A Survey of the Management and Classification of Patients presenting with Neck Pain to Osteopathic and Physiotherapy Practices

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A thesis submitted to Auckland University of Technology in fulfilment of the requirements for the degree of Master of Philosophy

2015

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ATTESTATION OF AUTHORSHIP

“I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.”

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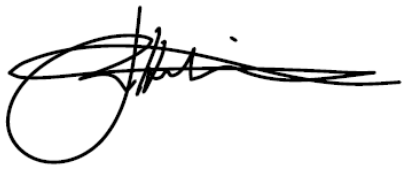

James Hutchinson

ACKNOWLEDGEMENTS

I would like to acknowledge a number of people who have contributed to the completion of this thesis.

Firstly, I want to thank my children Ryan, Cassia and Leo. Your understanding and support through this time has been exceptional. You, like your mother did, inspire me to be a better person. You are all awesome, I love you all. Secondly, my parents who have lent their support during this process.

Thirdly, a big thanks to two people, my supervisors Professor Wayne Hing and Associate Professor Duncan Reid. I would like to thank Wayne for setting me on the path of this thesis. Your enthusiasm and positivity have helped keep me focused on the finish line. And I wish to thank Duncan for the guidance and encouragement you offered during the final stages of this process, you have been an invaluable sounding board.

I would also like to express my gratitude to my colleague Robert Moran, who acted in an advisory role for this thesis. His advice and experience were invaluable.

I would also like to thank Sandra Faustl for her undying support and encouragement throughout this long-winded process.

Lastly I would like to thank all the practitioners who supported this research by taking the time to complete the survey.

ETHICS APPROVAL

The Auckland University of Technology Ethics Committee (AUTEC) granted ethical approval for this research on 25th October 2011. Approval number 11/260, see Appendix 1.

ABSTRACT

Background: Little is known about the management practices of Australian and New Zealand osteopaths and physiotherapists for patients with neck pain. By assessing the practice patterns of practitioners using a case-by-case approach it is possible to investigate the extent to which practitioners may be in alignment with best-practice guidelines. By identifying a practice-research gap it is possible to tailor educational and research efforts to improve management practices where necessary.

Aim: To survey the management approaches of Australian and New Zealand osteopaths and physiotherapists for patients with neck pain and describe their alignment with evidence-based practice.

Methods: A web-based questionnaire was administered from September 2012 to April 2013 to survey the intervention utilisation, and consistency with a treatment-based classification scheme amongst Australian and New Zealand osteopaths and physiotherapists treating patients with neck pain.

Results:
The highest proportion of respondent practitioners (n=48) was from New Zealand (52%, n=25). Osteopaths accounted for 54% of the respondents and physiotherapists 46%. In the patient subset (n=109), osteopaths reported on n=51 patient interactions, and physiotherapists on n=58. The most frequently occurring age bracket for patients was 36-45 years (29%), and the patient subset was predominantly female (62%). The most frequently reported presenting complaint was neck pain and headache (35%). Odds ratio (OR) and Chi square (X^2) analysis was performed to allow comparisons to be made between practitioner groups. Analysis indicated that both practitioner groups employed a multimodal approach in their management of patients with neck pain, with the interventions selected consistent with supporting evidence. Analysis of the classification subgroups showed a lack of evidence supporting practitioners applying a treatment-based classification system. Some of the interventions applied lacked evidential support in the literature. Osteopaths often applied a regional approach for the treatment of patients with neck pain, applying interventions more frequently than physiotherapists to the thoracic region as well as the cervical region.

Conclusion: The two groups of practitioners demonstrated a multimodal approach to their management of patients with neck pain and did not appear to apply groupings of interventions that were consistent with a treatment-based classification system. In addition, there were differences between osteopaths and physiotherapists in the frequency of utilisation of spinal manipulation, and the anatomical regions addressed.

Keywords: Survey, questionnaire, neck pain, practice patterns, multimodal management, treatment-based classification, osteopaths, physiotherapists

1.0 CHAPTER ONE: INTRODUCTION

1.1 Importance of the problem

Neck pain is becoming an increasingly costly burden in the general population. Neck pain is often associated with considerable functional disability (Hoving et al., 2004), and is one of the most common complaints among working age women (Pierre Cote et al., 2008; Hoy, Protani, De, & Buchbinder, 2010). As an episode of neck pain progresses from acute to chronic there is an increasing burden on society through associated direct and indirect costs (Hansson & Hansson, 2005). The direct costs can be attributed to increased demand for specialist resources, provider visits, imaging, and medication/ The indirect costs associated with neck pain can be attributed to production losses due to absenteeism and disablement. A strategy for minimal absenteeism that encourages and assists neck pain patients to return to work as soon as they achieve an adequate level of 'normal' physical function will often result in faster improvements in regards to pain and function (Hansson & Hansson, 2005; Widanarko et al., 2011).

1.2 Statement of the problem

Recent evidence for the conservative management of neck pain in primary care does not support any particular approach whether biologically or psychologically based (Jull & Sterling, 2009), and it remains unclear as to what is the most effective method of treatment in terms of costs, time and resolution (Tsertsvadze et al., 2014). These methods can include: a 'wait-and-see' approach; or 'usual care' from a family doctor including prescription of anti-inflammatories, muscle relaxants, or pain medications; manual therapy management delivered by an osteopath, physiotherapist, or chiropractor; and other modalities such as massage and acupuncture.

A recent study investigated the practice patterns of predominantly chiropractors and physical therapists across 19 countries (Carlesso, MacDermid, Gross, Walton, & Santaguida, 2014). Carlesso et al. (2014) compared the treatment preferences against clinical practice guidelines for the management of neck pain. Whilst their survey indicated that exercise and manual therapy were commonly used interventions in the management of neck pain, it was not possible to tell because of the design of the questionnaire whether the interventions were appropriately targeted. The results of the Carlesso study highlight there is a need to investigate management practices from a case-by-case analysis approach to assess whether musculoskeletal therapists apply the same combination of interventions for all neck pain patients, or adhere to evidence-based guidelines (Carlesso et al., 2014).

The management of neck pain by musculoskeletal therapists includes interventions such as therapeutic exercise (Bertozzi et al., 2013; Kay et al., 2012; Southerst et al., 2014), spinal manipulation (Cross, Kuenze, Grindstaff, & Hertel, 2011; Huisman, Speksnijder, & de Wijer, 2013; Schroeder, Kaplan, Fischer, & Skelly, 2013), mobilisation (Young, Walker, Snyder, & Daly, 2014) and manual therapy (Vincent, Maigne, Fischhoff, Lanlo, & Dagenais, 2013). Multimodal care consisting of a combination of these interventions is seen as a reasonable clinical approach (Bryans et al., 2014; Miller et al., 2010; Sutton et al., 2014), although the evidence supporting this has not been assessed in terms of cost effectiveness and often long term results are only marginally better in the intervention group than the control. The timing of application and dosage of manual therapy interventions early in a neck pain episode could reduce the burden of direct and indirect costs on society (Tsertsvadze et al., 2014). In recent times the clinical model and concept of regional interdependence has been revised to include an understanding that a patient's primary musculoskeletal symptom(s) may be directly or indirectly influenced by or related to impairments from other structures anatomically connected through fascia irrespective of proximity (Stecco, Meneghini, Stern, Stecco, & Imamura, 2014; Sueki, Cleland, & Wainner, 2013). Whilst there is an appreciation that regionally interdependent structures should be addressed when considering an effective management plan for neck pain (Yalcinkaya et al., 2014), there is limited evidence as to how often this concept is implemented in actual practice.

The heterogeneity of the subject groups is also likely to have been an influencing factor on the equivocal evidence reported by many studies investigating interventions for the management of neck pain (Aas Randi et al., 2011; Bryans et al., 2014; D'Sylva et al., 2010; Gross et al., 2010). Classification of patients into homogeneous subgroups has been proposed as a means of addressing this evidential shortfall and has been hypothesised to improve outcomes and reduce unnecessarily long intervention periods (Childs, Fritz, Piva, & Whitman, 2004). A classification system utilizing treatment-based clinical decision rules may aid musculoskeletal therapists in delivering the most appropriate and cost-effective patient care, and guide researchers in the development of intervention based randomized controlled trials (Fritz & Brennan, 2007; Hebert & Fritz, 2012; Murphy & Hurwitz, 2007; Stanton et al., 2011; Wang, Olson, Campbell, Hanten, & Gleeson, 2003). By understanding the needs and activities of practitioners, researchers can collaborate with practitioners to bridge the practice-research gap and translate research into meaningful practice (Driever, 2002).

Binkley, Finch, Hall et al. (1993) argued that a classification system can influence the therapist to assign undue influence to certain phenomena within the categories whilst causing them to disregard others that may be of significance. Walton et al. (2013) have argued that it is salient to identify where in the process the gap between theoretical and evidential guidelines, and actual practice develops. The attitudes and educational philosophy of a therapist can influence their choice of treatment approach and the effectiveness of the treatment (Vonk, Pool, Ostelo, & Verhagen, 2009). It has previously been recognized that whilst manual therapists might express an appreciation of evidence-based practice there has been little uptake of practice guidelines therefore there is limited utility of the guidelines in clinical practice (Walker, Stomski, Hebert, & French, 2013).

In their work utilising an internet-based survey of spinal pain researchers, Costa et al. (2013), reported the top three items on a new agenda for primary care research on lower back pain. The three items were, in order of importance: the identification of clinically relevant subgroups; the identification of distinct interventions for lower back pain targeted to improve outcomes in specific subgroups; and the implementation of validated high-quality research findings into general practice (Costa et al., 2013). Although it can be argued that the cervical spine and lumbar spine are anatomically and functionally different, their similarities would lend credence to adopting these three aims as priorities for primary care research on neck pain. There is little known about the management practices of Australian and New Zealand osteopaths and physiotherapists. Evidence-based practice involves the integration of clinical expertise with current best-evidence for the care of individual patients which can accommodate the patient's preferences and societal expectations (Driever, 2002). There is a need to establish whether osteopaths and physiotherapists in Australia and New Zealand are following best-practice guidelines, or implementing evidence-based methods into their practice.

1.3 Purpose of the study

- To investigate the management approaches of Australian and New Zealand osteopaths and physiotherapists in relation to patients presenting with neck pain.

- To investigate whether osteopaths and physiotherapists are sub-grouping their patients in a manner consistent with a treatment-based classification model in the management of patients with neck pain.

- To investigate whether the techniques applied by osteopaths and physiotherapists to patients with neck pain were in alignment with best-practice guidelines or current best-evidence.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The purpose of this literature review is to present a comprehensive summary of current best-practice management of neck pain in regards to manual therapy and exercise interventions, as delivered by osteopaths and physiotherapists. The review is presented in two main sections:

1. a narrative analysis of the current models of classification for neck pain, proposed clinical prediction rules, and published best-practice guidelines for the management of neck pain;
2. a systematic review of recent studies on interventions for neck pain;

2.2 Neck pain in the general populace

With a change in lifestyle and occupational habits in recent years, neck pain appears to be increasing, with as many as 50% of individuals experiencing an episode of neck pain in their adult life (Borghouts et al., 1999; Pierre Cote, Cassidy, & Carroll, 1998; Eriksen, Natvig, Knardahl, & Bruusgaard, 1999; Hoy et al., 2010; Tsauo, Jang, Du, & Liang, 2007), with an increased prevalence for females and adults between the ages of 20 and 45 years. Manual therapists, covering the disciplines of Osteopathy, Physiotherapy, and Chiropractic, often manage patients with neck pain (Jette, Smith, Haley, & Davis, 1994).

Neck pain represents one of the most frequent musculoskeletal disorders in the working population. The one-year prevalence of neck pain was reported to range between 17.1-73.0%, and the incidence in adults was reported to range between 13.3-17.9% (Hoy et al., 2010). Cote et al. (2004) reported that most participants in their sample suffered from recurrent episodes or persistent symptoms of disability associated with neck pain, with the annual rate of resolution reported to be 36.6% Earlier figures based on 1995 data have suggested that whilst there was a high incidence of neck pain in society, most cases were of low pain intensity and low disability, and therefore not interfering with activities of daily living (Côté, Cassidy, & Carroll, 2003).

In New Zealand during the year 1st January 2013 to 31st December 2013 there were approximately 45,000 new claims for neck sprain received by the Accident Compensation Corporation (ACC) from osteopaths (≈30%) and physiotherapists (≈70%). The total cost for ACC coverage of neck pain during the 2013 year amounted to $9.72 million of which osteopathic management amounted to approximately 24% and physiotherapeutic management amounted to approximately 76%.

In their epidemiological study of the anatomical pattern and determinants of neck pain Walker-Bone et al. (2004) observed that neck and upper limb pain is strongly associated with poor mental health. Decreased stress, increased job satisfaction, and the availability of exercises in the work place can have a significant impact on the development and maintenance of neck pain in sedentary workers (Tsauo et al., 2007). Neck pain is a functionally limiting condition that can have recurrent episodes of minor to severe pain, and become disabling to a small percentage of the general population (Carroll et al., 2008; Pierre Cote et al., 1998). The increasing occurrence of neck pain especially among computer bound office workers is adding a burden of primary healthcare costs (Pierre Cote et al., 2008; Hansson & Hansson, 2005).

2.3 Sources of neck pain

Some sources of neck pain have a low incidence rate and are from known serious pathologies that can be easily diagnosed such as fracture, cancer, myelopathy, or infection. After ruling out serious pathology and specific diseases the anatomical source of the symptoms is difficult to derive in many neck pain patients. Consequently, the remaining presentations are classified as Non-Specific Neck Pain (NSNP), which is of limited usefulness for practitioners to manage aspects of the problem (Tsakitzidis et al., 2009). Within the literature the terms Non-Specific Neck Pain and Cervical Pain of Unknown Origin have been used interchangeably (Clair, Edmondston, & Allison, 2006). For the purpose of this literature review the term Non-Specific Neck Pain (NSNP) will be adopted.

Neck pain has previously been defined as pain perceived by the patient as arising in a region bounded superiorly by the superior nuchal line, laterally by the lateral margins of the neck, and inferiorly by an imaginary transverse line through the first thoracic spinous process (Bogduk, 2003). The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders defined the anatomical region bounded superiorly by the superior nuchal line, laterally by the lateral margins of the neck, and inferiorly by the spine of the scapula posteriorly around to the suprasternal notch anteriorly via the superior border of the clavicle (Guzman, Hurwitz, et al., 2008). This region incorporates anatomical structures related to the cranial base, the cervical spine, the first thoracic spinous process and associated rib head, the cervical neurovascular structures, and the muscular and connective tissue elements.

Structures in the neck, such as the muscles, deep fascia, zygapophysial joints, intervertebral disks, cervical dura mater, and vertebral artery are highly innervated, providing a multitude of potential sources of nociceptive pain (Bogduk, 2003; Pavan, Stecco, Stern, & Stecco, 2014; Stecco et al., 2014). The cervical dorsal rami innervate the posterior neck muscles and the cervical zygapophysial joints (Bogduk, 2003). The lateral atlanto-axial joint and atlanto-occipital joint are innervated by the ventral ramus of C2 and C1 respectively. Bogduk (2003) reports that the sinuvertebral nerves of C1, C2, and C3 innervate the medial atlanto-axial joint and its ligaments, and the dura mater of the spinal cord. Branches of the cervical ventral rami innervate the prevertebral and lateral muscles of the neck.

The cervical intervertebral disks are innervated by structures posteriorly (branches of the posterior vertebral plexus), anteriorly (branches of the cervical sinuvertebral nerves), and laterally (from branches of the vertebral nerve). The vertebral artery receives somatic innervation from the vertebral nerve (Bogduk, 2003). The deep cervical fascia is richly innervated with mechano- and chemo-nociceptors, which are thought to contribute to the pathophysiology of musculoskeletal pain (Stecco, Gesi, Stecco, & Stern, 2013; Stecco et al., 2011).

It has been reported in the literature that noxious stimulation of cervical zygapophysial joints and cervical intervertebral disks can result in pain patterns distributed to similar areas; the C2-3 levels refer rostrally to the head, the C3-4, and C4-5 levels refer to the posterior neck (C3-4 more rostral), C5-6 refers to an area over the supraspinous fossa of the scapular, and C6-7 refers to an area covering the scapular (Bogduk, 2003). Experimental studies have described how applying an anaesthetic block to a painful C2-3 joint can abolish headaches for some patients; similarly applying an anaesthetic block to the lateral atlanto-axial joints has the same effect. The referral of symptoms into the upper limb in patients can be associated with cervical radiculopathy (Rhee, Yoon, & Riew, 2007), non-specific neck pain (Greening & Lynn, 1998), or mechanical neck pain (Frank, De Souza, & Frank, 2005). McLean et al. (2011) reported preliminary evidence of strong correlation between patients with severe neck pain or disability and reporting severe upper limb disability.

2.4 An overview of classification approaches

Rose (1989) proposed the development of a diagnostic system that could categorise patients to inform and direct treatment and management strategies, that is, treatment-based classification systems that can be of most benefit to the patient (Stucki, 2005). A possible contributing factor for the lack of evidence for many common interventions relates to the broad inclusion criteria employed by many studies resulting in heterogeneous samples (J. M. Fritz, Cleland, & Childs, 2007). This is the antithesis to the reality recognized and experienced by clinicians that a single treatment approach will not benefit all patients. Buchbinder, Goel, Bombardier and Hogg-Johnson (1996) identified that in the pure research paradigm categories that are mutually exclusive can, when applied to clinical practice, cross-over with one-to-two other categories. Whilst this would be commonly appreciated in clinical practice for the purpose of applying a treatment-based classification system the practitioner's judgement as to the primary complaint would come into contention. Simplification of category criteria has been suggested as a means to increase reliability (Petersen, Thorsen, Manniche, & Ekdahl, 1999).

