacy. Unfortunately, when the business management modules were being constructed the author of this study was not consulted. Not only were there content deficiencies but also factual errors in the final product delivered to students. There were also problems with the functionality of the online modules (e.g. some embedded links were inactive, pages within the module did not always transition properly). Although these IT problems

were resolved over subsequent years they, coupled with what was perceived as inadequate business content, led to student frustration with this learning experience and low perception of its value to them.

The intradepartmental meetings that reconstructed the JEB course also eliminated the Year IV lecture-based business course that did exist (as well as the course that taught undergraduate students different chiropractic technique systems). Likewise, the Year IV assignment that required interns to develop a business plan for opening a chiropractic practice was also terminated, despite the fact that project that been an integral and successful component of the jurisprudence since its inception in the 1970s. The results of this study support the development of a series of business or entrepreneurship courses for students, perhaps housed within its own dedicated department, in much the same way there are departments dedicated to anatomy, clinical diagnosis and technique.

To be fair, healthcare professional education is often-times underrepresented with respect to business management content. Ciolfi and Kasen⁹ surveyed a group of Ontario chiropractors in order to examine the relationship between chiropractors' perceived level of business knowledge required and perceived level of current business knowledge. They found there was a significant knowledge gap in six of eight variables examined (strategic management, marketing, accounting, organizational behavior, operations and legal and ethics). A more recent study by Ciolfi *et al.*¹⁰ interviewed 16 Ontario practicing chiropractors (not all CMCC graduates) and asked them about their perceptions of the quality of business education they received while at chiropractic college. The majority of interviewees stated that, while their requirements for business education were both broad and essential, they perceived the education they did receive minimally contributed to their business skills upon graduation.

Gleberzon, Perle, and Lamarch¹¹ conducted a workshop during the 2011 Association of Chiropractic College and Research Agenda Conference (ACC-RAC) on the topic of ethical practice management. Workshop attendees identified student debt load as the most common reason for a chiropractor to engage in unethical practice activities, although some attendees also identified a new graduate impatience to develop a successful practice and a sense of entitlement as other contributing factors. Attendees suggested chiropractic students be presented with

examples of ethically-based chiropractic practices, positive role-models and examples of unethical activities, especially if they resulted in disciplinary action by licensing boards.

Moreover, workshop attendees unanimously advocated for a standardized model curriculum for practice building to be taught at all chiropractic programs that emphasized business skills and financial acumen, undergirded by an ethical framework. Workshop attendees suggested business content ought to include: understanding contracts; basic accounting skills; effective advertising; how to use demographic information to increase patient traffic; staff training; insurances and; continuing education requirements.¹¹

That said, at the same time the workshop were being conducted in 2011, based on a comparative audit of 11 North American chiropractic programs, Gleberzon¹² reported there was a lack of standardization of jurisprudence and business management courses and there was no consensus of a model curriculum.

Changes to course based on student survey results

As a result of this survey, several changes were made to the course for the 2019-2020 academic year. The lecture on 'career options, contracts, banking and dealing with the media' was revamped, with additional information on insurance, contracts and operating and capital expenditures added.

The small group session that discussed the lack of a spousal exemption in Ontario that would allow a healthcare professional to treat a spouse was dropped in favor of a session discussing how to operate a chiropractic practice.

There were specific assignments provided by Lean Canvas for each online business module. Two of the four assignments were decoupled from their associated business module and replaced with assignments that focused on issues related to operating a practice. One assignment tasked student with investigating the types and costs of various insurances associated with chiropractic (see list above), licensing body registration fees and costs of attending various seminars, workshops or programs a chiropractor may wish to pursue (e.g. acupuncture, animal chiropractor, Webster technique, paediatric chiropractic care, Active Release Technique© and other chiropractic technique systems).

The other assignment asked students to provide the pros and cons of working in an urban, suburban or rural setting. Students were also asked to consider the pros and cons of operating a practice in a medical building, of having a street level practice, of practicing in a strip mall or of having a home-based practice. Lastly students were asked to list the pros and cons of various career options including: sole practitioner; partnership; associateship; locum doctor; providing only home treatments; conducting independent assessments and; becoming involved in teaching, research and chiropractic professional organizations (e.g. OCA, CCA, CCO, WFC, AFC).

In order to quell the anxiety some students had with respect to the content and format of the Chiro-Legal Report, more details were provided along with links to representative examples. Lastly, a separate chart was constructed that clearly listed the due dates for all assignments of the course.

Limitations

There were several limitations to this study. There were only two questions inquiring about a student's perception of the lectures and small group sessions in the course. It is possible additional questions would have revealed more information and produced different scores. It is also possible the questions were too restrictive.

Even though the survey was distributed at the end of the course when all other course assignments had been submitted and graded it is still possible students skewed their responses to curry favor with the course coordinator. Theoretically this potential limitation could have been avoided by administering the survey after each lecture and small group session, but this would have resulted in several other problems.

First, there were eight lectures and 12 small groups sessions (facilitated by five different faculty members) delivered every other week, meaning there would have been 32 surveys (eight from lecture and 24 from small group sessions) to collate and extract data from, rather than the only one survey administered in this study. An even bigger problem would be the variability of the number of students who attended each lecture.

Since college policy prohibits making lecture attendance mandatory, number of students who attended each lecture varied considerably throughout the course. For example, based on a very rough visual estimate the majority

of students attended the first lecture and the Panel discussion but fewer students attended the lecture on the prohibition against having sex with a patient. This would have resulted in a varying number of surveys being completed, assuming all students in attendance completed them. With a varying denominator for each survey response rate it would be very difficult to draw any conclusions from the data. By contrast, because the survey was administered only once, the number of respondents was consistent and overall student perceptions easier to explore.

Students may have suffered from recall bias since the survey was administered in April and some lectures and small group sessions were conducted the previous September. However, this was probably mitigated by the fact the survey was administered during the final examination which was comprehensive and based on the entire year's work; this meant that, in order to prepare for the exam (which had a class average of roughly 85%), students ought to have reviewed all course work including lectures and small group sessions.

Lastly, a significant limitation of this study was the survey itself. Beyond a certain degree of face validity, no attempt was made to validate it in terms of its content, construct or criterion. If used in future studies the survey used in this study could be tested to establish its overall validity.

Conclusions

A unique paper 56-item questionnaire delivered at the end of the JEB course resulted in 94% response rate that yielded important information on students' perception of its lectures, small group sessions, assignments and online business management modules. Overall students had very favorable perceptions of the restructured course components that included lectures, small group sessions and course assignments. Unfortunately, students had poor perceptions of the Lean Canvas business modules. There are no current solutions to address these concerns.

Future studies are needed to establish model and standard jurisprudence and business management curricula in chiropractic education. Comparisons of jurisprudence, ethics, and business management courses taught at other chiropractic programs worldwide may offer further guidance on how to enhance this component of chiropractic education.

The results of a comparative audit of JEB courses

taught elsewhere, in addition to this study, may serve as a template for quality improvement efforts to enhance standardization of jurisprudence and business management courses in chiropractic curricula.

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Conservative management of neck and thoracic pain in an adult with neurofibromatosis-1

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Objective: *To describe the case of a 21-year-old female with previously diagnosed neurofibromatosis type 1 (NF-1) with neck, scapular, lumbar, and temporomandibular discomfort along with headaches.*

Clinical features: *The patient had chronic tightness and pain in the cervicothoracic region as well as pain in the lumbar spine at the site of prior neurofibroma removal. Radiographs demonstrated multilevel osseous changes. In addition to NF-1, she was diagnosed with cervical myalgia, tension-type headaches, and chronic temporomandibular joint disorder.*

Intervention and outcomes: *Treatment consisted of a course of manual therapy including cervical flexion-distraction, myofascial release, patient education on workplace ergonomics, and an at-home active care plan. The patient experienced a reduction in pain and headache frequency.*

Traitement conservateur des douleurs cervicales et thoraciques de l'adulte atteint de neurofibromatose de type 1

Objectif : *Présenter le cas d'une jeune femme de 21 ans atteinte de neurofibromatose de type 1 (NF1) et ressentant une gêne au cou, aux épaules, à la région lombaire, à l'articulation temporomandibulaire et souffrant de maux de tête.*