A recurrent theme in systematic reviews of treatment intervention for neck pain is the assertion by authors that the magnitude of the reported treatment effect may change dependent upon the homogeneity of the participants under investigation (Fernández-de-las-Peñas & Courtney, 2014; O'Riordan, Clifford, Van De Ven, & Nelson, 2014; Southerst et al., 2014; Vincent et al., 2013; Walton et al., 2013). There has been a shift from the pathoanatomical model of diagnosis towards the development of prognostic tests that can separate a heterogeneous population into treatment-oriented sub-groups that will inform patient management and be cost effective (Huijbregts, 2007; Laupacis, Sekar, & Stiell, 1997). The pathoanatomical model has proven limited for the correlation between diagnosis and clinical decisions regarding treatment management plans because different diagnoses often exhibit similar symptoms (Wang et al., 2003). Classification of patients with neck pain can fall under the auspices of clinical practice guidelines (Bryans et al., 2014; Childs et al., 2008; Graham et al., 2013; Guzman, Haldeman, et al., 2008); clinical prediction rules (Cai, Ming, & Ng, 2011; Fernández-de-las-Peñas et al., 2011; Hanney et al., 2013; Hebert & Fritz, 2012; Puentedura et al., 2012; Saavedra-Hernández et al., 2011) and treatment-based classification (Farrell & Lampe, 2011; Fritz & Brennan, 2007; Heintz & Hegedus, 2008).

Clinical prediction rules are decision-making tools that can inform the formulation of a diagnosis and patient management plan for patients with a unique set of signs and symptoms. (Beattie & Nelson, 2006; Beneciuk, Bishop, & George, 2009; Fernández-de-las-Peñas et al., 2011). Clinical prediction rules are formulated by a cluster of clinical tests that can provide greater value than stand-alone clinical tests for the diagnosis and management of patients (Cook & Hegedus, 2011). The utilisation of clinical practice guidelines is recommended as a means to appropriately apply effective therapies, and inform and implement evidence-based practice, with the view to providing cost-effective care with improved outcomes (Fritz, Cleland, & Brennan, 2007). Fritz et al. (2007) reported that adherence to a physical therapy clinical guideline for patients with acute lower back pain was associated with improved clinical outcomes and lowered cost of treatment.

There is limited evidence for the efficacy of treatment-oriented clinical prediction rules for NSNP within the musculoskeletal therapy disciplines of Osteopathy, Physiotherapy, and Chiropractic (Cleland, Childs, Fritz, Whitman, & Eberhart, 2007; Cleland et al., 2010; Fernández-de-las-Peñas et al., 2011; Raney et al., 2009; Thiel & Bolton, 2008; Tseng et al., 2006). Recent reviews have surmised a lack of evidence to support the proposed clinical prediction rules, due to the poor methodological quality reported (Beneciuk et al., 2009; Nee & Coppieters, 2011; Stanton, Hancock, Maher, & Koes, 2010). While not all patients have been found to fit comfortably into neck pain clinical prediction rules, it has been proposed that classification systems can categorise a wider range of patients and lead to better assignment of treatment modalities (Childs et al., 2004; Delitto, Erhard, & Bowling, 1995; Fritz & Brennan, 2007; Stanton et al., 2011; Widerström, Olofsson, Arvidsson, Harms-Ringdahl, & Larsson, 2012).

2.4.1 Treatment-based classification systems

Determining an appropriate method for the classification of patients with neck pain into suitable sub-groups that are likely to respond better to specific targeted treatment, in a timely fashion has been an emphasised theme in cervical pain literature (O'Riordan et al., 2014; Southerst et al., 2014; Takasaki & May, 2014; Tsertsvadze et al., 2014). Murphy and Hurwitz (2007) recognized that the challenge of diagnosing a patient with spinal pain is to overcome the multi-factorial nature of spinal pain, for which many of the factors do not have objective tests. The authors described how patients were grouped through a diagnostic algorithm and assigned into a relevant category for management. The patient may well have more than one diagnostic factor present, and the clinician decides which primary complaint to treat first. This is the essence of a treatment-based classification system that seeks to classify patients into a sub-grouping so that they can receive the most efficacious treatment intervention based on their current presentation. Anderson-Peacock et al. (2005) accorded qualitative judgements to treatment effect sizes in accordance with previous authors (Bronfort et al., 2001; Hurst & Bolton, 2004). They stated that a treatment effect size below 0.5 is clinically ‘unimportant’, an effect size between 0.5 to 0.79 was ‘moderately important’, and 0.8 or greater was ‘important’. Anderson-Peacock et al. (2005) concluded that solely assessing the efficacy of a treatment is unsatisfactory in directing good practice, and it would be more beneficial to develop an effective algorithm of care.

2.4.2 Treatment-based classification systems for neck pain

There have been five classification systems investigated for patients with neck pain (Clair et al., 2006; Fritz & Brennan, 2007; Schellingerhout et al., 2008; Wang et al., 2003; Werneke, Hart, & Cook, 1999). Childs et al. (2004) proposed a classification system based on potential matched interventions. The authors defined five categories into which they proposed classifying patients; "mobility", "centralization", "conditioning and increase exercise tolerance", "pain control", and "reduce headache". They proposed a treatment approach for each classification that was thought most likely to benefit the patient, and their system was investigated by Fritz and Brennan (2007).

Werneke, Hart & Cook (1999) investigated the centralisation phenomenon in a descriptive study of 289 patients referred for physical therapy with neck pain or low back pain. Forty-nine percent of the patients were female, and 22.8% of all patients reported with neck pain. The interventions applied were based around the McKenzie mechanical diagnosis, so as to facilitate centralisation with exercises and manual therapy, at the discretion of the treating practitioner. Primary outcome measures included the numeric rating scale (NRS) for pain intensity, and the neck disability index (NDI) for perceived function. For the neck pain group, the prevalence of centralisation was 24.6%, non-centralisation 24.6%, and partial-reduction 46.4%. The authors chose to report the results for both spinal types (neck and low back) combined. Overall patients categorised into the centralisation or partial-reduction groups had greater improvements in pain intensity and perceived function than the non-centralisation group ($p<0.001$). Limitations in the design of this study prevent the assessment of the predictive value of centralisation. The McKenzie diagnosis allowed the therapists to classify the patients into three groups. Of these, both the centralisers and partial-reducers appeared to respond to the treatments applied, however, as the choice of interventions was at the discretion of the therapist, the interventions cannot be clearly linked to a classification. Limited inference can be taken from this study by Werneke et al. (1999), as the authors reported pooled data for all participants, of which only 23% had neck pain, and the choice of treatment intervention was not standardized to a classification category

Wang, Olson, Campbell et al. (2003) sought to determine the effectiveness of treating neck pain with an individualised physical therapy intervention based on a clinical reasoning algorithm. Fifty-seven patients were enrolled in a quasi-experimental control group design study. A cohort control group (n=27) was selected by convenience from participants who met the inclusion criteria but were unable to commence treatment due to the following reasons: delays in insurance approval; current exacerbation of chronic neck pain symptoms without physician referral; and time constraints from work or travel. There was no stipulation in the inclusion criteria as to the duration of the current episode of neck pain. The clinical decision-making algorithm (Figure 1) consisted of four primary categories; category I *radicular arm pain with/without neck pain*; category II *referred arm pain with/without neck pain*; category III *cervicogenic headaches*; category IV *neck pain only*.

Figure 1 Clinical decision-making algorithm for neck pain (categories I, II, III, IV).

From Figures 1 and 2, it can be seen that the decision algorithm led to 14 neck and/or arm patterns and four cervicogenic headache patterns. However, the suggested treatment approaches for these illustrated patterns were often similar and contained many treatment approaches that were utilised for more than one pattern. For instance, for patients presenting with neck pain patterns 11 and 13 the same treatment approaches were recommended; *specific joint mobilisation to the involved level* and *postural exercise*. Experimental outcome measures included cervical range of motion (CROM), pain intensity measured on the NRS, two endurance tests (the timed weighted overhead test and the timed capital flexion test), and the patient-specific functional scale (PSFS) as a measure of disability. The intervention group were treated 2-3 times per week for about 4 weeks. There was a significant improvement ($p \leq 0.05$) in all five outcome measures compared with the control group. Limitations in this study included a lack of blinding for the assessor, and a lack of randomisation of the patients, which both impact on the internal validity of the results and can be a source of bias. The algorithms are quite involved and were only applied by the creator of the model, which may also limit the applicability of the results to other practitioners with different or less experience. Considering the number of similar treatment options relating to the patterns that were similar, this algorithm could have been simplified to make it easier to apply in a clinical setting. The algorithm proposed by Wang et al. (2003) was presented with numerous clinical decision-making tests that have limited or no evidence to support their specificity and validity. Furthermore, the validity of the evidence reported by Wang et al. (2003) is limited by the chosen methodology, which was subject to bias.

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Figure 2 Cervicogenic headaches algorithm (category III)

[ENT: ear, nose, and throat; OA: occipitalatlantal; AA: atlantoaxial] From "Effectiveness of Physical Therapy for Patients with Neck Pain: An Individualized Approach Using a Clinical Decision-Making Algorithm" by W. Wang, S. Olson, A. Campbell, W Hanten, & P Gleeson (2003). *American Journal of Physical Medicine & Rehabilitation*, 82(3), 203-218. Copyright © 2003 by Lippincott, Williams & Wilkins. Reprinted with permission.

Clair, Edmondston and Allison (2006) reported on a prospective cohort study investigating the treatment dose applied to NSNP patients (n=92, female=61, mean age=58.8years) when classified into two distinct groups. The groups were a movement group (i.e. "movement disorder") and a loading group (i.e. "loading disorder'). The movement group assignment was based on the following criteria: pain provoked by movement or repetitive activity; an active-movement impairment; and symptom reproduction associated with impaired movement. The loading group criteria were: pain provoked with sustained postures; active-movements pain-free; and unrestricted active-movement. The therapists involved in the study were blinded to the classification assigned to each patient and were able to treat as they deemed appropriate for as many sessions as were required. The movement disorder group received significantly (p=0.014) more treatment sessions (mean ± SD, 11.5 ± 5.9) than the loading group (mean ± SD, 7.3 ± 4.5). Individuals in the loading group were 2.4 times (95% CI 1.1 to 4.1, p<0.005) more likely to be discharged at each treatment session than those in the movement group. There was no significant difference in VAS for pain intensity, and the Neck Pain and Disability scale between the two groups.

This two group classification system appeared a useful prognostic indicator of the treatment dose required to achieve a significant response to manual therapy for subjects with neck pain. It is possible that with further investigation these sub-groups could be developed as part of a treatment-based classification system.

In a prospective longitudinal study investigating a proposed treatment-based classification system, Fritz and Brennan (2007) reported on 274 neck pain patients (74% female) with a mean age of 44.4, who were recruited from 4 physical therapy clinics. Data was collected on standardised forms, so as to allow post intervention analysis in regards to the proposed classification decision-making algorithm (Figure 3).

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Figure 3 Classification decision-making algorithm.

MVA=motor vehicle accident, NDI=Neck Disability Index From "Preliminary Examination of a Proposed Treatment-Based Classification System for Patients Receiving Physical Therapy Interventions for Neck Pain" by Fritz, J. M., & Brennan, G. P. (2007). Reprinted from *Phys Ther. 2007;* 87(5), 513-524. With permission of the American Physical Therapy Association.

Prior to data collection Fritz and Brennan (2007) defined the intervention components that were to be matched to each classification (Table 1), on the basis of current evidence-based practice and standard care. This article provides preliminary evidence in support of a treatment-based classification system. The patients who received a matched treatment (n=113) displayed significant improvements ($p<0.05$) for self-reported disability (NDI, Cohen's $d=0.90$) and pain intensity (NRS, Cohen's $d=0.92$) compared to patients who received non-matched treatments (n=161, NDI Cohen's $d=0.64$, NRS Cohen's $d=0.67$). After adjustment for all covariates, the general trend for patients across the individual sub-group analysis was reflected in the whole group analysis, patients receiving matched interventions showed greater changes in both self-reported disability scores (NDI mean difference for adjusted scores = 5.6, 95%CI = 2.6 to 8.6) and pain rating scores (NRS mean difference for adjusted scores = 0.74, 95%CI = 0.21 to 1.3). A lack of randomisation in the assignment of patients to receive matched or non-matched treatments is a source of bias that was not controlled for in this design. Allowing the therapists to choose interventions rather than following a standardised intervention protocol that could account for dosage, intensity of exercise and the specific manual techniques employed has allowed the potential cross-over of intervention effects between the classification groups.

Heintz and Hegedus (2008) reported on a case study that illustrated the application of the treatment-based classification system proposed by Fritz and Brennan (2007) above. The patient was a 51-year-old female computer worker with a chief complaint of left-sided neck pain that radiated into her ipsilateral shoulder and arm. Her symptoms were exacerbated by almost any task performed in a sitting or standing position. The authors placed her in the centralisation classification based on her peripheralisation of symptoms with motion testing, her age, and the duration of her symptoms (Heintz & Hegedus, 2008). During the intervention sequence the patient was transitioned from the centralisation classification to the exercise and conditioning classification. After 6-weeks of weekly physical therapy interventions based on the two treatment-based classifications that were applied the patient reported remaining pain-free and demonstrated improvements in CROM, consistent with the findings of Fritz and Brennan (2007), though anecdotal.

Table 1 Matched treatment components for each classification category.

Adapted from "Preliminary Examination of a Proposed Treatment-Based Classification System for Patients Receiving Physical Therapy Interventions for Neck Pain" by Fritz, J. M., & Brennan, G. P. (2007). *Physical Therapy*, 87(5), 513-524.

Classification	**Requirements**	**Proposed interventions matched to presentation**
MOBILITY	The listed interventions must ***both*** be administered within the first 3 sessions	a. cervical or thoracic mobilisation or manipulation b. Strengthening exercises for the deep neck flexor muscles
CENTRALIZATION	***Either*** of the listed interventions must be received in at least half the sessions	a. mechanical or manual cervical traction b. cervical retraction exercises
EXERCISE & CONDITIONING	The listed interventions must ***both*** be received in at least half of the sessions	a. strengthening exercises for the upper-quarter muscles b. strengthening exercises for the deep neck flexor muscles
PAIN CONTROL	The listed interventions must ***both*** be received with the first 3 sessions	a. cervical spine mobilisation b. cervical range-of-motion exercises
HEADACHE	The listed interventions must all be received, on ***all*** sessions	a. cervical spine manipulation or mobilisation b. strengthening exercises for the deep neck flexor muscles c. strengthening exercises for the upper-quarter muscles

Schellingerhout, Verhagen, Heymans et al. (2008) sought to identify subgroups of patients with NSNP who were likely to benefit from either physiotherapy, spinal manipulation therapy (SMT), or usual care. They combined data from three RCTs with similar designs and settings (n=329). From their analysis they reported three characteristics that could direct treatment choices for improved outcomes for patients with NSNP. The characteristics were age, pain intensity, and no accompanying low back pain (Figure 4). The physiotherapy protocol consisted of active exercises combined with manual traction, or stretching, or massage, employed with the aim of improving strength or range of motion. The spinal manipulation therapy protocol involved the mobilisation by low-velocity passive movements within or at the end of range of joint movement in the cervical spine, to reduce pain and improve function. The usual care protocol was based on general practitioner advice on self-care, prognosis, and the prescription of analgesics if necessary. An educational booklet was provided containing ergonomic advice, and exercises to improve strength and cervical spine mobility.

From their combined decision model (Figure 4) it can be seen that the authors suggest the spinal manipulation therapy for all instances of patients presenting with non-specific neck pain. High-velocity thrust techniques were not used in the spinal manipulation therapy group as part of the treatment protocol, and no justification was given for this omission.

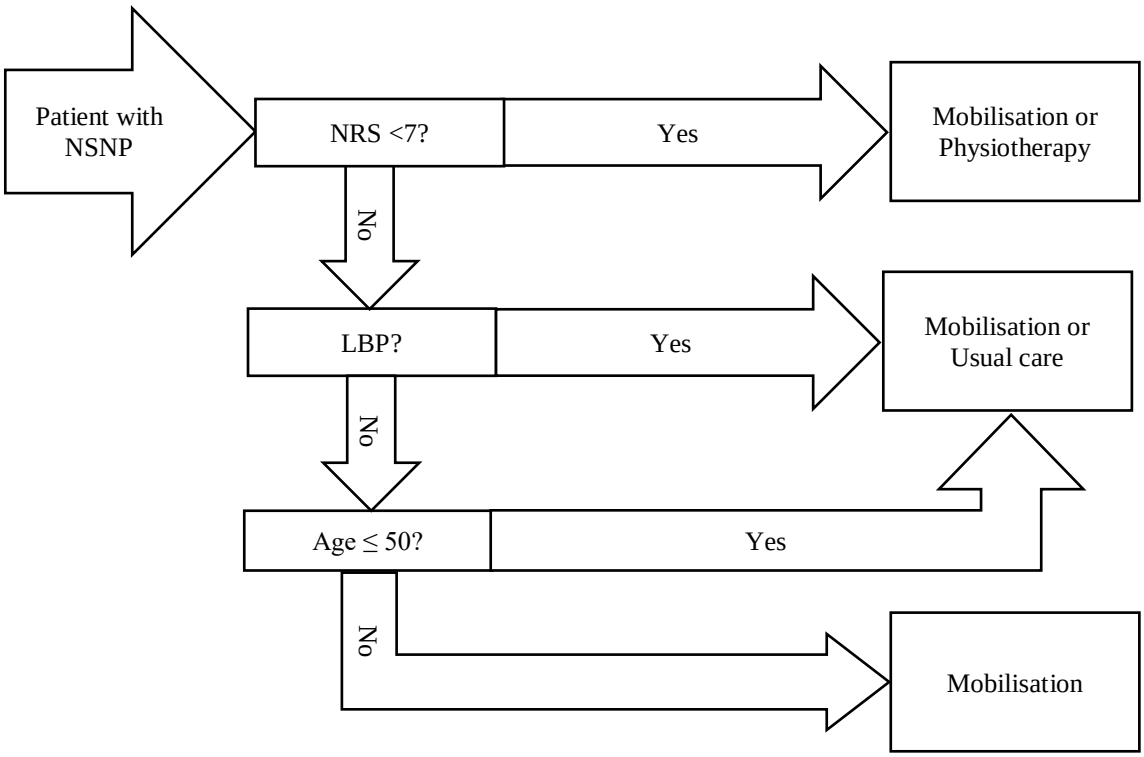


Figure 4 Short- and long-term classification model

Adapted from "Which subgroups of patients with non-specific neck pain are more likely to benefit from spinal manipulation therapy, physiotherapy, or usual care?" by Schellingerhout, J. M., Verhagen, A. P., Heymans, M. W., Pool, J. J. M., Vonk, F., Koes, B. W., & de Vet, H. C. W. (2008). *Pain*, 139(3), 670-680.