Caractéristiques cliniques : *La patiente se plaignait de raideurs chroniques et de douleurs à la région cervicothoracique et à la colonne lombaire au point d'ablation d'un neurofibrome. Les clichés radiographiques montraient des altérations osseuses à plusieurs étages. En plus d'être atteinte de NF1, la patiente avait des myalgies cervicales, des céphalées de tension et un trouble chronique de l'articulation temporomandibulaire.*

Intervention et résultats : *On a opté pour une thérapie manuelle consistant en une décompression discale en flexion-distraction, un relâchement myofascial, l'information sur l'ergonomie du poste de travail et un plan de soins actifs à domicile. Les douleurs et la fréquence des maux de tête de la patiente ont diminué.*

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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 patient provided consent for case publication.

Summary: *Manual therapy in the form of cervical flexion-distraction with myofascial release and education on workplace ergonomics were effective in reducing neck and thoracic pain as well as reducing headache frequency in a 21-year-old with NF-1.*

(JCCA. 2021;65(1):121-126)

KEY WORDS: active care, cervical flexion-distraction, cervicgia, chiropractic, manual therapy, neurofibromatosis

Introduction

Neurofibromatosis type 1 (NF-1), also known as von Recklinghausen disease, is an inherited genetic condition of neuroectodermal origin affecting roughly one in 2500 to one in 3000 births¹ and is characterized by abnormal growth of nerve tissue resulting in neurofibromas. It is possible to diagnose NF-1 at young ages because characteristic cutaneous manifestations typically present during childhood.² Clinicians should be aware of these signs, as they can be easily recognized by clinical observation. For clinicians who discover skin lesions in children and are suspicious of NF-1, referral to a primary care provider (PCP) or neurologist for laboratory and genetic testing is warranted.

Because patients may experience neck and back pain as well as clinical neurologic deficits as a result of spinal deformity due to the presence of neurofibromas³, patients with NF-1 may seek chiropractic treatment. Subsequent surveillance and management of neurologic complications and spinal deformity of NF-1 are typically handled by the PCP and/or the neurologist. The purpose of this case report is to review the etiology, epidemiology, and clinical manifestations of NF-1, discuss these factors within a chiropractic context, and demonstrate the outcomes of conservative management and active care of a patient with this condition.

Patient presentation

A 21-year-old female nursing student presented to a chiropractic clinic seeking care for neck, bilateral scapular, low back, and temporomandibular joint discomfort as well as

Résumé : *La thérapie manuelle sous forme de décompression en flexion-distraction, le relâchement myofascial et l'information sur les postes de travail ergonomiques ont permis de réduire les douleurs cervicales et thoraciques et la fréquence des maux de tête chez une jeune femme de 21 ans atteinte de NF1.*

(JACC. 2021;65(1):121-126)

MOTS CLÉS : soins actifs, décompression cervicale en flexion-distraction, cervicgia, chiropratique, thérapie manuelle, neurofibromatose

weekly headaches of moderate severity. Her headaches were described as “tightness” which wrapped around her orbital, temporal, and occipital regions. She was previously diagnosed with NF-1, which was being managed by her primary care physician. The patient also described occasional mild “shooting” pain in her right hand and cubital area that she attributed to local neurofibromas in these areas.

She initially attributed her complaint of headaches to her condition, mentioning that at one point she was undergoing bi-annual head MR Imaging to monitor for any cranial changes related to NF-1. However, at the time of presentation it had been approximately two years since her last MR Imaging study.

She had undergone two previous surgical procedures related to her condition: in 2001 to remove neurofibromas from her left kidney, resulting in decreased kidney function on this side, and in 2009 to remove painful neurofibromas adjacent to the posterior aspect of her right iliac crest. Vital signs, including bilateral blood pressure, pulse, and respiration were within normal limits.