A pilot study was conducted to assess the implementation of a treatment-based classification for patients with neck pain (Farrell & Lampe, 2011). The study was conducted in two phases; phase one assessed the current state of potentially matched interventions by therapists unaware of the proposed treatment-based classification system; during phase two therapists were given training on the assessment and intervention protocols for the proposed treatment-based classification system and were asked to implement these, so as to appropriately match interventions. The algorithm used was modelled on the categories described by Fritz and Brennan (2007). Nine therapists agreed to take part in phase one of the study and provided data on 33 patients. In phase two, eight therapists took part and provided data on 14 patients.

The authors reported that during phase one there were significant improvements in NDI (mean change ± SD; 19.6 ± 9.7, $p<0.001$) and for NRS (mean change ± SD; 3.8 ± 2.0, $p<0.001$). One third of the patients received treatments which were considered appropriate in terms of the treatment-based classification. In phase two there were similar improvements reported for NDI (mean change ± SD; 19.2 ± 18.2, *p* not reported) and NRS (mean change ± SD; 4.0 ± 2.4, *p* not reported), and two thirds of the patients received appropriately matched treatments. There were no significant differences in NDI ($p=0.958$) or NRS ($p=0.805$) change scores between phase one and phase two. Overall the results indicate that intervention, regardless of whether the therapist was trained in the treatment-based classification system or whether the treatment was matched, was accompanied by similar levels of significant improvement in perceived disability and pain intensity as reported by a sample of patients with neck pain.

2.4.3 Clinical prediction rules

Clinical prediction rules can help to classify patients for treatment, offer insight into patient prognosis, and illustrate the potential presence or absence of a condition (Beattie & Nelson, 2006). Clinical prediction rules utilised by physical therapists are an assimilation of statistically meaningful predictors for a particular musculoskeletal condition, which can be implemented to classify a heterogeneous group of patients into subgroups (Beattie & Nelson, 2006). The number and type of predictors will vary dependent on the complexity of the condition. They can be based on physical findings alone, or patient history, or patient beliefs in combination with patient history and physical findings. By providing probabilities for positive or adverse outcome for patients, clinical prediction rules can inform the classification process of patients for treatment (Beattie & Nelson, 2006; Cai et al., 2011; Cleland et al., 2007; Fernández-de-las-Peñas et al., 2011). Clinical prediction rules have a rigorous methodology for development involving a multistep process of derivation, validation, and analysis of impact (Hebert & Fritz, 2012; Laupacis et al., 1997; McGinn et al., 2000). The methodology implemented in the development of a clinical prediction rule requires that the external validity of a rule must be observed in different settings, with a wide range of patients, and a variety of practitioners before the clinical prediction rule can be confirmed as generalisable (Beattie & Nelson, 2006; Childs, Fritz, Flynn, Irrgang, & et al., 2004; Hancock, Maher, Latimer, Herbert, & McAuley, 2008; Patel et al.; Reilly & Evans, 2006).

A prospective cohort study was conducted by Fernández-de-las-Peñas, Cleland, Palomeque-del-Cerro et al. (2011) with 76 women (mean age 44.1) suffering from tension-type headache, to develop a clinical prediction rule (CPR) to indicate the best candidates for joint mobilisation and muscle trigger point (TrP) therapy. As this investigation sought to develop a CPR, and the treatment outcome was to be used as a reference criterion, all participants received the semi-standardized treatment irrespective of the clinical examination findings. All patients received a single session of multimodal manual therapy from the same therapist. The intervention consisted of: posterior-anterior mobilisations applied to T4 to T1 thoracic vertebrae, the cervico-thoracic junction (C7-T1), and the C1-C2 cervical vertebrae; and a range of TrP techniques (including soft tissue stroke, and muscle energy) applied to the head, neck and shoulder muscles (temporalis, suboccipitals, upper trapezius, levator scapulae, sternocleidomastoid, and superior oblique). For analysis patients were grouped as 'success' or 'non-success' based on their perceived treatment response as reported by the global rating of change (GROC), in which a score ≥ +5 ('a very great deal better', 'a great deal better', or 'quite a bit better') was considered a 'success'. Forty-seven percent of the patients were classified as having a successful outcome after the intervention. The eight predictors for success were: a mean age <44.5 years; presence of TrPs in suboccipital muscles, left sternocleidomastoid muscle, and/or left superior oblique muscle, cervical rotation to the left > 69^{o}, total tenderness score < 20.5, NDI < 18.5, and a referred pain area of the right upper trapezius muscle TrP > 42.23. The likelihood of a successful outcome increased to 86% if 5 out of the 8 predictor variables were met, if more than 5 of the predictor variables were met the likelihood of success improved to 100%.

2.4.4 Clinical prediction rules for interventions in patients with neck pain

Saavedra-Hernandez, Castro-Sanchez, Fernández-de-las-Peñas et al. (2011) reported on a prospective investigation to define clinical predictors for identifying patients with mechanical neck pain likely to improve after spinal manipulation to the thoracic and cervical spine regions. Eighty-one patients (mean age 39.4 years, female 70%) with mechanical neck pain were assessed and 103 clinical variables were recorded for analysis in terms of 'responders' after spinal manipulation. Similarly, to the study by Fernández-de-las-Peñas et al. (2011) the researchers employed a semi-standardized treatment irrespective of the clinical examination findings. The patients attended up to two treatment sessions (depending on whether they exceeded the GROC score of +5 after the first session), where they received three high-velocity low amplitude (HVLA) thrust manipulations targeted to the mid-cervical spine, the

cervico-thoracic junction, and the upper-thoracic spine region. The actual level chosen in the mid-cervical and upper thoracic regions was left to the therapist's discretion based on predefined criteria. The mid-cervical spine and upper-thoracic spine manipulations were performed with the patient supine, and the cervico-thoracic junction manipulation was performed with the patient prone. For analysis patients were grouped as 'responders' or 'non-responders' based on their perceived treatment response as reported by the GROC, a score ≥ +5 was considered a 'responder'. Sixty-two percent of the patients were classified as being a 'responder' to the intervention. The five predictors for a positive response were pain intensity > 4.5 points; cervical extension less than 46^{o}; presence of hypomobility at T1; a negative upper limb neural tension test, and gender (female). If 3 out of the 5 predictor variables are present the likelihood of success increased from 61.7% to 70.7%, and if 4 out of the 5 predictor variables are present the likelihood of success improved to 75.4%.

A prospective cohort of 82 patients with mechanical neck pain (mean age 38.3 years, female 59%) were investigated in the development of CPRs for cervical spine manipulation (Puentedura et al., 2012). Similar to the studies reported above, Puentedura et al. (2012) employed a semi-standardized treatment irrespective of the clinical examination findings. The patients attended up to two treatment sessions (depending on whether they exceeded the GROC score of +5 after the first session), where they received mid-lower (C3-C7) cervical spine HVLA thrust manipulations, exact level at the discretion of the therapist, followed by gentle active ROM exercises (10 repetitions to be performed 3-4 times daily). For analysis patients were grouped as 'success' or 'non-success' based on their perceived treatment response as reported by the GROC, a score ≥ +5 was considered a 'success'. Thirty-two percent of the patients were classified as having a successful outcome after the intervention. Four predictive variables were reported as part of the CPR: symptom duration < 38 days; positive expectation that manipulation will help; side-to-side difference in cervical rotation ROM ≥ 10^{o}, and pain with posterior-anterior spring testing of mid-cervical spine. A patient who met 3 out of 4 criteria had an increased likelihood of success from 39% to 90%.

Hanney, Kolber, George et al., (2013) conducted a prospective cohort study of 91 patients (mean age 45.6 years, female 75.8%) to identify CPR variables for patients with NSNP who may respond to exercise-based intervention. The patients attended 12 clinical sessions over 6 weeks where they undertook supervised stretching and strengthening exercises. They were asked to complete the stretching exercises on a daily basis outside of clinic attendance. The standardized intervention involved the following stretches; upper trapezius, anterior and middle scalenes, suboccipital, and pectoralis major. The stretches were held for 30 secs and repeated bilaterally twice. The graduated isometric strengthening exercises involved cervical extension, shoulder protraction, cranio-cervical flexion, seated row, horizontal shoulder abduction with external rotation, and shoulder elevation in the plane of scaption. For analysis, patients were grouped as 'success' or 'non-success' based on their perceived treatment response as reported by the GROC. A score ≥ +4 ('moderately better') or above was considered a 'success'. Fifty-five percent of the patients were classified as having a successful outcome after the intervention. Five predictive variables were reported for the CPR; NDI score < 18; presence of shoulder protraction during static postural assessment; patient does not cycle for exercise; cervical side-bending < 32^{o}, and Fear Avoidance Belief Questionnaire-physical activity score < 15. A patient who met 4 out of the 5 predictive variables had an increased likelihood of success from 56% to 78%.

2.4.5 Practice guidelines for neck pain

In order to manage the inherent costs of an increasing prevalence in NSNP within the general population it is imperative to develop osteopathic and physiotherapeutic multi-modal intervention programs that are cost effective, patient appropriate, and time efficient (Bryans et al., 2014; O'Riordan et al., 2014). The cost effectiveness and time efficiency components of the treatment interventions can be investigated through appropriately designed randomized clinical trials (Tsertsvadze et al., 2014), whereas the patient appropriate approach will best be investigated through the application of homogenous subgrouping of patients, as has been attempted in several treatment-based classification schemes. A large variety of interventions practiced by osteopaths and physiotherapists can be utilised in the management of NSNP, including spinal manipulation and mobilisation (Bryans et al., 2014; Gross et al., 2004), active exercises (Kay et al., 2012; O'Riordan et al., 2014), and manual therapy (Miller et al., 2010; Vincent et al., 2013).

The Bone and Joint Decade 200-2010 Task Force on Neck Pain and its Associated Disorders made recommendations supporting the use of a multimodal approach in the management of patients with Grade I neck pain (neck pain with no signs of major pathology and little interference with daily activities) and Grade II neck pain (neck pain with no signs of major pathology, but interference with daily activities) (Guzman, Haldeman, et al., 2008).

The American Physical Therapy Association published a set of clinical guidelines for the treatment of neck pain in 2008 (Childs et al., 2008). The authors stated there was strong evidence in support of the use of cervical manipulation and mobilisation for reducing neck pain, headache, and disability. They elaborated further that a multimodal approach that combined manipulation or mobilisation with exercise therapy was more effective. Childs et al. (2008) reported only weak evidence in support of thoracic spine manipulation for the management of patients with neck and referred arm pain. Strong evidence was reported for the use of coordination, strengthening, and endurance exercises for the management of patients with neck pain and headaches.

An evidence-based guideline for the management of patients with headache reported moderate evidence in support of spinal manipulation for patients with episodic or chronic migraine, and weekly massage therapy for patients with episodic migraine (Bryans et al., 2011). The authors reported moderate evidence in support of the use cranio-cervical mobilisation for the management of chronic tension-type headaches, whereas, there was moderate evidence that spinal manipulation was of no additional benefit to these patients. The management of cervicogenic headache patients with a multimodal approach that incorporated spinal manipulation, mobilisation, and deep flexor exercises was supported by moderate evidence. This chiropractic guideline for the treatment of adults with headaches did not specify what spinal levels the recommended spinal manipulation interventions should be applied.

Bryans, Decina, Descarreaux et al. (2014) reported recent evidence in support of the pragmatic use of manipulation, exercise and soft tissue work as part of a multimodal health care package for patients with NSNP. They reported moderate evidence in support of cervical manipulation or mobilisation in the management of patients with neck pain, and weak evidence in support of spinal manipulation or exercise in the management of chronic or acute neck pain respectively. Bryans et al. (2014) reported strong evidence in favour of a multimodal management approach for chronic neck pain. The authors reported insufficient evidence to support the use of thoracic manipulation in the management of acute and chronic neck pain. Their results are biased by an inclusion criterion that required all papers selected for review to include a practicing chiropractor in the research team.

2.5 Systematic review of recent studies on interventions for neck pain

The aim of this section is to undertake a critical review using a systematic approach to critically evaluate RCT studies that have been published since 2012, that have examined the effectiveness of manual therapy and exercise intervention either together or separately for the treatment of non-specific neck pain patients with or without concomitant headaches.

2.5.1 Literature search strategy

A search was conducted to identify recent literature relevant to the treatment of patients with neck pain with or without headache, using the electronic databases, PEDro, SPORTDiscus, CINAHL, and PUBMED.

The keywords used in isolation or combination were neck pain OR cervical spine pain OR mechanical neck pain OR non-specific neck pain OR migraine OR tension-type headache OR cervicogenic headache OR spinal manipulation OR spinal mobilization OR cervical spine manipulation OR cervical spine mobilization OR thrust manipulation OR high velocity low amplitude OR thoracic spine manipulation OR thoracic spine mobilisation OR exercise OR osteopathic OR physiotherapy OR physical therapy OR chiropractic OR manual therapy OR massage OR myofascial release OR strengthening OR stretching OR endurance (see Appendix 2).

The search was limited to studies published in English, with human participants over the age of 18 years, and published between January 2012 and September 2014. Filters were applied to select for *randomized controlled trial* or *clinical trial*. The references of each selected paper were also reviewed in order to ascertain whether any relevant studies had been missed by the database search.

2.5.2 Study selection

2.5.2.1 Inclusion criteria

The following criteria were applied in the selection of included studies:

- study design – Randomized controlled trials comparing one or more manual therapy interventions for neck pain or headache relating to either efficacy or effectiveness of intervention;
- type of participants – the participants had to be over the age of 18 years with non-whiplash associated neck pain and no coexisting musculoskeletal or underlying rheumatological, neurological, cardiovascular, or congenital conditions affecting the spine, head or upper extremity;
- type of intervention – trials had to investigate at least one of the following: manipulation or mobilisation or exercise or soft tissue manipulation prescribed, or supervised by an osteopath or physiotherapist or chiropractor or physical therapist or manual therapist;
- outcome measures to include at least one of the following – pain intensity rating (e.g. visual analogue scale or numeric pain scale), cervical range of motion (CROM), Neck Disability Index or other questionnaires assessing functional limitations.

2.5.2.2 Review and analysis of methodological quality

The PEDro scale is a validated tool (Maher, Sherrington, Herbert, Moseley, & Elkins, 2003; Reid, Rydwanski, Hing, & White, 2012) used to assess the methodological quality of randomized controlled trials investigating physical therapy interventions. The PEDro Scale is available online (http://www.pedro.org.au/english/downloads/pedro-scale/). The PEDro scale is an 11-item scale, and various criteria of the PEDro scale relate to different aspects of RCT analysis such as internal and external validity, statistical analysis, and reproducibility. Internal validity is crucial when making quantitative analysis of the presented evidence so as to show a cause and effect relationship without bias (Reid et al., 2012).

For this review the methodological quality score (MQS) was based on a total of 10 of the 11 criteria. Item one relates to external validity and was not used (see Appendix 3). The methodological quality of the papers in this review was assessed by one reviewer.

Seven of the PEDro scale criteria relate to internal validity (criteria 2, 3, 5, 6, 7, 8, and 9). Previous authors have suggested that an internal validity score (IVS) can be summated for heterogeneous studies under review to allow a qualitative assessment of the evidence (Ellis, Hing, & Reid, 2007; Reid et al., 2012), when a quantitative analysis would be otherwise difficult when the RCTs may not be employing like interventions. The following levels were used to interpret the overall strength of the evidence (Ellis et al., 2007; Reid et al., 2012);

- level 1 – strong evidence provided by generally consistent findings in multiple RCTs of high quality (IVS≥6);
- level 2 – moderate evidence provided by generally consistent findings in one RCT of high quality (IVS≥6) and one or more lower quality RCTs (IVS≤5);
- level 3 – limited evidence provided by generally consistent findings in one RCT of moderate quality (IVS=4-5) and one or more low quality RCT (IVS≤3);
- level 4 – insufficient evidence provided by generally consistent findings of one or more RCTs of limited quality (IVS≤3), no RCTs available, or conflicting results.

Previous authors (Ellis et al., 2007; Reid et al., 2012), have outlined a qualitative framework for the IVS derived from the PEDro scale. An IVS between: 6 and 7 suggests a study of high methodological quality; 4 and 5 suggests a study of moderate quality; and 0 and 3 suggests a study of limited quality. 'Consistent findings' was defined as ≥75% of the trials reporting a similar trend in findings from the main outcome measures (Reid et al., 2012).

2.5.2.3 Selection of studies

The search with an emphasis on the treatment of neck pain with manual therapy or exercise intervention yielded 173 potentially eligible studies. Following the exclusion process, 22 RCTs were selected for critical review (Figure 5). Of these 13 (Table 2) had an emphasis on manual therapy treatment and 9 (Table 3) had an emphasis on exercise intervention. The search with an emphasis on manual therapy treatment for headache yielded 30 potentially eligible studies (Figure 6). Following the exclusion, process 5 RCTs were selected for critical review (Table 4). The selection of studies for review was conducted by a single reviewer.

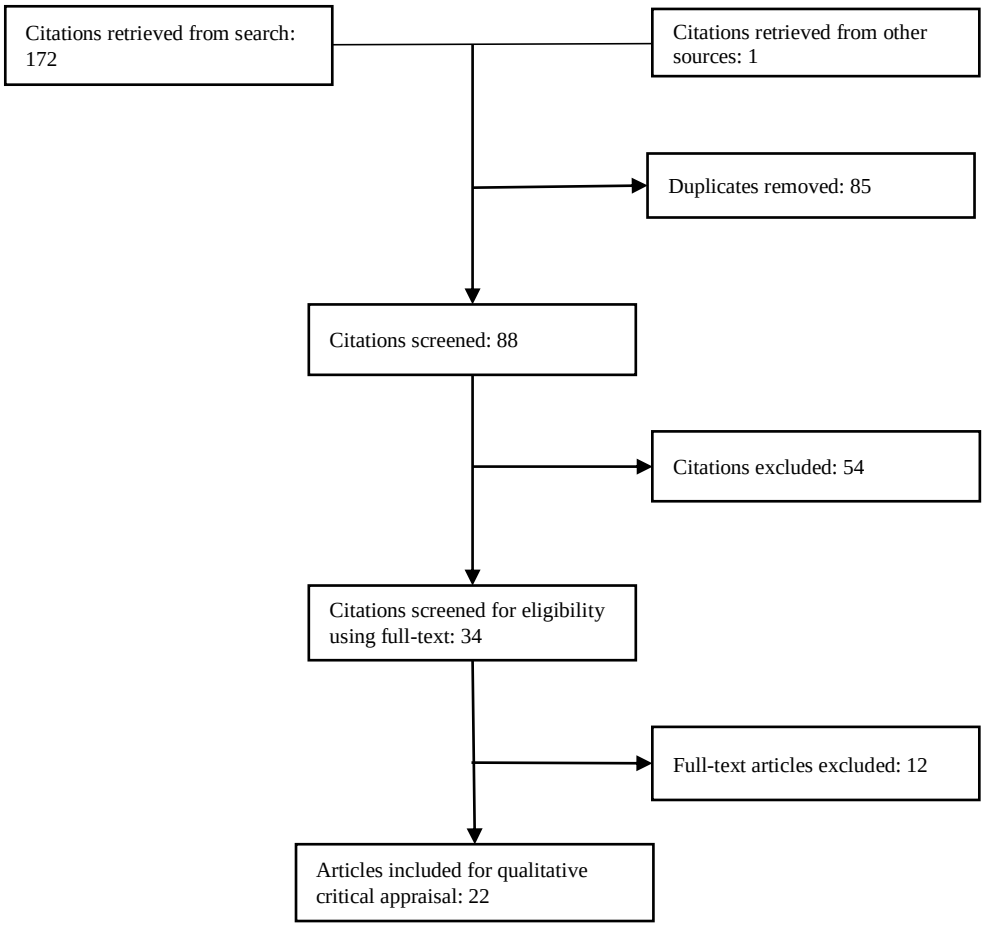


Figure 5 PRISMA flow diagram of article retrieval and selection of randomized trials for the treatment of neck pain with manual therapy or exercise intervention.

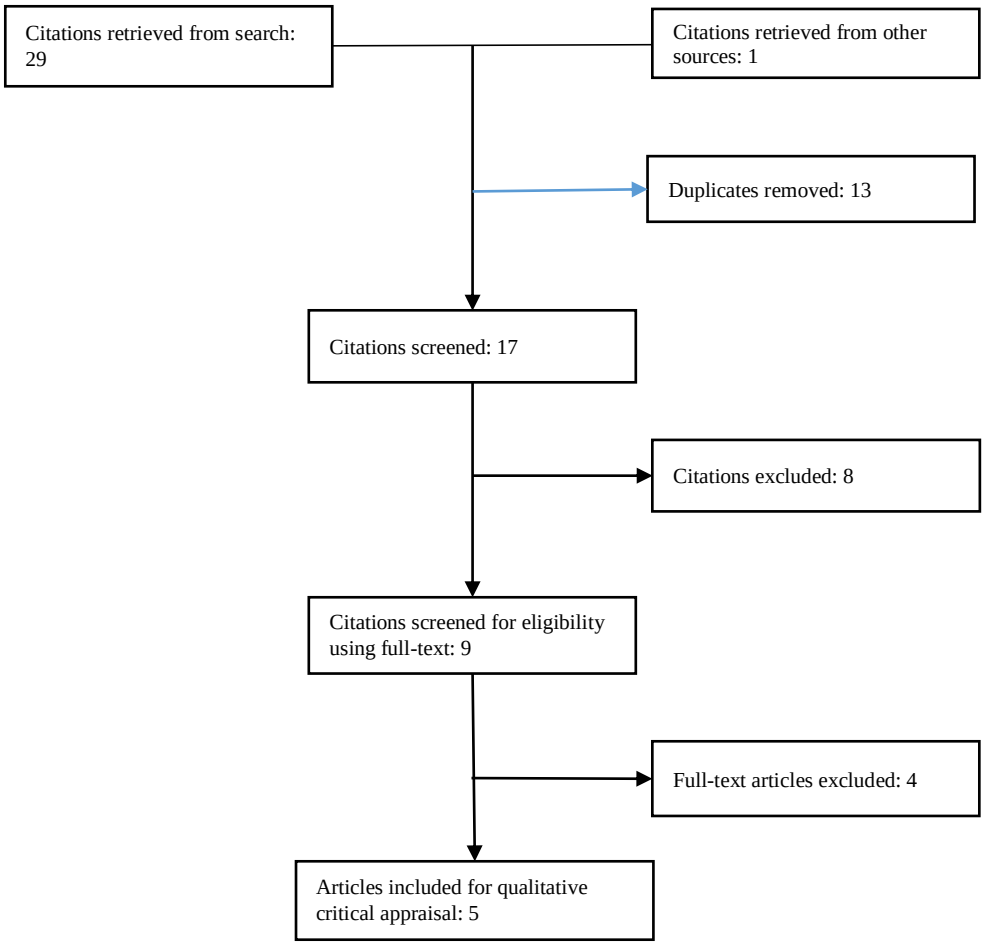


Figure 6 PRISMA flow diagram of article retrieval and selection of randomized trials of manual therapy with an emphasis on treatment of headaches.

2.5.2.4 Methodological quality

The methodological quality of the selected RCTs have been presented in three tables; Table 2 presents a detailed analysis of the methodological quality of each paper with an emphasis on manual therapy treatment for neck pain Table 3 presents a detailed analysis of the methodological quality of each paper with an emphasis on exercise intervention for neck pain, and Table 4 presents a detailed analysis of the methodological quality of each paper with an emphasis on manual therapy treatment of headaches using the PEDro, MQS, and IVS rating scales. These RCTs were selected and assessed by a single reviewer. The mean MQS for the reviewed studies with an emphasis on: manual therapy treatment for neck pain was 7.5/10 (range 6-9); exercise intervention for neck pain was 7.2/10 (range 6-8); and treatment of headaches with manual therapy was 7.6/10 (range 6-9). As expected for studies investigating manual therapy interventions (Bryans et al., 2014), blinding of participants and care providers was difficult (or not possible) for most of the studies under review.

Out of the 27 studies under critical review, only two of the RCTs with an emphasis on manual therapy treatment for neck pain stated blinding of participants (Casanova-Méndez et al., 2014; Snodgrass, Rivett, Sterling, & Vicenzino, 2014), along with two of the RCTs with an emphasis on treatment of headaches (Espi-Lopez & Gomez-Conesa, 2014; Shin & Lee, 2014). None of the 27 RCTs met criterion 6, which relates to therapist blinding. All of the studies in this critical review satisfied the PEDro criteria 2, 4, 8, 10, and 11 relating to random allocation of participants, groups being similar at baseline, measures of at least one key outcome being reported, the results of between-group statistical comparisons being reported for at least one key outcome, and both point measures and measures of variability for at least one key outcome being reported. In regards to assessor blinding; one of the studies with an emphasis on manual therapy treatment for neck pain failed to meet the criterion (Masaracchio, Cleland, Hellman, & Hagins, 2013); three of the studies with an emphasis on exercise intervention for neck pain failed to meet the criterion (Andersen et al., 2012; Borisut, Vongsirinavarat, Vachalathiti, & Sakulsriprasert, 2013; Lidegaard et al., 2013); and three of the studies with an emphasis on treatment of headaches failed to meet the criterion (Berggreen, Wiik, & Lund, 2012; Shin & Lee, 2014; Youssef & Shanb, 2013).

There was a moderate level of evidence (level 1-2) for the effectiveness of manual therapy treatment for neck pain to reduce pain and improve disability. This result is based on the qualitative analysis described above where two studies were of high quality (IVS≥6), ten studies were of moderate quality (IVS=4-5) and one study was of low quality (IVS≤3) (Table 2). Seventy-seven percent of the studies of manual therapy treatment for neck pain were in favour of the intervention. This meets the 75% consistency trend favouring the intervention. There was limited evidence (level 3) for the effectiveness of exercise intervention for neck pain to reduce pain and improve disability. This result is based on there being eight studies of moderate quality (IVS=4-5) and one study of low quality (IVS≤3) (Table 3). Eighty-nine percent of the studies of exercise intervention for neck pain were in favour of the intervention, and this meets the 75% consistency trend favouring the intervention. There was moderate evidence (level 2) for the effectiveness of manual therapy treatment for headaches to reduce pain and improve disability. This result is based on there being one study of high quality (IVS≥6), three studies of moderate quality (IVS=4-5) and one study of low quality (IVS≤3) (Table 4). One hundred percent of the studies of manual therapy treatment for headaches were in favour of the intervention, and this again meets the 75% consistency trend favouring the intervention.

Table 2 PEDro scores of randomised controlled trials investigating manual therapy treatment for neck pain

Reference	PEDro Criteria											MQS		IVS
Author Name (Year)	2	3	4	5	6	7	8	9	10	11				
(Casanova-Méndez et al., 2014)	1	1	1	1	0	1	1	1	1	1		9		6
(Snodgrass et al., 2014)	1	1	1	1	0	1	1	1	1	1		9		6
(Martinez-Segura, de-la-Llave-Rincon, Ortega-Santiago, Cleland, & Fernandez-de-las-Penas, 2012)	1	1	1	0	0	1	1	1	1	1		8		5
(Saavedra-Hernández et al., 2013)	1	1	1	0	0	1	1	1	1	1		8		5
(Saavedra-Hernández et al., 2012)	1	1	1	0	0	1	1	1	1	1		8		5
(Dunning et al., 2012)	1	0	1	0	0	1	1	1	1	1		7		4
(Evans et al., 2012)	1	0	1	0	0	1	1	1	1	1		7		4
(Bronfort et al., 2012)	1	0	1	0	0	1	1	1	1	1		7		4
(Lluch et al., 2014)	1	0	1	0	0	1	1	1	1	1		7		4
(Maiers et al., 2014a)	1	0	1	0	0	1	1	1	1	1		7		4
(Masaracchio et al., 2013)	1	1	1	0	0	0	1	1	1	1		7		4
(Salom-Moreno et al., 2014)	1	0	1	0	0	1	1	1	1	1		7		4
(Izquierdo Pérez et al., 2014)	1	0	1	0	0	1	1	0	1	1		6		3

1 = Criterion satisfied; 0 = Criterion not satisfied; MQS = Methodological Quality Score (out of 10); IVS = Internal Validity Score (out of 7); For Criteria, see Appendix 3

Table 3 PEDro scores of randomised controlled trials investigating exercise interventions for neck pain

	PEDro Criteria											MQS		IVS
Author Name (Year)	2	3	4	5	6	7	8	9	10	11				
(Cramer et al., 2013)	1	1	1	0	0	1	1	1	1	1		8		5
(Falla, Lindstrøm, Rechter, Boudreau, & Petzke, 2013)	1	1	1	0	0	1	1	1	1	1		8		5
(Gram et al., 2014)	1	1	1	0	0	1	1	1	1	1		8		5
(Andersen et al., 2012)	1	1	1	0	0	0	1	1	1	1		7		4
(Borisut et al., 2013)	1	1	1	0	0	0	1	1	1	1		7		4
(McLean, Klaber Moffett, Sharp, & Gardiner, 2013)	1	0	1	0	0	1	1	1	1	1		7		4
(O'Leary, Jull, Kim, Uthaikhup, & Vicenzino, 2012)	1	0	1	0	0	1	1	1	1	1		7		4
(Salo et al., 2012)	1	0	1	0	0	1	1	1	1	1		7		4
(Lidegaard et al., 2013)	1	0	1	0	0	0	1	1	1	1		6		3
1 = Criterion satisfied; 0 = Criterion not satisfied; MQS = Methodological Quality Score (out of 10); IVS = Internal Validity Score (out of 7); For Criteria, see Appendix 3														

Table 4 PEDro scores of randomised controlled trials investigating manual therapy treatment for headaches

	PEDro Criteria											MQS		IVS
Author Name (Year)	2	3	4	5	6	7	8	9	10	11				
(Espi-Lopez & Gomez-Conesa, 2014)	1	1	1	1	0	1	1	1	1	1		9		6
(Espí-López et al., 2014)	1	1	1	0	0	1	1	1	1	1		8		5
(Shin & Lee, 2014)	1	1	1	1	0	0	1	1	1	1		8		5
(Youssef & Shanb, 2013)	1	1	1	0	0	0	1	1	1	1		7		4
(Berggreen et al., 2012)	1	0	1	0	0	0	1	1	1	1		6		3
1 = Criterion satisfied; 0 = Criterion not satisfied; MQS = Methodological Quality Score (out of 10); IVS = Internal Validity Score (out of 7) ; For Criteria, see Appendix 3														

Table 5 Key characteristics of randomised controlled trials investigating manual therapy treatment for neck pain

Article	Type	Gender distribution female(%f)	Mean age (years)	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Casanova-Méndez et al., 2014)	NSNP	43 (72%)	37.6	None	Dog-technique group (DTG) n= 30; TSP Toggle-Recoil group (TRG) n=30	DTG: supine thrust at T4 level. TRG: prone spring recoil at T4 level	Single intervention	**VAS** PPT CROM	- Immediate - 20 minutes	DTG ≈ TRG for improvements in pain intensity, tissue sensitivity, and ROM
(Snodgrass et al., 2014)	CNSNP	48 (75%)	33.4	Placebo n=21	Low Force MOB n=22; High Force MOB n=21	Low Force MOB applied to CSP High Force MOB applied to CSP Placebo received detuned laser treatment	Single intervention	**PPT** VAS CROM Spinal Stiffness	- Immediate - 4 days	For pain intensity after 4-days: High force MOB > Low force MOB or Placebo For spinal stiffness after 4-days: High force MOB > Placebo
(Martinez-Segura et al., 2012)	CMNP	46 (51%)	36.3	None	CSP HVLA Right n=29; CSP HVLA Left n=28; TSP HVLA n=33	CSP HVLA applied supine to C3/4 TSP HVLA applied supine to T1-4	Single intervention	**PPT** NRS CROM	Immediate	CSP HVLA ≈ TSP HVLA
(Saavedra-Hernández et al., 2013)	CMNP	41 (50%)	44.5	None	CSP HVLA n=41; Full HVLA n=41	CSP HVLA: mid CSP HVLA. Full HVLA: mid CSP HVLA, cervico-thoracic junction HVLA, and upper TSP HVLA	Single intervention	**NRS** NDI CROM	- 1 week	For disability at 1-week: Full HVLA > CSP HVLA For pain intensity and ROM at 1-week: Full HVLA ≈ CSP HVLA
(Saavedra-Hernández et al., 2012)	CMNP	36 (45%)	45.0	None	CSP HVLA n=40; Taping n=40	CSP HVLA: mid CSP HVLA Taping: kinesio tape applied to CSP	Single intervention	**NRS** NDI CROM	- 1 week	For rotation at 1-week: CSP HVLA > Taping For pain intensity and disability at 1-week: CSP HVLA ≈ Taping
(Dunning et al., 2012)	MNP	73 (68%)	42.0	None	HVLA thrust manipulation n=56; Non-thrust MOB n=51	HVLA applied supine to CSP and TSP. MOB applied prone to CSP and TSP.	Single intervention	**NDI** NRS CROM GROC CCFT FRT	- 48 hours	HVLA > MOB for pain intensity and disability and also ROM

Article	Type	Gender distribution female(%f)	Mean age (years)	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Evans et al., 2012)	CNP	195 (72%)	46.3	None	ET + SMT n=91; ET n=89; HEA n=90	ET: supervised exercise therapy ET + SMT: exercise therapy with HVLA HEA: home exercise routine.	12 week intervention period – patients required to attend at least 80% of their scheduled visits	NRS NDI SF-36 CROM Medication use GROC Isometric strength Static & Dynamic Endurance	- 4 weeks - 12 weeks - 26 weeks - 52 weeks	At 12 weeks: ET + SMT or ET > HEA for pain intensity, global perceived effect, and satisfaction
(Bronfort et al., 2012)	NSNP	178 (65%)	47.9	None	SMT n=91; MED n=90; HEA n=91	SMT: main treatment either HVLA or MOB MED: received prescriptions from GP HEA: regular daily exercise	12 week intervention	**NRS** NDI Global improvement Satisfaction with care SF-36 CROM (at 4 and 12 weeks) Medication use	During intervention - 2 weeks - 4 weeks - 8 weeks - 12 weeks Post intervention - 26 weeks - 52 weeks	SMT > MED at 12 weeks for pain intensity
(Lluch et al., 2014)	CNSNP	15 (83%)	42.0	None	CCF Exercise n=9; MOB + CCF n=9	CCF Exercise patients supine. MOB + CCF assisted exercise patients supine	Single intervention	**NRS** CROM PPT EMG of SCM, AS and splenius capitis muscles during CCFT	Immediate	CCF Exercise ≈ MOB + CCF for pain at rest. CCF Exercise > MOB + CCF for pain on movement, tissue sensitivity, and motor function.