Bilateral palpable and audible clicking of the temporomandibular joint upon active opening and closing of the mouth was present without lateral deviation. Upon cutaneous inspection, the patient had multiple café-au-lait spots located on her upper back, neck, and arms, as well as multiple fibroma molluscum located on her anterior and lateral neck. Her right posterior iliac crest demonstrated scar tissue with a blue-purple coloration characteristic of a bruised, edematous focus. Predictably, this region was palpated to be tender, and the patient de-

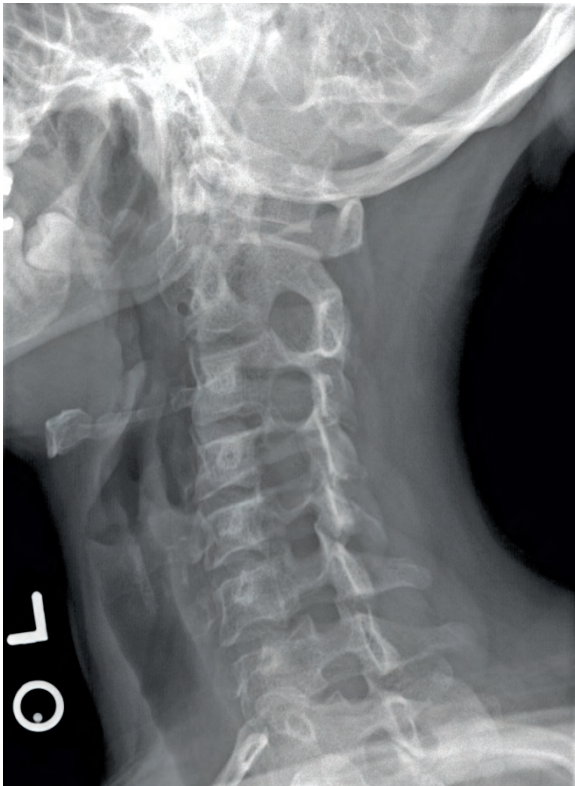


Figure 1.

Left posterior oblique radiograph. Intervertebral foraminal widening at C2-C3 through C5-C6 on the right.



Figure 2.

Right posterior oblique radiograph. Intervertebral foraminal widening at C2-C3 on the left.

scribed it as a source of irritation with sitting or direct contact.

Palpation of the cervical and thoracic spine revealed joint restrictions at C2, C3, T1, T4 and T6. Tenderness and hypertonicity were palpated in muscles around the temporomandibular joint, upper cervical spine, cervicothoracic junction, and mid-thoracic spine. Additionally, palpation provoked pain in the trapezius and rhomboid muscles, which were also hypertonic bilaterally.

Cranial nerves, as well as C5-T1 and L3-S1 dermatomes, myotomes, and deep tendon reflexes each tested normal. Discomfort in the cervical spine was elicited with active cervical flexion, and in the left scapular region with resisted external rotation of the arm. Cervical spine ranges of motion were otherwise full and pain-free. Spurling A and cervical distraction tests did not reproduce her hand

or cubital pain, suggesting that this complaint did not originate from the cervical spine. Seated Kemp's test yielded no reproduction of symptoms. Neer's, Yergason's, and Empty Can test were negative and did not produce shoulder symptoms. Straight leg raising and Patrick's test were negative and did not produce any low-back symptoms.

Prior to initiating chiropractic manipulative therapy, radiographs of the thoracic and cervical spine were obtained to assess for potential osseous and postural alterations that are commonly associated with NF-1. The radiographs demonstrated intervertebral foraminal widening, most notably at C2-C3 through C5-C6 on the right (Figure 1) and to a lesser degree at C2-C3 on the left (Figure 2). Osseous remodeling and posterolateral vertebral body scalloping were present at C3-C5, more prominent on the right with complete erosion of the right C5 uncinat

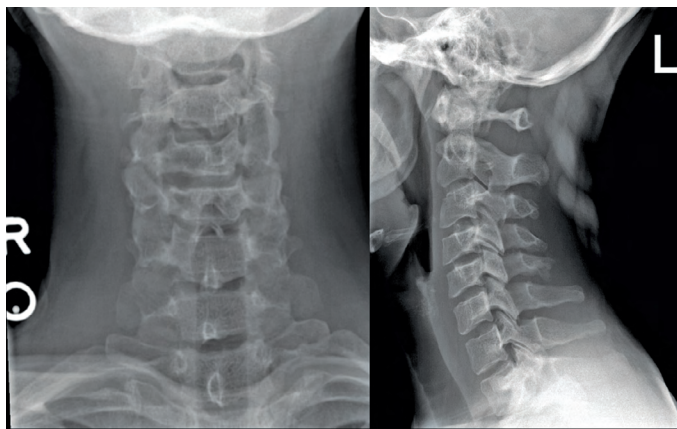


Figure 3.