Article	Type	Gender distribution female(%f)	Mean age (years)	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Maiers et al., 2014a)	CNP	113 (47%)	72.3	HEA n=79	SMT + HEA n=80; SRE + HEA n=82	HEA:. Simple individualised exercises were prescribed to do daily at home, to improve flexibility, balance, and coordination, as well as enhance trunk strength and endurance. SMT + HEA: HEA as described above. Plus chiropractic SMT using either HVLA or MOB. SRE + HEA: HEA as described above. Plus and an extension of the HEA with supervised exercises.	12 week intervention period	**NRS** NDI SF-36 Satisfaction with care Global improvement Medication use CSP motion Cervical isometric flexion & extension strength	- 4 weeks -12 weeks - 26 weeks - 52 weeks	For pain intensity at 12 weeks: SMT + HEA > SRE + HEA SMT + HEA > HEA For satisfaction with care at 12 weeks: SMT + HEA > HEA Generally: SRE + HEA ≈ HEA
(Masaracchio et al., 2013)	MNP	50 (76%)	32.5	None	Comparison group n=32; Experimental group n=34	Comparison group: CSP MOB and exercise Experimental group: same as Comparison group plus TSP HVLA	Day 1; Day 3-4;	**NRS** NDI GROC	- 1 week	For pain intensity, and GROC at 1-week: Experimental group > Comparison group
(Salom-Moreno et al., 2014)	CMNP	22 (42%)	33.0	None	TSP HVLA n=27; TSP MOB n=25	TSP HVLA applied to mid TSP. TSP MOB applied to mid TSP	Single intervention	**PPT** NRS	Immediate	For pain intensity TSP HVLA > TSP MOB
(Izquierdo Pérez et al., 2014)	MNP	26 (51%)	36.5	None	HVLA n=19; MOB n=21; SNAG n=21	HVLA applied supine to CSP MOB applied prone to CSP SNAG applied seated	2 weeks – 4 sessions each patient.	VAS NDI CROM active GROC	- Immediate after last treatment - 1 month - 2 months - 3 months	HVLA ≈ MOB ≈ SNAG

Abbreviations
'>' = better than in terms of study result CNP = Chronic Neck Pain MNP = Mechanical Neck Pain CMNP = Chronic MNP NSNP = Non-Specific Neck Pain CNSNP = Chronic NSNP CCF = Cranio-Cervical Flexion EMG = Electromyography
HVLA = High Velocity Low Amplitude MOB = Mobilisation SNAG = Sustained Natural Apophyseal Glide VAS = Visual Analogue Scale NRS = Numeric Rating Scale NDI = Neck Disability Index
CROM = Cervical Range of Motion GROC = Global Rating of Change CSP = Cervical Spine TSP = Thoracic Spine MCID = Minimal Clinically Important Difference ET = Exercise Therapy
SMT = Spinal Manipulation Therapy HEA = Home Exercise & Advice SF-36 = Medical outcomes study 36-Item short form health survey SRE = Supervised Rehabilitative Exercise
CCFT = Cranio-Cervical Flexion Test AS = anterior scalene muscle SCM = sternocleidomastoid muscle PPT = Pressure Pain Threshold MDC = Minimal Detectable Change FRT = Flexion-Rotation Test

Table 6 Key characteristics of randomised controlled trials investigating exercise intervention for neck pain

Article	Type	Gender distribution female(%f)	Mean age	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Cramer et al., 2013)	CNSNP	42 (82.4%)	47.8	None	Yoga (n=25); Exercise (n=26)	Yoga weekly yoga classes with fixed routine. Exercise group given a home exercise program	Yoga: attended a mean of 6 ± 2.3 yoga classes, and practiced at home for 45 ± 35 minutes per week. Exercise: practiced at home for 53 ± 39 minutes per week.	**VAS** NDI SF-36 CROM VAS with movement JPE PPT (at 3 locations) A diary of adherence	- 9 weeks	For pain intensity after 9 weeks: Yoga > Exercise
(Falla et al., 2013)	CNP	46 (100%)	38.8	Control n=23	Training n=23	Training supervised CCF exercises	8 weeks 10-20 min/day	**NDI** VAS SF-36 PSFS FABQ EMG of SCM and splenius capitis	- 8 weeks	For disability and pain intensity after 8-weeks: Training > Control
(Gram et al., 2014)	NSNP	218 (62%)	45.6	REF n=101	3WS n=126; 3MS n=124	REF: no training 3WS maximally supervised high-intensity strength training 3MS: minimally supervised high-intensity strength training	20 weeks	**Nordic questionnaire** Headache characteristics Headache Duration	- 20 weeks	For pain intensity (neck/shoulder/headache) after 20-weeks: 3WS or 3MS > REF 3WS ≈ 3MS
(Andersen et al., 2012)	NSNP	279 (62%)	46	REF n=101	1WS n=116; 3WS n=126; 9WS n=106	REF: no training 1WS:1x60 min a week of supervised high-intensity strength training. 3WS: 3x20 min a week of supervised high-intensity strength training. 9WS: 9x7 min a week of supervised high-intensity strength training.	20 weeks	**NRS** DASH Muscle strength Adherence	- 20 weeks	For pain intensity after 20 weeks: 1WS or 3WS or 9WS > REF

Article	Type	Gender distribution female(%f)	Mean age	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Borisut et al., 2013)	CNP	100 (100%)	30.6	Control n=25	Strength n=25; CCF Exercise n=25; Combined n=25	Strength: strength and endurance exercises CCF Exercises utilised Combined: both the strength-endurance and the CCF exercises.	12 weeks	**VAS** NDI EMG of upper trapezius, CES, SCM, AS	- 12 weeks	For pain intensity and disability at 12-weeks: Strength or CCF Exercise or Combined > Control
(McLean et al., 2013)	NSNP	90 (60%)	53.8	None	Graded Exercise Treatment (GET) n=75; Usual Physiotherapy (UP) n=76	GET: exercise prescription UP: usual care from physiotherapists	6 weeks	**NPQ** DASH	- 6weeks - 26 weeks - 52 weeks	At all follow-up time points (6, 26, and 52 weeks) in terms of pain intensity and disability: GET ≈ UP
(O'Leary et al., 2012)	CMNP	35 (58%)	37.9	Active Mobility training (AMTr) n=20	Endurance training (ETr) n=20; Coordination training (CTr) n=20	AMTr: active movement exercises in upright posture CTr: training of flexor muscles in supine ETr: trained in upright posture. Participants in the CTr and ETr groups also performed the same exercises as the AMTr group.	10 weeks Weekly for first 6 weeks followed by a 2 week review at 8 weeks	Isometric CCF-strength and endurance CCFT EMG of SCM and AS CROM VAS NDI	- 10 weeks - 26 weeks	In terms of cervical flexor muscle endurance at 10-weeks: ETr > CTr or AMTr And at 26-weeks: ETr > AMTr For coordination of movement at 10- and 26-weeks: CTr > ETr or AMTr For pain and disability at both time points: AMTr ≈ ETr ≈ CTr
(Salo et al., 2012)	CNP	91 (90%)	41.0	Stretching-exercise group (SG) n=52	Combined Strength-training and Stretching-exercise group (CSSG) n=49	CSSG: combined strength training and stretches focused on neck, shoulders and upper extremities. SG: Performed the same stretching exercises as the CSSG.	12-months	**RAND-36** (HRQoL Finnish version of SF-36) Training adherence	-12 months	At 12 months for all dimensions: SG ≈ CSSG

Article	Type	Gender distribution female(%f)	Mean age	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Lidegaard et al., 2013)	CNP	30 (100%)	41.0	Control n=15	Training n=15	Training: daily at work exercises Control: weekly email	10 weeks	**EMG of upper trapezius and splenius capitis**	- 10 weeks	For pain intensity and muscle relaxation after 10-weeks: Training > Control

Abbreviations
'>' = better than in terms of study result CNP = Chronic Neck Pain CMNP = Chronic MNP NSNP = Non-Specific Neck Pain CNSNP = Chronic NSNP PSFS = Patient Specific Function Scale CCF = Cranio-Cervical Flexion CCFT = CCF Test
FABQ = Fear Avoidance Belief Questionnaire EMG = Electromyography HRQoL = Health related quality of life VAS = Visual Analogue Scale NRS = Numeric Rating Scale NDI = Neck Disability Index
CROM = Cervical Range of Motion SF-36 = Medical outcomes study 36-Item short form health survey NPQ = Northwick Park Neck Pain Questionnaire PPT = Pressure Pain Threshold AS = anterior scalene muscle
DASH = Disabilities of Arm, Shoulder and Hand Questionnaire JPE = Joint Position Error SCM = sternocleidomastoid muscle CES = cervical erector spinae muscle

Table 7 Key characteristics of randomised controlled trials investigating manual therapy treatment for headaches

Article	Type	Gender distribution female(%f)	Mean age	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Espi-Lopez & Gomez-Conesa, 2014)	TTH	68 (81%)	39.7	Control n=22	Manual therapy group n=20; Manipulation group n=22; Combination group n=20	Manual therapy group: soft-tissue inhibition supine to suboccipital muscles. Manipulation group: bilateral HVLA to occiput-atlas-axis. Combination group: received both the soft-tissue inhibition and the HVLA. Control: lying supine for 10 min.	4 weeks – 1 treatment per week	**MPQ** (Spanish version) CROM Frequency of headache Headache intensity (NRS)	- Immediate after last treatment - 1 month	For all 5 dimensions of the MPQ and cervical rotation after 4 weeks: Manual therapy group ≈ Manipulation group ≈ Combination group > Control
(Espí-López et al., 2014)	TTH	68 (81%)	39.7	Control n=22	Manual therapy group n=20; Manipulation group n=22; Combination group n=20	Manual therapy group: soft-tissue inhibition supine to suboccipital muscles. Manipulation group: bilateral HVLA to occiput-atlas-axis. Combination group: received both the soft-tissue inhibition and the HVLA. Control: lying supine for 10 min.	4 weeks – 1 treatment per week	Headache Impact Test-6 (HIT-6) Headache Disability Inventory (HDI-Spanish version) Headache intensity (VAS) CROM Headache diary – frequency, intensity and pericranial tenderness	- Immediate after last treatment - 1 month	For the impact of headache (HIT-6) after 4-weeks: Manipulation group or Combination group > Manual therapy group or Control For disability associated with headache after 4-weeks: No significant differences between all groups
Article	Type	Gender distribution female(%f)	Mean age	Control Group	Experimental Group/s	Intervention	Frequency	Assessment post-intervention	Follow-up	Results
(Shin & Lee, 2014)	CGH	40 (100%)	48.1	Control n=20	SNAG group n=20	SNAG group: Mulligan SNAG Control: placebo SNAG	4 weeks – 3 times per week	**VAS – headache intensity** Headache duration NDI	- Immediate after last treatment	For headache intensity, duration and neck disability after 4-weeks: SNAG > Control

(Youssef & Shanb, 2013)	CGH	16 (42%)	31.7	None	CSP MOB n=20; Massage n=18	CSP MOB: Upper cervical MOB Massage: Standardised regime	6 weeks – 2 sessions (30-40 min) per week	Headache intensity (VAS) Headache frequency Headache duration NDI CROM	- Immediate after last treatment	For headache intensity, frequency, and duration after 6-weeks: CSP MOB > Massage
(Berggreen et al., 2012)	CTTH	39 (100%)	40.5	Control n=19	Treatment n=20	Control: no treatment Treatment: based on location of TrPs, all active TrPs were treated with myofascial massage, including 2-5 minutes ischemic compression for each TrP,	10 weeks 1 session treatment per week	**VAS morning** VAS evening VAS inconvenience Number TrPs Medication use MPQ SF-36	- Immediate after last treatment - 4 weeks (for VAS and Medicine use)	For pain intensity and number of TrPs after 10-weeks: Treatment > Control For Medication use, and disability after 10-weeks: Treatment ≈ Control

Abbreviations
'>' = better than in terms of study result CTTH = Chronic Tension-Type Headache TTH = Tension-Type Headache CGH = Cervicogenic Headache TrP = Trigger Point HVLA = High Velocity Low Amplitude MOB = Mobilisation
SNAG = Sustained Natural Apophyseal Glide VAS = Visual Analogue Scale NDI = Neck Disability Index CROM = Cervical Range of Motion CSP = Cervical Spine NRS = Numeric Rating Scale
SF-36 = Medical outcomes study 36-Item short form health survey MPQ = McGill's Pain Questionnaire

2.5.3 Study characteristics

The key characteristics of the studies are presented in three tables: Table 5 presents each paper with an emphasis on manual therapy treatment for neck pain; Table 6 presents each paper with an emphasis on exercise intervention for neck pain; and Table 7 presents each paper with an emphasis on manual therapy treatment of headaches.

2.5.3.1 Participants

For the studies with an emphasis on manual therapy treatment for neck pain a total of n=1408 participants were recruited with a mean age range from 32.5 to 72.3 years. The majority of these participants were females (range 42-83%). For the studies with an emphasis on exercise intervention for neck pain a total of n=1339 participants were recruited with a mean age ranged from 30.6 to 53.8 years. The majority of these participants were females (range 58-100%). For the studies with an emphasis on manual therapy treatment for headaches a total of n=285 participants were recruited with a mean age ranged from 31.7 to 48.1 years. The majority of these participants were females (range 42-100%).

2.5.3.2 Interventions

The manual therapy studies compared a variety of interventions. All 13 studies investigated spinal manipulation or mobilisation, and together involved n=851 participants in the intervention groups and n=557 participants in the comparison groups. The duration and frequency of the interventions ranged from a single intervention applied once up to a 12-week period with up to 20 sessions of the intervention allowed. The follow-up period ranged in time from an immediate follow-up up to 52-weeks. Overall there was moderate evidence in support of spinal manipulation based on the results of eleven studies (Bronfort et al., 2012; Casanova-Méndez et al., 2014; Dunning et al., 2012; Evans et al., 2012; Izquierdo Pérez et al., 2014; Maiers et al., 2014b; Martinez-Segura et al., 2012; Masaracchio et al., 2013; Saavedra-Hernández et al., 2013; Saavedra-Hernández et al., 2012; Salom-Moreno et al., 2014). This suggests that for patients presenting with NSNP, spinal manipulation is a worthwhile intervention to consider. It should be noted that there was a great variety in the application of the manipulations. Four of the studies investigated the effects of spinal manipulation for NSNP with a pragmatic approach that allowed the treating practitioner to choose the spinal segments they judged most appropriate to manipulate. In two of these four studies the treating practitioner applied thrust interventions to both the cervical and

thoracic spine regions (Bronfort et al., 2012; Evans et al., 2012), and in the other two studies the practitioner applied the thrust intervention to the cervical spine only (Izquierdo Pérez et al., 2014; Maiers et al., 2014b). Five of the remaining studies investigated the effects of spinal manipulations for NSNP applied to predetermined cervical and thoracic levels (Dunning et al., 2012; Martinez-Segura et al., 2012; Masaracchio et al., 2013; Saavedra-Hernández et al., 2013; Saavedra-Hernández et al., 2012), and two studies investigated spinal manipulation applied to a predetermined thoracic level (Casanova-Méndez et al., 2014; Salom-Moreno et al., 2014). For spinal mobilisation there was limited evidence in support of the intervention from one study investigating the effects of the pragmatic application of mobilisation in the cervical spine for NSNP (Snodgrass et al., 2014), and equivocal evidence reported by one study investigating the effects of a predetermined application of mobilisation to the cervical spine (Lluch et al., 2014).

In the nine studies investigating exercise interventions for the treatment of neck pain, there were a total of n=1002 participants in the intervention groups. The duration and frequency of the interventions ranged from daily interventions applied for a 10-week intervention period, up to a 52-week period. The follow-up period ranged in time from an immediate post intervention period of follow-up, up to 52-weeks. Seven out of the nine studies provided limited evidence in support of the exercise protocol to reduce pain or improve self-reported disability (Andersen et al., 2012; Borisut et al., 2013; Cramer et al., 2013; Falla et al., 2013; Gram et al., 2014; Lidegaard et al., 2013; O'Leary et al., 2012), and the two remaining studies reported equivocal evidence (McLean et al., 2013; Salo et al., 2012). This suggests that exercise therapy may be a useful intervention to employ for patients with NSNP.

In terms of the studies reporting evidence on manual therapy interventions for headache with neck pain, a total of n=202 participants received an intervention. The interventions applied in the studies investigating manual therapy for patients with headaches were varied and included trigger point therapy (Berggreen et al., 2012), manipulation of a predetermined level and soft-tissue massage (Espi-Lopez & Gomez-Conesa, 2014; Espí-López et al., 2014), sustained natural apophyseal glides (Shin & Lee, 2014), and mobilisation (Youssef & Shanb, 2013). The duration and frequency of the interventions ranged from interventions applied three times per week for a four-week intervention

period, up to weekly interventions for a ten-week period. The follow-up period concluded for all studies immediately after the completion of the intervention period.

2.5.3.3 Control groups

Only one out of the thirteen manual therapy studies had a control group. Five out of the nine exercise intervention studies had a control group. Likewise, four out of the five headache studies had control groups. All other studies made comparisons between groups receiving some form of active intervention.

2.5.3.4 Outcome measures

There were a variety of outcome measures employed across the studies including pain intensity, pressure pain threshold, disability, and function. The pain intensity measurement instruments included the Numeric Rating Scale (Andersen et al., 2012; Bronfort et al., 2012; Dunning et al., 2012; Evans et al., 2012; Lluch et al., 2014; Maiers et al., 2014b; Martinez-Segura et al., 2012; Masaracchio et al., 2013; Saavedra-Hernández et al., 2013; Saavedra-Hernández et al., 2012; Salom-Moreno et al., 2014), the Visual Analog Scale used to assess levels of neck pain (Borisut et al., 2013; Casanova-Méndez et al., 2014; Cramer et al., 2013; Falla et al., 2013; Izquierdo Pérez et al., 2014; O'Leary et al., 2012; Snodgrass et al., 2014) and headache intensity (Berggreen et al., 2012; Espí-López et al., 2014; Shin & Lee, 2014; Youssef & Shanb, 2013), the McGill Pain Questionnaire(Berggreen et al., 2012; Espi-Lopez & Gomez-Conesa, 2014), and the Northwick Park Pain Questionnaire. Pressure pain thresholds were assessed using algometry. Disability measurement instruments included the Neck Disability Index, the Medical Outcomes Study 36-Item short form health survey (English and Finnish versions), the Disabilities of Arm, Shoulder and Hand Questionnaire, and the Headache Disability Index. Instruments used to assess function included; the Nordic Questionnaire, the Patient Specific Function Scale, the Headache Impact Test-6, Electromyography, and cervical range of motion.

2.5.4 Discussion

Similar to previous systematic reviews undertaken investigating the benefits of manual therapy in the management of neck pain, it has been shown with this review that there is moderate evidence to support a multimodal approach. This concurs with published guidelines from different professional bodies involved in providing manual therapy interventions in the management of neck pain.

Five systematic reviews investigating the evidence for manual therapy in the management of neck pain reported a range of evidence from 'no evidence' to 'good evidence' in support of the intervention. The systematic review by Takasaki and May (2014) reported there was no evidence that Mechanical Diagnosis and Therapy was of greater benefit than a 'wait-and-see' approach for the management of patients with neck pain. Huisman, Speksnijider and de Wijer (2013) reported limited evidence in support of thoracic spine manipulation with exercise therapy when compared to thoracic mobilisation with exercise therapy for the management of patients with neck pain. However, Huisman et al. (2013) found no evidence to support using thoracic spine manipulation instead of cervical spine manipulation, when considering perceived disability and pain intensity. Likewise, Young, Walker, Snyder et al. (2014) described variable quality evidence in support of thoracic spine manipulation in the management of mechanical neck pain, when considering pain intensity, range of motion, and perceived disability. Vincent, Maigne, and Fischoff (2013) reported moderate evidence in support of the short-term benefits associated with thoracic and cervical spine manipulations, and limited evidence in support of the medium to long-term benefits of cervical spine manipulation. A multimodal approach to care that includes spinal manipulation, exercise, and education was supported by good evidence reported by Sutton, Cote, Wong et al. (2014).

The Three systematic reviews with an emphasis on exercise in the management of neck pain provided 'good' evidence in support of a multimodal approach to care. The study by Bertozzi, Gardenghi, Turoni et al. (2013) reported evidence that supports the use of therapeutic exercise in the management of chronic NSNP. O'Riordan, Clifford, Van de Ven, and Nelson (2014) provided evidence supporting the use of a multimodal approach in the management of chronic neck pain, with benefits in terms of strength, improved function, health-related quality of life, and reduced pain intensity.

O’Riordan et al. (2014) reported that active strengthening exercise achieved all these outcomes, and the effect could be enhanced with the addition of stretching and aerobic exercise. Likewise, Southerst, Nordin, Cote et al. (2014) provided evidence in support of exercise programs with components focused on strengthening, range of motion, and flexibility for the management of neck pain. It could be inferred from the small effect sizes reported when exercise interventions are studied in isolation, that by combining them with other interventions that have small effect sizes, the overall effect might be magnified, such as is found in a multimodal approach.

Racicki, Gerwin, and Diclaudio et al. (2013) provided evidence in support of a multimodal approach that included mobilisation, manipulation, and cervico-scapular strengthening exercises, for the management of cervicogenic headache.

2.7 Summary

This review of the literature has offered a summary of the current research evidence for the treatment of NSNP by practitioners applying manual therapy and exercise interventions. The review highlighted the following key findings:

(1) A multimodal approach can be beneficial in the treatment of NSNP in the short and medium term;

(2) Multimodal approaches that employed spinal manipulation or mobilisation directed to the cervical and thoracic spine can be more advantageous than approaches that address only one region;

(3) While the short-term benefits of specific treatments applied to patients with neck pain have been demonstrated, long term advantageous changes in tissue sensitivity and neck disability have been less frequently reported;

(4) The heterogeneity of study participants has made it difficult to formulate concrete recommendations based on meta-analyses of RCTs,

(5) There have been similarities in the recommendations in clinical practice guidelines offered by the different professional bodies of various types of musculoskeletal therapists.

While there is a growing consensus published in the literature in regards to what constitutes best-practice for the management of NSNP, to date there have been a limited number of published reports analysing whether practitioners follow these guidelines in their typical daily practice. There have been attempts made by consensus groups to formulate algorithms that can assist and benefit the practitioner and patient. While these algorithms have been suggested and recommended in the literature, there have been no attempts made to analyse whether practitioners already follow a similarly structured approach to the administration of treatment interventions in their practice. Research is needed to address these gaps in knowledge.

3.0 CHAPTER THREE: METHODOLOGY

3.1 Questionnaire on neck pain patients

3.1.1 Introduction

A questionnaire was developed and administered online to survey the management practices of osteopaths and physiotherapists in relation to patients with neck pain. Data collection was conducted from September 2012 to April 2013. This research project was granted approval by the Auckland University of Technology Ethics Committee (AUTEC11/260).

3.1.2 Questionnaire development

The questionnaire was developed after a review of the literature on the management of neck pain (Chapter 2) provided insight into the recommendations made by previous guidelines and recent research literature that supports these guidelines. The key research questions were:

a) How are practitioners subgrouping patients presenting with neck pain as the primary complaint?
b) Do the groupings of patients by practitioners match a published treatment-based classification model for the management of neck pain?
c) Do the treatment techniques chosen by practitioners match those suggested in the literature for the subgroup that best fits their neck pain patient?
d) Are the treatment techniques being used by practitioners consistent with best practice guidelines or current best-evidence?
e) Are there differences in the treatment choices made by osteopaths and physiotherapists?
f) Does either group of practitioners appear to consider regionally interdependent structures in their management of neck pain patients?
g) Does one group of practitioners utilise more manipulative techniques when compared to the other?
h) Do practitioners apply a multimodal care approach as suggested in the literature?

The questionnaire items were designed to be appropriate for both osteopaths and physiotherapists involved in the manipulative therapeutic care of neck pain patients (MacDermid, Walton, Cote, et al., 2013).

By utilising the treatment-based classification algorithm proposed by Fritz and Brennan (2007), a questionnaire algorithm was developed to enable data gathering on the management of neck pain patients under the care of osteopaths and physiotherapists.

A pilot study was conducted at a tertiary teaching osteopathic health clinic based on patients of Master of Osteopathy students from December 2011 until February 2012. After initial pilot work, practitioners from both disciplines were asked to review the pilot questionnaire items and requirements of participation. Feedback was ascertained on the nature of the classification systems they were employing, if any, their impressions of the neck pain questionnaire, and the usefulness of an electronic system to input patient data for survey respondents. On review of the pilot data and after consultation with practitioners from both the osteopathic and physiotherapy professions, an online version of the survey was developed.

3.1.3 Online questionnaire refinement

An online version of the questionnaire was constructed using web-based software SurveyMonkey© (SurveyMonkey Inc., Palo Alto, California, USA www.surveymonkey.com). The web-based system allowed participating practitioners to access and complete the questionnaire via a web-link sent to their email address. The questionnaire was designed around the template for a treatment-based classification system algorithm described by Fritz and Brennan (2007). The questionnaire algorithm (Figure 7), was structured using a closed question format, involving ‘yes’ or ‘no’ responses, a multi-choice option for selecting interventions applied, and Likert-type responses for demographic questions relating to the patient in question. After the first draft of the online questionnaire was assessed for content, it was sent out to a small number of osteopaths and physiotherapists involved in tertiary teaching for expert review. Face validity was further established through expert review by a small group of practitioners from both the osteopathic and physiotherapy fields. Issues of time requirements and readability were deliberated. On receiving feedback from the reviewers, several small changes were made in order to improve clarity of some questions.

The final version of the online questionnaire for practitioners reporting on a patient presenting with neck pain was comprised of 11 questions (Figure 7). The style of questions provided categorical dichotomous (‘yes’, ‘no’) data for techniques applied by anatomical region (‘Cervical Spine’, ‘Thoracic Spine’). Demographic questions provided categorical and ordinal data respectively, on the ‘Presenting Complaint’ and ‘Age Bracket’ for patient Appendix 4.

When the respondents reached the conclusion of the algorithm they were asked to record all interventions applied to their neck pain patient. The intervention options available are shown in Figure 8. An ‘Other’ option was provided in the selection of treatment interventions to allow for specific responses that could not be adequately covered by the alternatives available. The questionnaire was designed in such a way as to blind the practitioners to the existence of theoretical sub-groups under investigation. The comparison of management approaches between osteopaths and physiotherapists could be investigated at a group level, and on a sub-group level in consideration of either technique applied, patient classification, or patient presentation.

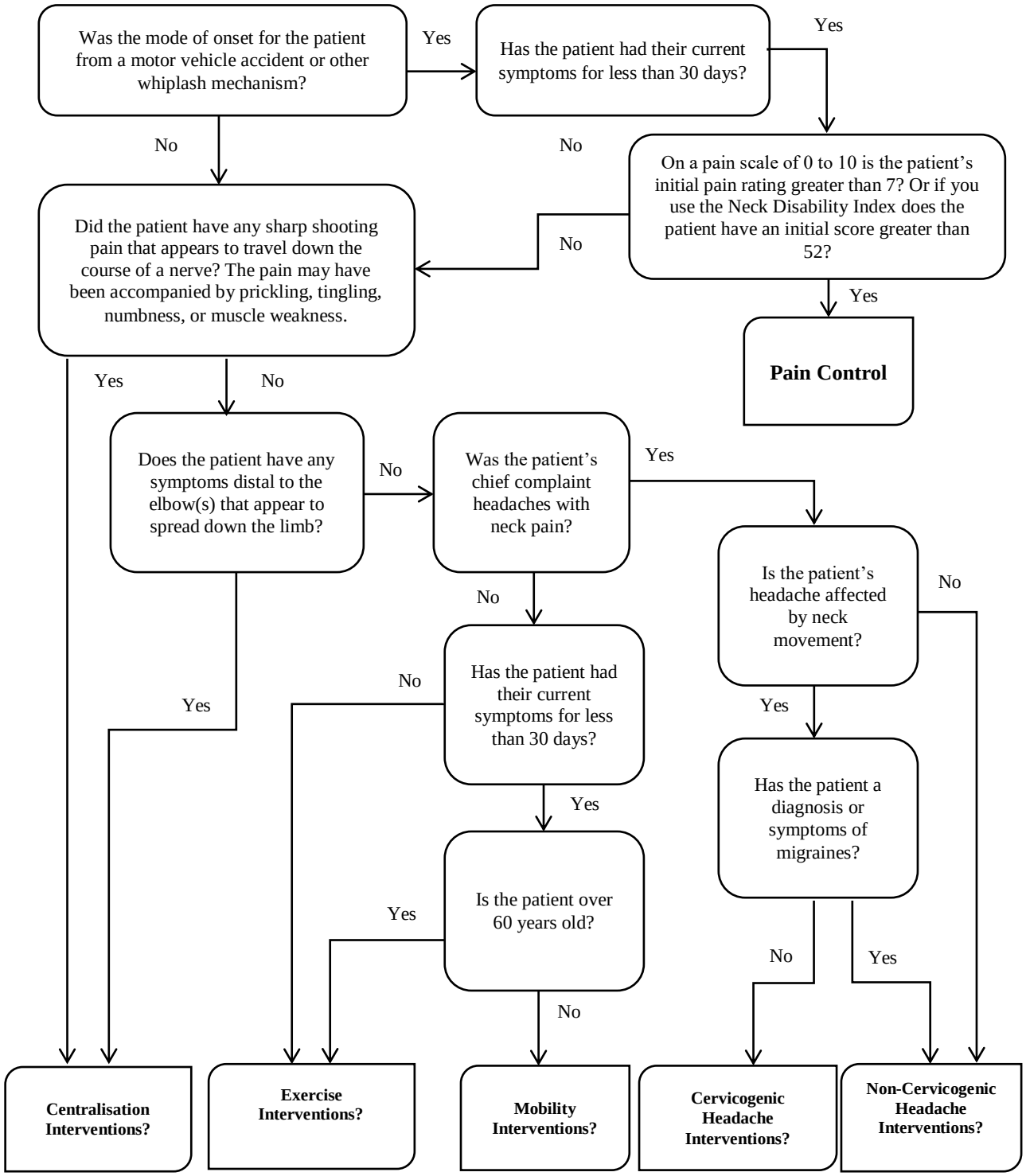


Figure 7 Survey Algorithm used for Patient Classification adapted from: Fritz & Brennan (2007)

To allow for the differences in profession specific terminology used to describe a variety of similar techniques utilised by osteopaths and physiotherapists the question designed to retrieve information on interventions applied allowed a broad range of choices (Figure 8). For each option the practitioner could select either the cervical and/or the thoracic spine regions.

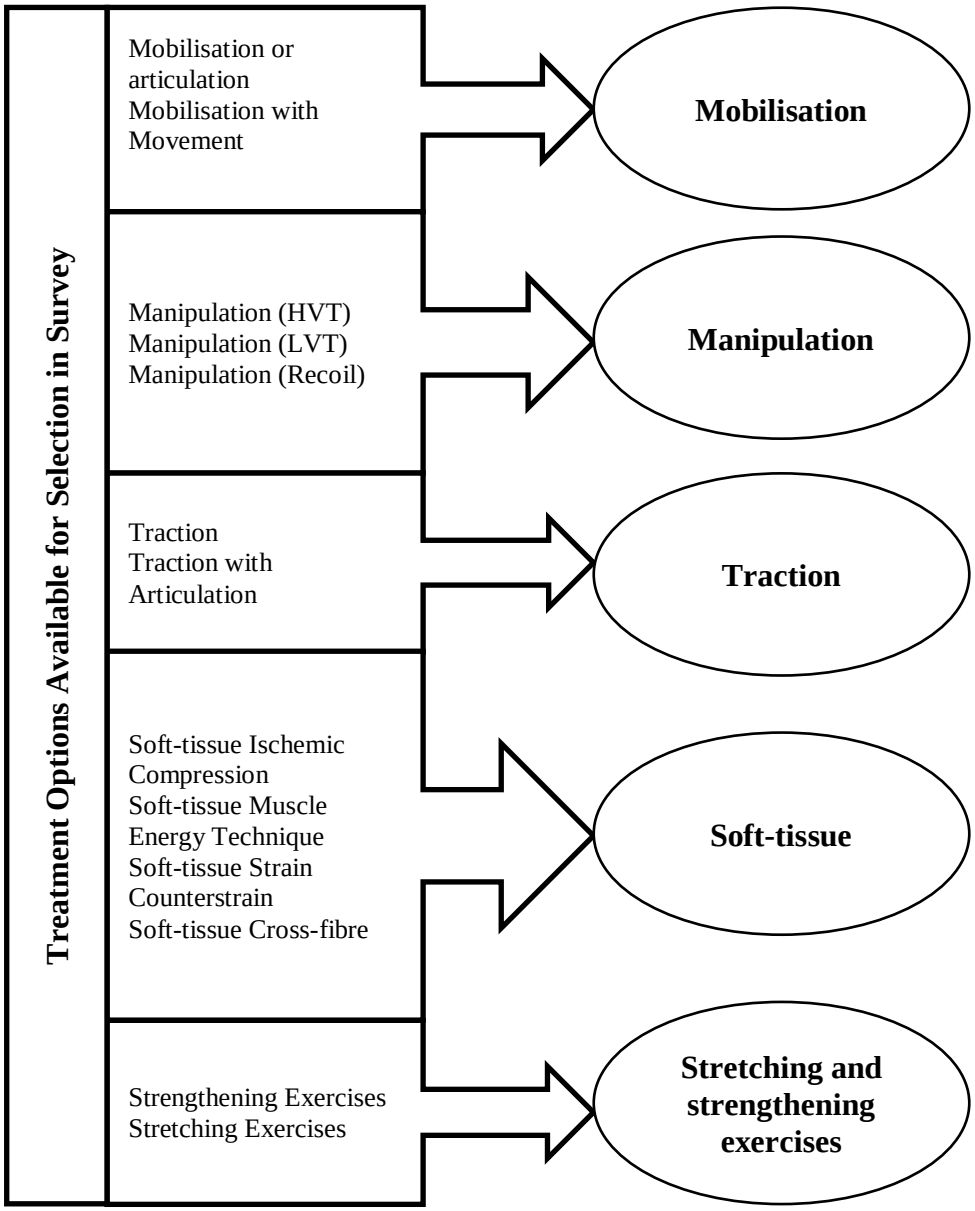


Figure 8 Amalgamation of Treatment Options

3.1.4 Survey administration

An email link to the neck pain questionnaire was distributed to various professional associations of Australian and New Zealand osteopaths and manipulative physiotherapists (Table 8). After the initial email inviting practitioners to participate in the survey, two follow-up emails were sent two months after the initial email and three months after the initial email. There was no identifying information regarding patients collected beyond gender and age bracket. Respondent practitioners were required to read participant information and click on a consent button before proceeding with the survey.

Table 8 Number of potential recipients of email link to the neck pain survey questionnaire

Professional Body or Association	Number of Registrants / Members
Osteopathic Council of New Zealand	386
Australian Osteopathic Association	1300
New Zealand Manipulative Physiotherapists Association	410
Musculoskeletal Physiotherapy Australia	2073

3.2 Analysis

Descriptive statistics were used to summarize characteristics of the respondents and their responses to the key questions. Data from the intervention question was pooled for analysis, see Figure 8, allowing summation of the interventions applied. Where participants had selected the 'Other' option as part of their intervention selection, their description was assessed and where appropriate added to the corresponding intervention group. In cases where the 'Other' option referred to modalities outside of the scope of this investigation the response was ignored.

Odds Ratios (ORs) were used to investigate which intervention was more likely to be applied between osteopaths and physiotherapists. The Odds Ratio was calculated as the odds of a particular intervention occurring in one group (for instance osteopathy patients) divided by the odds of the same intervention occurring in the comparison group (for instance physiotherapy patients). Chi Square tests were conducted to compare frequency of intervention application by region (cervical or thoracic spine) between professions. Chi Square tests were conducted using Minitab 17 (Minitab, Inc., PA, USA.). Fisher's exact test was used when cell counts were low ($n<5$).

Comparisons resulting in p-values of >0.1 were considered to indicate ‘no probable difference’ between the groups in the application of the intervention, p-values between 0.05 and 0.1 were considered to show ‘very weak evidence of a difference’ between groups in the application of the intervention, p-values between 0.01 and 0.05 were considered to show ‘moderately strong evidence of a difference’ between groups in the frequency of application of the intervention, and a p-value <0.01 was considered to show ‘strong evidence of a difference’ between groups in the frequency of application of the intervention (Eden, de Vries, Moss, Richards, & Oliver, 2014; Hopkins, Marshall, Quarrie, & Hume, 2007).

4.0 CHAPTER FOUR: RESULTS

4.1 Practitioner information

Table 9 provides a summary of the characteristics for the whole sample of both the responding practitioners and the neck pain patients. There were n=48 respondents (26 osteopaths and 22 physiotherapists) from New Zealand, Australia, Singapore, and Canada. Within the whole sample the majority (52%) were from New Zealand, and Australia (38%) with a small number (10%) of respondents distributed between England (1), Singapore (1), and Canada (3). The respondents outside of Australia and New Zealand were members of the professional bodies of either of these two regions. The distribution of responding practitioners for the whole sample based on gender indicated slightly more females (52%), and for the individual professions the gender distributions were osteopaths 46% female and physiotherapists 59% female. Sixteen osteopaths and 11 physiotherapists provided information on the number of years in practice.

Table 9 Demographic information for practitioners (participants)

Practitioner Information		**Osteopaths**	**Physiotherapists**	**All Respondents**
Location	New Zealand	13	12	52%
	Australia	12	6	38%
	Other	1	4	10%
Gender	Female	12	13	52%
	Male	14	9	48%
Years in Practice	<5 yrs	2	0	
	6-10 yrs	5	4	
	11-15 yrs	5	3	
	16-20 yrs	1	0	
	21-30 yrs	1	1	
	>31 yrs	2	3	
	unknown	10	11	

4.2 Patient subset information

Across the patient subsets, the total number of patients with neck pain reported on by practitioners was n=109. The osteopaths group reported on n=51 patients (female 73%) and the physiotherapists n=58 patients (female 53%). The gender distribution for patients presenting with neck pain reported by the practitioners indicated more female patients (62%) than male. The age distribution for the patient sample was normally distributed around a peak percentage for the 36-45 years age group (29%). For the osteopathic neck pain patients, the 36-45 years age group represented a large part of the group (39%) (Figure 9).