AP lower cervical and lateral cervical neutral radiographs. Osseous remodeling with posterolateral vertebral body scalloping, more prominent on the right with complete erosion of the right C5 uncinat process.

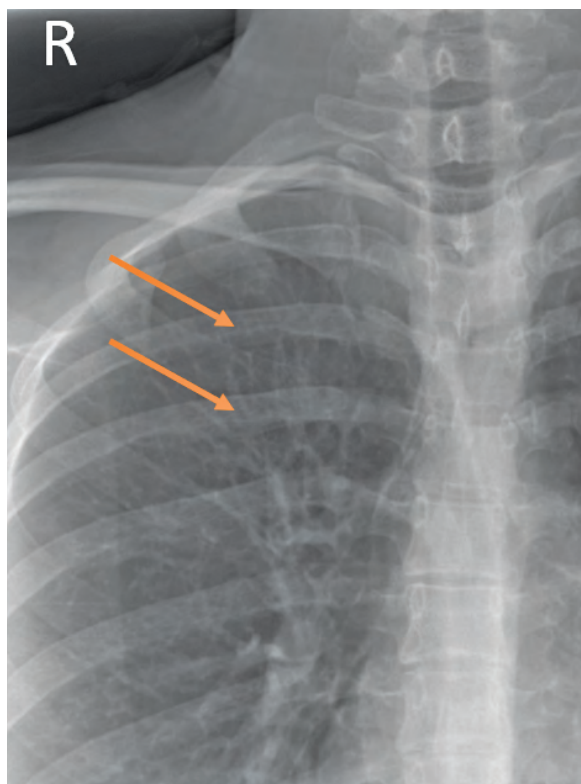


Figure 4.

Cropped AP thoracic radiograph demonstrating mild scalloping of the inferior aspect of the right fourth and fifth ribs.

cess (Figure 3). The thoracic spine study demonstrated mild scalloping of the inferior aspect of the right posterior fourth and fifth ribs with no soft tissue or mediastinal masses (Figure 4). No posterior vertebral body scalloping was seen in the thoracic spine or visualized upper lumbar segments. No kyphoscoliosis or other spinal deformity was present.

Upon completion of history and examination, she was diagnosed with tension-type headaches, temporomandibular joint disorder, and myalgia of the trapezius and scalene muscles. We concluded that these diagnoses were likely secondary to the patient's activities of daily living and independent of her diagnosis of neurofibromatosis-1. MR imaging of the cervical spine was recommended to fully characterize the extent and location of the neurofibromas. The patient declined the MR study, and, since there was no evidence of radiculopathy or myelopathy, the MR study was deferred.

Due to complications of NF-1, including intervertebral foraminal widening in the cervical spine, cervical spinal manipulative therapy was considered a relative contraindication, in accordance with World Health Organization guidelines. Thus, the low-force technique of cervical flexion-distraction was the primary method of treatment for addressing her cervical joint restrictions and myalgia by promoting motion via gentle traction. This was supplemented with manual soft tissue mobilization of the cervicothoracic spine musculature. Furthermore, this patient's treatment plan included patient education on workplace ergonomics and an at-home stretching and strengthening regimen. The patient reported pain relief at the conclusion of each treatment session.

The temporomandibular complaints were addressed with myofascial release technique of the masseter and temporalis muscles. Instruction on strategies to reduce jaw clenching were provided which included applying self-massage and mindfully relaxing the jaw when conscious of clenching. Treatment of the patient's low back complaint was deferred due to the prior surgical history; it was recommended that she see her primary care physician to address the scarring and continued dermal pain as well as to monitor for additional potential complications, including vascular abnormalities.

The patient underwent a treatment plan to include 8 weekly visits, of which the patient attended six visits. As of her last visit, her verbal analog scale with regards to her

neck pain reduced from a 5/10 to a 2/10. Her temporomandibular joint discomfort was resolved, and she reported a reduction of headache frequency to approximately 1 per month of mild severity. The patient continued with her nursing studies and no longer sought care as her condition improved.