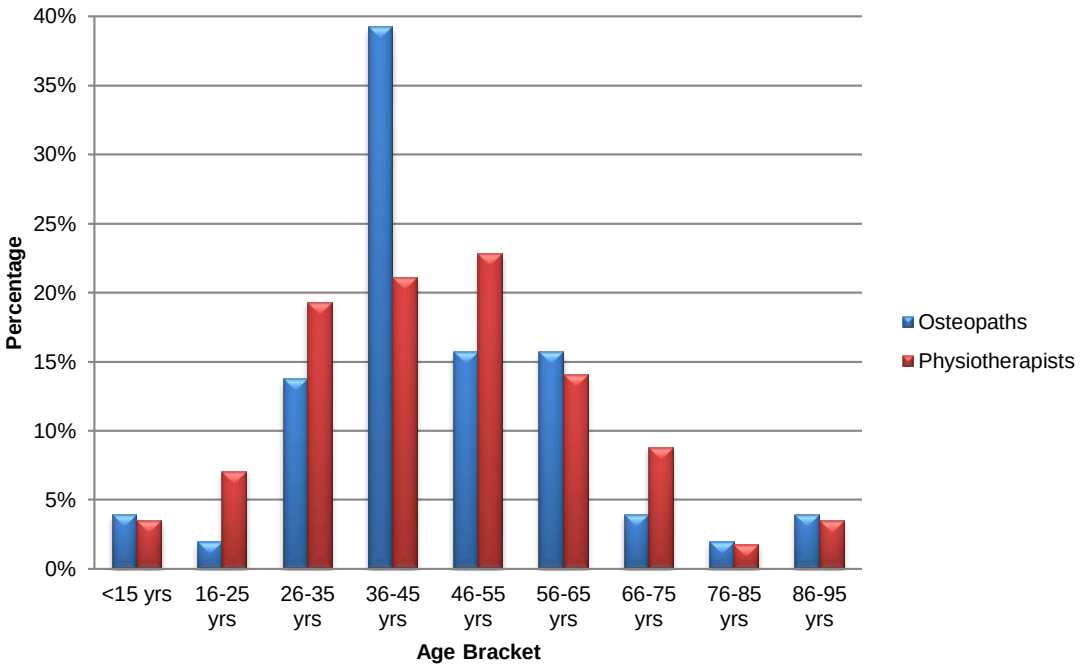


Figure 9 Percentage distribution of patients by age bracket

The presenting complaint 'Neck Pain with Headache' was the most frequently reported condition (35%) for the whole patient sample, followed by 'Neck Pain with Shoulder and Arm Symptoms' (28%), 'Neck Pain only' (19%), and 'Neck Pain with Headache, and Shoulder and Arm Symptoms' (18%). For the osteopathic group the proportion of 'Neck Pain and Headache' was moderately higher (39%). In the physiotherapy group, three of the presenting complaint groups each represented 25-31% of the sample (Figure 10).

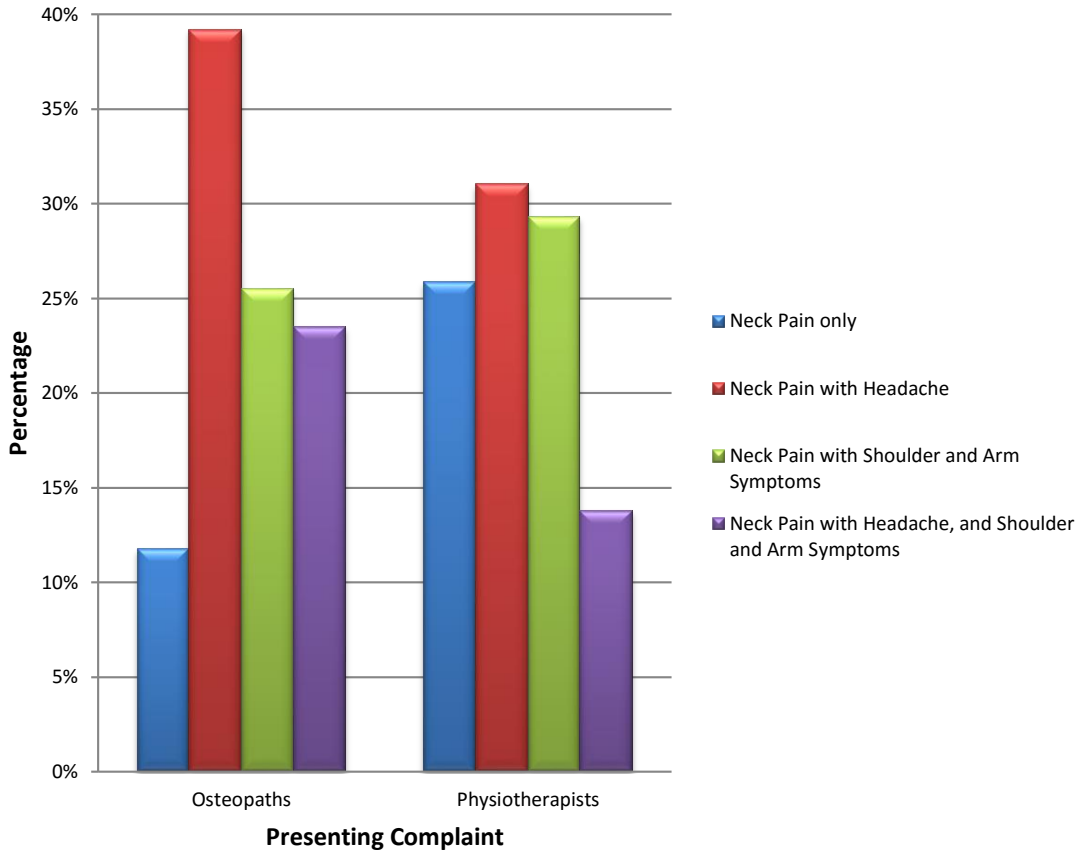


Figure 10 Percentage distribution of patients by presenting complaint

The frequency of application of selected interventions for all respondents was high for cervical mobilisation (85%), cervical soft-tissue (82%), and moderate for thoracic mobilisation (58%), cervical stretching and strengthening exercises (61%), and cervical traction (53%). The frequency of utilising cervical manipulation (26%) and thoracic manipulation (38%) was low for all respondents. From a profession perspective, osteopaths tended to apply the selected interventions to both the cervical and thoracic regions when treating patients presenting with neck pain (Figure 11) more often than physiotherapists.

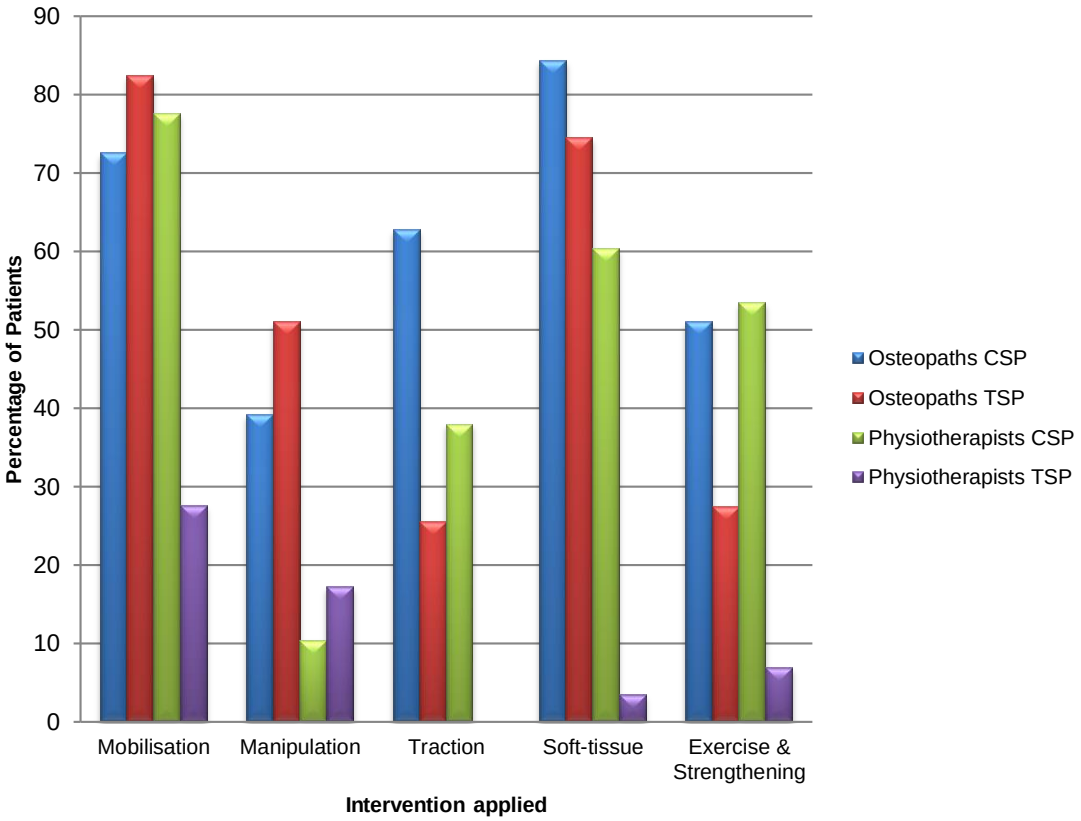


Figure 11 Percentage distribution of patients by treatment received in each anatomical region. CSP = cervical spine TSP = thoracic spine

Table 10 displays the percentage distributions of the regional application of interventions in consideration of each classification sub-group and by practitioner profession. The data shows that osteopaths applied a greater percentage of interventions to the thoracic region when treating all classification sub-groups. The highlighted squares correspond to the matched interventions for each subgroup from the evidence statements (Childs et al., 2008).

Table 10 Percentage distribution of patient subsets from osteopaths and physiotherapists in relation to treatment received by each classification sub-group in each anatomical region

	Classification sub-groups from Childs et al. (2008)							
Intervention Applied	**Centralisation**		**Exercise**		**Mobility**		**Cervicogenic Headache**	
Osteopaths	CSP	TSP	CSP	TSP	CSP	TSP	CSP	TSP
Mobilisation	83	92	44	89	91	91	87	87
Manipulation	42	67	33	56	55	55	40	47
Traction	67	42	56	11	73	36	73	20
Soft-tissue	92	83	100	78	100	82	80	80
Stretching and strengthening exercises	50	25	67	44	64	36	47	20
Physiotherapists								
Mobilisation	93	27	88	44	100	31	100	25
Manipulation	13	13	13	6	15	31	0	75
Traction	33	0	56	0	54	0	25	0
Soft-tissue	53	0	75	6	85	8	100	0
Stretching and strengthening exercises	53	7	56	13	92	0	50	25
The highlighted squares correspond to the matched interventions for each subgroup from the evidence statements.								

Tables 11 through to 14 provide an odds ratio analysis of the classification sub-groups in respect to whether the matched interventions were applied to the patients in each sub-group by the practitioners. For the ‘Cervicogenic Headache’ sub-group osteopaths were 20 times more likely to apply thoracic mobilisation as an intervention ($p<0.05$). In the ‘Mobility’ sub-group osteopaths were 23 times more likely to apply thoracic mobilisation ($p<0.01$). For the ‘Exercise’ sub-group there was strong evidence to suggest that osteopaths were 53 times more likely to address the thoracic region with soft-tissue interventions ($p<0.01$), and weak evidence that osteopaths were 6 times more likely to apply exercise and strengthening exercises to the thoracic region ($p=0.09$). For the ‘Centralisation’ sub-group osteopaths were 30 times more likely to apply thoracic mobilisation and 13 times more likely to apply thoracic manipulation as an intervention respectively ($p<0.01$).

Table 11 Odds ratios and Chi square analysis of matched technique use by osteopaths and physiotherapists within cervicogenic headache classification sub-group

			Matched		Odds	Odds ratio	95% Confidence limits		Chi-square	
SUB-GROUP	Technique		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
Cervicogenic Headache	CSP Mobilisation	osteopath	2	13	6.5	---	---	---		---
		physiotherapist	0	4	*infinity*					
	TSP Mobilisation	osteopath	2	13	6.5	**19.5**	1.29	292.77	Fisher	**0.04**
		physiotherapist	3	1	0.33					
	CSP Manipulation	osteopath	9	6	0.67	---	---	---		---
		physiotherapist	4	0	0					
	TSP Manipulation	osteopath	8	7	0.88	0.88	0.09	7.95	Fisher	0.67
		physiotherapist	2	2	1					
	CSP Exercise & Strengthening	osteopath	7	8	1.14	---	---	---		---
		physiotherapist	0	4	*infinity*					
	TSP Exercise & Strengthening	osteopath	12	3	0.25	0.75	0.06	10.03	Fisher	0.65
		physiotherapist	3	1	0.33					

Table 12 Odds ratios and Chi square analysis of matched technique use by osteopaths and physiotherapists within mobility classification sub-group

			Matched		Odds	Odds ratio	95% Confidence limits		Chi-square	
SUB-GROUP	Technique		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
Mobility	CSP Mobilisation	osteopath	1	10	10.00	0.83	0.05	15.09	Fisher	0.72
		physiotherapist	1	12	12.00					
	TSP Mobilisation	osteopath	1	10	10.00	**22.50**	2.11	240.49	Fisher	**<0.01**
		physiotherapist	9	4	0.44					
	TSP Manipulation	osteopath	5	6	1.20	2.70	0.51	14.37	Fisher	0.22
		physiotherapist	9	4	0.44					
	CSP Exercise & Strengthening	osteopath	4	7	1.75	0.15	0.01	1.58	Fisher	0.11
		physiotherapist	1	12	12.00					
	TSP Exercise & Strengthening	osteopath	7	4	0.57	6.86	0.64	74.19	Fisher	0.11
		physiotherapist	12	1	0.08					

Table 13 Odds ratios and Chi square analysis of matched technique use by osteopaths and physiotherapists within exercise classification sub-group

			Matched		Odds	Odds ratio	95% Confidence limits		Chi-square	
SUB-GROUP	Technique		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
Exercise	CSP Exercise & Strengthening	osteopath	3	6	2.00	1.56	0.28	8.53	Fisher	0.47
		physiotherapist	7	9	1.29					
	TSP Exercise & Strengthening	osteopath	5	4	0.80	**5.60**	0.77	40.59	Fisher	**0.09**
		physiotherapist	14	2	0.14					
	CSP Soft-tissue	osteopath	1	8	8.00	2.67	0.25	28.44	Fisher	0.39
		physiotherapist	4	12	3.00					
	TSP Soft-tissue	osteopath	2	7	3.50	**52.50**	4.05	640.95	Fisher	**<0.01**
		physiotherapist	15	1	0.07					

Table 14 Odds ratios and Chi square analysis of matched technique use by osteopaths and physiotherapists within centralisation classification sub-group

			Matched		Odds	Odds ratio	95% Confidence limits		Chi-square	
SUB-GROUP	Technique		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
Centralisation	CSP Traction	osteopath	4	8	2.00	4.00	0.80	20.02	1.78	0.18
		physiotherapist	10	5	0.50					
	CSP Mobilisation	osteopath	2	10	5.00	0.36	0.03	4.50	Fisher	0.57
		physiotherapist	1	14	14.00					
	TSP Mobilisation	osteopath	1	11	11.00	**30.25**	2.90	315.70	8.93	**<0.01**
		physiotherapist	11	4	0.36					
	TSP Manipulation	osteopath	4	8	2.00	**13.00**	1.92	87.99	Fisher	**<0.01**
		physiotherapist	13	2	0.15					

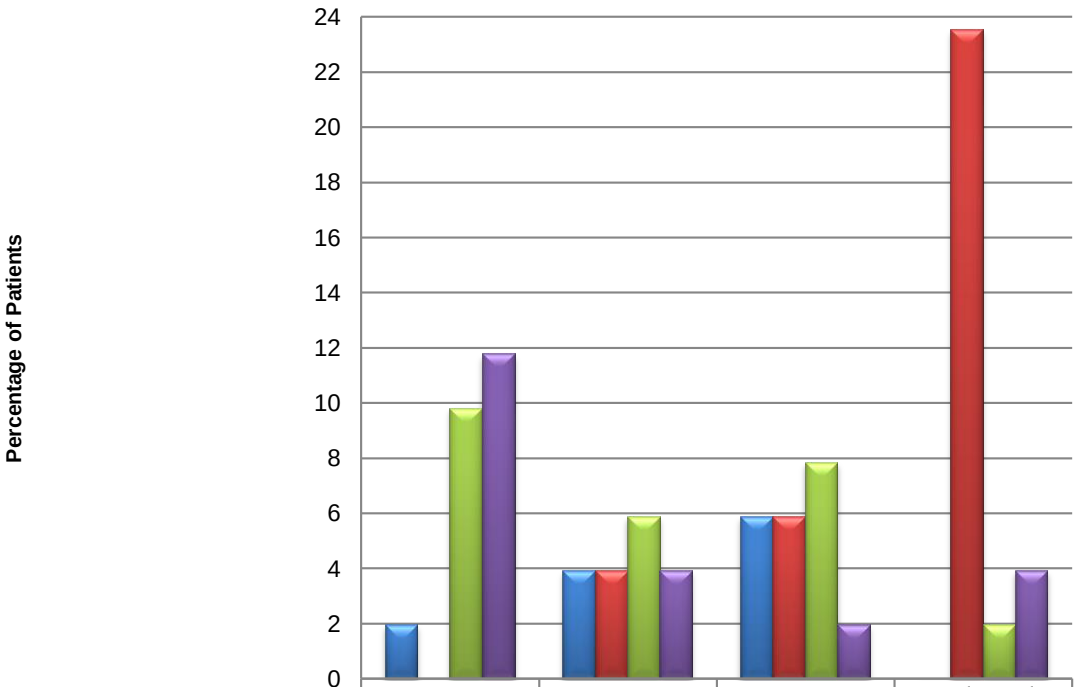
Table 15 Odds ratios and Chi square analysis of overall technique use by osteopaths and physiotherapists