Discussion

NF-1 is an autosomal dominant phakomatosis resulting from a mutation on chromosome 17.⁴ Clinical diagnostic criteria of NF-1 includes two or more of the following: café-au-lait spots (patches of skin appearing darker than the surrounding dermal tissue), two or more neurofibromas or one plexiform neurofibroma, cutaneous freckles in the axillary and/or inguinal areas, presence of two or more Lisch nodules (melanocytic hamartomas on the surface of the iris), presence of an optic glioma, sphenoid wing dysplasia or bowing of a long bone, and a first-degree relative with NF-1.¹ The cutaneous features are typically present during childhood, making NF-1 possible to diagnose at a young age.²

As many as 40% of adults with NF-1 have internal neurofibromas, which cannot be seen on physical examination and are likely to be asymptomatic.⁵ Vascular associations of NF-1 include peripheral vascular abnormalities including aneurysms and stenosis.⁶ Furthermore, there is potential for malignant transformation of a neurofibroma, particularly multiple large plexiform types, into a malignant peripheral nerve sheath tumor, which has a lifetime risk of 8-13% in those with NF-1 and is the leading cause of mortality in this population.⁷ Unfortunately, there are no reliable clinical screening tests to evaluate for malignant peripheral nerve sheath tumors.⁸

Spinal manifestations of NF-1 are quite common and occur in 60% of patients.⁹ Imaging findings of the spine include scoliosis, exaggerated kyphosis, vertebral body scalloping, intervertebral foraminal widening, and thinning of the pedicles, transverse processes, and ribs.¹⁰ Due to the foraminal involvement, oblique radiographs of the cervical spine should be included when imaging this region. Unilateral dysplasia of the posterior wall of the orbit, creating a “bare orbit” appearance¹¹ may be visualized on frontal skull (and sometimes cervical) radiographs.

Previously, our patient had undergone biannual MR imaging of her brain, however it is suggested that routine MR imaging screening is not recommended for the de-

tection of the majority of complications in patients with NF-1.¹² Routine imaging does not influence the management of this condition and should not be performed.¹² However, in our case, treatment choice was influenced by radiographs which revealed widened cervical intervertebral foramina with adjacent osseous remodeling, warranting low force spinal manipulative techniques in this region.

There is limited research on chiropractic manipulation in patients with NF-1. A previous case study reported that the Thompson-drop technique was effective in treatment of a NF-1 patient with low-back pain without gross radiographic contraindication to manipulation.¹³ Chiropractors should exercise caution when applying spinal manipulation in patients with NF-1 given the presence of neoplastic growth on nerve tissue and potential for vascular manifestations.⁶ The World Health Organization suggests that spinal manipulative therapy is contraindicated in patients with “neoplastic disease of muscle or other soft tissue”.¹⁴ These case studies suggest that low force techniques, such as flexion-distraction or Thompson-drop techniques¹⁵ could provide symptomatic relief in NF-1 patients with musculoskeletal discomfort provided there are no gross osseous contraindications in that region. Chiropractors should be mindful of their scope of practice and limitations of manipulative therapy; thus, patients should be appropriately co-managed with a PCP or neurologist to address potential complications of NF-1.

Flexion-distraction technique has been widely utilized to relieve chronic low back pain¹⁶, however, research pertaining to the cervical region is limited. Flexion-distraction differs from high-velocity, low amplitude manipulations in that it is a slow manual traction and mobilization.¹⁶

It has also been shown that muscle stretching and strengthening regimens are beneficial in patients with NF-1.^{13,17} Active care management with prescribed at-home stretching and strengthening was found to improve and relieve postural complaints.¹³ A 20-session physical therapy regimen was shown to completely relieve cervical pain and headaches in a 17-year-old girl with NF-1.¹ This suggests that active care combined with patient education on proper muscle stretching and strengthening and continued primary care co-management is effective in patients managing NF-1.

Summary

Musculoskeletal complaints happen in people who suffer from NF-1 as they do in other individuals, but when treating patients who have NF-1 various factors should be considered when choosing a manual therapy technique. Our case study summarized cervical spine indicators we used in considering a treatment protocol for a woman with NF-1 who presented with neck and thoracic pain.

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