		Applied		Odds	Odds ratio	95% Confidence limits		Chi-square	
TECHNIQUE		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
CSP Mobilisation	osteopath	10	41	4.10	0.47	0.16	1.41	1.19	0.28
	physiotherapist	6	52	8.67					
TSP Mobilisation	osteopath	7	44	6.29	**12.90**	4.90	33.96	29.71	**<0.01**
	physiotherapist	39	19	0.49					
CSP Manipulation	osteopath	29	22	0.76	**6.58**	2.39	18.06	13.62	**<0.01**
	physiotherapist	52	6	0.12					
TSP Manipulation	osteopath	21	30	1.43	**6.10**	2.58	14.44	16.71	**<0.01**
	physiotherapist	47	11	0.23					
CSP Traction	osteopath	18	33	1.83	**2.42**	1.12	5.25	4.26	**<0.05**
	physiotherapist	33	25	0.76					
TSP Traction	osteopath	37	14	0.38	**21.57**	2.72	171.02	13.04	**<0.01**
	physiotherapist	57	1	0.02					

Table 15 cont. Odds ratios and Chi square analysis of overall technique use by osteopaths and physiotherapists

		Applied		Odds	Odds ratio	95% Confidence limits		Chi-square	
TECHNIQUE		**No**	**Yes**			**Lower limit**	**Upper Limit**	**Yates**	***p*-value**
CSP Soft-tissue	osteopath	3	48	16.00	**6.63**	1.81	24.25	8.44	**<0.01**
	physiotherapist	17	41	2.41					
TSP Soft-tissue	osteopath	9	42	4.67	**130.67**	26.82	636.65	66.95	**<0.01**
	physiotherapist	56	2	0.04					
CSP Exercise & Strengthening	osteopath	22	29	1.31	0.69	0.32	1.51	0.53	0.47
	physiotherapist	20	38	1.90					
TSP Exercise & Strengthening	osteopath	36	15	0.42	**3.61**	1.28	10.19	5.18	**<0.05**
	physiotherapist	52	6	0.12					

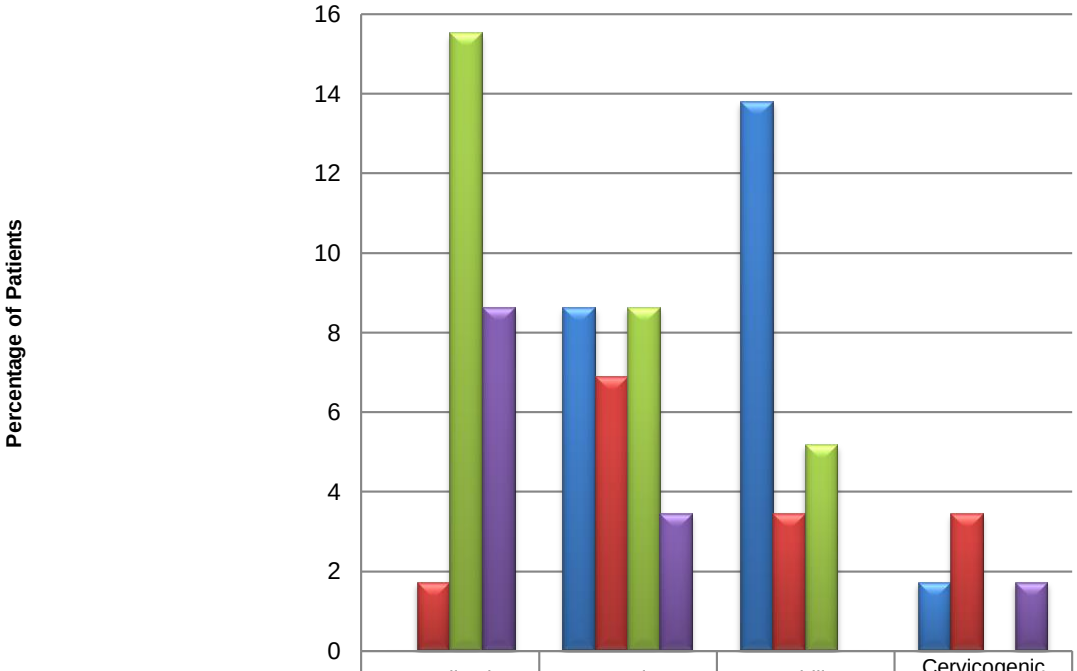
Table 15 provides and odds ratio analysis of the interventions applied by each practitioner group irrespective of classification sub-group or presenting complaint. Osteopaths were 13 times more likely to apply thoracic mobilisation ($p<0.01$) and were 2 times and 22 times more likely to apply traction to the cervical and thoracic regions respectively ($p<0.05$). Osteopaths were 7 times and 6 times more likely to utilise cervical and thoracic manipulation respectively ($p<0.01$). Osteopaths were 7 times more likely to apply soft-tissue interventions to the cervical region and 130 times more likely to address the thoracic region with soft-tissue interventions ($p<0.01$). Osteopaths were 4 times more likely to apply stretching and strengthening exercise interventions to the thoracic region ($p<0.05$).



	Centralisation	Exercise	Mobility	Cervicogenic Headache
Neck Pain only	2	4	6	0
Neck Pain with Headache	0	4	6	24
Neck Pain with Shoulder and Arm Symptoms	10	6	8	2
Neck Pain with Headache, and Shoulder and Arm Symptoms	12	4	2	4

Figure 12 Percentage distribution of osteopathic patients for each classification sub-group in relation to presenting complaint.

Figures 12 and 13 show the percentage distribution for presenting complaint subsets of osteopathic and physiotherapeutic patients in relation to the classification sub-groups of ‘Centralisation’, ‘Exercise’, ‘Mobility’ and ‘Cervicogenic Headache’ respectively. For the osteopathic patients there were no patients categorised into the ‘Pain Control’ sub-group, there were 12 patients in the ‘Centralisation’ sub-group, 9 patients in the ‘Exercise’ sub-group, 11 patients in the ‘Mobility’ sub-group, 4 patients in the ‘Non-Cervicogenic Headache’ sub-group, and 15 patients in the ‘Cervicogenic Headache’ sub-group. For the physiotherapy patients there was 1 patient in the ‘Pain Control’ sub-group, there were 15 patients in the ‘Centralisation’ sub-group, 16 patients in the ‘Exercise’ sub-group, 13 patients in the ‘Mobility’ sub-group, 9 patients in the ‘Non-Cervicogenic Headache’ sub-group, and 4 patients in the ‘Cervicogenic Headache’ sub-group.



	Centralisation	Exercise	Mobility	Cervicogenic Headache
Neck Pain only	0	9	14	2
Neck Pain with Headache	2	7	3	3
Neck Pain with Shoulder and Arm Symptoms	16	9	5	0
Neck Pain with Headache, and Shoulder and Arm Symptoms	9	3	0	2

Figure 13 Percentage distribution of physiotherapy patients for each classification sub-group in relation to presenting complaint

When considering the whole sample 37% of the patients reported as having a presenting complaint of ‘Neck Pain with Headache’ were classified into the ‘Cervicogenic Headache’ sub-group by the respondent practitioners. For ‘Neck Pain with Shoulder and Arm Symptoms’ 47% of the patients were classified into the ‘Centralisation’ sub-group, and for ‘Neck Pain with Headache, and Shoulder and Arm Symptoms’ 55% were classified into the ‘Centralisation’ sub-group.

5.0 CHAPTER FIVE: DISCUSSION

5.1 Analysis of practitioner subgrouping in relation to a treatment-based classification model

From the practitioner's answers to the algorithm questions we were able to allocate their patients to a treatment-based classification sub-group. Based on the patient's presenting complaint in comparison to the resultant sub-group that the patient fell into that osteopaths tended to answer the algorithm questions that placed the patient in the appropriate sub-group, whereas the physiotherapists seemingly answered the questionnaire such that a reasonable percentage of patients that presented with 'neck pain and headache' or 'neck pain with shoulder and arm symptoms' ended up in the exercise sub-group (Figures 12 and 13).

The results of this study indicate that practitioners were not employing interventions in groupings that are consistent with those of a treatment-based classification system suggested in the literature. There was a lack of obvious cohesive groupings of interventions in relation the subgroups of 'Centralisation', 'Exercise', 'Mobility' and 'Cervicogenic Headache', (Table 10). There is weak evidence to suggest that the practitioners are applying interventions that match the sub-group (Tables 11 to 14).

It has been suggested that the reason for the number and variety of classification schemes for low back pain is that the heterogeneity of the normal population cannot be adequately covered with a single classification scheme (Karayannis, Jull, & Hodges, 2012). This argument has also been proffered in response to the attempts to develop suitable classification schemes for neck pain (Clair et al., 2006; Cleland et al., 2010). Several classification schemes used to guide treatment of low back pain patients have been proposed and examined in the literature, including the Mechanical Diagnosis and Treatment (MDT), the Treatment Based Classification (TBC), the Pathoanatomic Based Classification (PBC), the Movement System Impairment Classification (MSI), and the O'Sullivan Classification System (OCS) schemes (Karayannis et al., 2012). There is substantial variation in these treatment approaches, and the types and purpose of clinical assessments. Biomechanical assessment is the basis in three of the schemes (MDT, PBC, and MSI). In contrast, psychosocial aspects were considered in both the TBC

(fear-avoidance) and OCS (cognitive and behavioural). Takasaki and May (2014) suggested that lack of an observed clinical benefit in utilising a MDT approach for neck pain when compared with a 'wait and see' approach, in terms of pain intensity and disability, could have been influenced by the level of training in MDT of the therapists under investigation.

5.2 Analysis of technique choice in relation to best-practice guidelines or current best evidence

5.2.1 Centralisation subgroup

For a centralisation subgroup the evidence supports the application of cervical and thoracic mobilisation (Childs et al., 2008; Dunning et al., 2012), cervical traction (Cai et al., 2011; Raney et al., 2009), thoracic manipulation (Cross et al., 2011; Huisman et al., 2013), and cervical stretching and strengthening exercise interventions (Andersen et al., 2011; Boyles, Toy, Mellon, Hayes, & Hammer, 2011). In a recent systematic review, Aoyagi, Mani, Jayamoorthy, and Tumilty (2014) found very low quality evidence in support of the use of spinal manipulation in the management of upper limb pain.

For the centralisation subgroup of this study, osteopathic practitioners applied suitable matched interventions more often than physiotherapists (Table 10). Alongside these interventions the osteopaths also applied a considerable percentage of non-matched interventions to both the cervical and thoracic regions. In contrast, the physiotherapists applied matched interventions less frequently with the exception of cervical mobilisation. In the 'Centralisation' sub-group, there is strong evidence ($p<0.01$) that osteopaths will apply thoracic mobilisation and manipulation interventions more often that physiotherapists (Table 14). Of note the physiotherapists did not apply any traction or soft-tissue interventions to the thoracic region, this is the antithesis of a regional interdependence approach. The moderate frequency (42%) of cervical manipulation applied by osteopaths is supported by the concept of regional interdependence for patients complaining of neck and arm pain
(Aoyagi et al., 2014).

5.2.2 Exercise subgroup

The evidence statements for the 'Exercise' subgroup indicate stretching exercises, strengthening exercises and soft-tissue interventions are the key treatment options (Childs et al., 2008; Kay et al., 2012). Kay et al. (2012) reported low to moderate

quality evidence in support of the use of cervical and scapula region stretching and strengthening exercises for people with mechanical neck pain. The authors only considered exercise interventions in isolation from other treatment modalities, so the merit of a multimodal approach cannot be assessed from their results. Protocols have been developed for exercise interventions for patients with NSNP that focus on strength training. However, a cause-and-effect relationship between muscle weakness and associated neck pain is yet to be defined (Yalcinkaya et al., 2014). There is evidence to support the application of various soft-tissue interventions, such as strain-counterstrain (Klein, Bareis, Schneider, & Linde, 2013), massage (Cheng & Huang, 2014), muscle energy (Mahajan, Kataria, & Bansal, 2012) trigger-point inhibition (Nagrale, Glynn, Joshi, & Ramteke, 2010), and muscle inhibition (Heredia Rizo et al., 2012).

For the exercise subgroup, osteopathic practitioners more often applied matched interventions to the cervical and thoracic regions, alongside these they applied they often applied unmatched interventions (Table 10). Similarly, the physiotherapists often applied matched interventions to the cervical region. In contrast, physiotherapists applied fewer matched interventions to the thoracic region. In the 'Exercise' sub-group, there is strong evidence ($p<0.01$) that osteopaths will apply thoracic interventions more often that physiotherapists (Table 13). Both groups often applied mobilisation to the cervical or thoracic regions, although this is not supported in the literature (Childs et al., 2008). The results of this study in regard to the application of stretching and strengthening exercises is consistent with the findings of their international survey of practitioners by Carlesso et al. (2014), who reported that exercise and manual therapy were core treatments applied in patients presenting with either acute or chronic NSNP.

5.2.3 Mobility subgroup

For the mobility subgroup, osteopathic practitioners often applied matched interventions to the cervical and thoracic regions (Table 10). The osteopaths also often applied unmatched interventions to both the cervical and thoracic regions. Similarly, the physiotherapists often applied the matched interventions of mobilisation and stretching and strengthening exercises to the cervical region, and less frequently they applied the matched interventions cervical and thoracic manipulation, thoracic mobilisation, and thoracic stretching and strengthening exercises. In the 'Mobility' sub-group, there is strong evidence ($p<0.01$) that osteopaths will apply thoracic mobilisation interventions more often that physiotherapists (Table 12). Of note is the distinct pattern of application

of regionally interdependent interventions by osteopaths in contrast to the physiotherapists. This is highlighted by the limited application of manipulation to either the cervical or thoracic regions by the physiotherapists.

Dunning et al. (2012) provided evidence in support of the application of cervical and thoracic manipulations used in tandem in the treatment of mechanical neck pain. A systematic review investigating the evidence for therapeutic exercise as a treatment for chronic NSNP found moderate evidence in support if such exercise from a range of medium to low quality studies (Bertozzi et al., 2013). Evidence supporting the utility and clinical effectiveness of a combined exercise intervention including strengthening, range of motion, and flexibility indicated this was just as effective as other supervised exercise programs, such as, yoga (Southerst et al., 2014).

5.2.4 Cervicogenic Headache subgroup

For the cervicogenic headache subgroup, osteopathic practitioners often applied matched interventions to the cervical region. The osteopaths also often applied unmatched interventions to both the cervical and thoracic regions (Table 10). Similarly, the physiotherapists often applied some matched cervical interventions. In contrast, the physiotherapists rarely applied the matched intervention for the cervicogenic headache subgroup of cervical manipulation. The physiotherapists also applied unmatched interventions to varying degrees to the cervical and thoracic regions. In the 'Cervicogenic Headache' sub-group, there is strong evidence ($p<0.01$) that osteopaths will apply thoracic mobilisation interventions more often that physiotherapists (Table 12). Again this subgroup highlights the differences in application of manipulation in both the matched interventions (between the practitioner groups).

Treatment for cervicogenic headache can benefit from a multimodal approach that includes cervical manipulation and mobilisation, and cervico-scapular strengthening exercises (Racicki et al., 2013).

5.3 Analysis of the management approach of osteopaths and physiotherapists for patients presenting with neck pain

5.3.1 Treatment of regionally interdependent structures

The results of the current study indicate that osteopathic practitioners were more likely to apply an intervention to a regionally interdependent structure for patients presenting with neck pain (Figure 11). The odds ratio analysis (table 15) demonstrates strong evidence that osteopaths were more likely to apply interventions to the thoracic spine ($p<0.05$), osteopaths were more likely to apply cervical manipulation ($p<0.01$).

The range of interventions applied by osteopaths encompassed a larger number of associated structures than that of physiotherapists. Yalcinkaya et al. (2014) have suggested that practitioners should consider not only the neck region, but also regionally interdependent structures (i.e. the upper back and shoulders), levels of whole body physical fitness, and psychosocial factors such as anxiety and depression, when developing intervention strategies for patients with neck pain. The effectiveness of applying interventions to regionally interdependent structures is supported in the literature (Cross et al., 2011; Dunning et al., 2012; Saavedra-Hernández et al., 2013) and conceptually by the work of Stecco et al. (2014). In the current study there was also a greater application of soft-tissue interventions reported by osteopaths. Bronfort et al. (2010) reported moderate quality evidence in support of massage therapy for NSNP. One of the underlying principles of osteopathy is to consider 'the body as a unit' (Ward, 2003). Similarly, from a teaching perspective physiotherapists contextualise the concepts of body, movement and interaction (Broberg et al., 2003). The research-practice gap between the taught concepts and typical clinical practice could be explained by whether practitioners have adopted the concepts of regional interdependence (Aoyagi et al., 2014).

5.3.2 Frequency in application of manipulation

The evidence from the current study suggests that osteopaths apply cervical and thoracic manipulations more frequently in comparison to physiotherapists (Table 10). There is strong evidence ($p<0.01$) that osteopaths will apply cervical and thoracic manipulation more often that physiotherapists (Table 15).

Young et al. (2014) reported there was a significant amount of variable quality evidence in support of the short-term benefits of thoracic manipulation for the treatment of patients with mechanical neck pain, whereas there was no definitive evidence to support the clinical efficacy of thoracic mobilisation. Cross et al. (2011) reported weak evidence for the use of thoracic manipulation in the short-term to improve patients with mechanical neck pain. In contrast, Vincent et al. (2013) reported moderate evidence for the utility of thoracic manipulation in patients with NSNP. The difference in the rates of application of manipulation between practitioner groups may have been due to the differences in training of the two professions. Osteopaths undertake a five year course with an emphasis on spinal manipulation as a main component of the clinical paradigm, whereas for physiotherapists spinal manipulation is a post-graduate study option. It has been recognised that practitioner effects, such as individual skills, knowledge, beliefs, preferences and experiences, can independently, or in combination modify the effectiveness of a treatment (MacDermid, Walton, & Miller, 2013). There is also the likelihood that the practitioner effects can interact with the needs and preferences of patients to affect outcomes from treatment.

5.3.3 Multimodal care

Multimodal treatment is defined as the combination of at least two different therapy modalities used for the treatment of a complaint (Tsakitzidis et al., 2009). For example, cervical manipulation combined with strengthening exercises. A recent review of multimodal care for neck pain reported that a multimodal protocol incorporating manual therapy (i.e. manipulation) and supervised exercise prescription can benefit patients with whiplash associated disorders and patients with neck pain and associated disorders (Sutton et al., 2014). In contrast, there is equivocal support for the application of spinal manipulation in conjunction with strengthening exercises (Evans et al., 2012). Tsakitzidis et al. (2009) reported strong evidence supporting the use of a multimodal approach incorporating supervised exercises and cervical manipulation or mobilisations, for short- and long-term benefits in pain and functionality, although they recognised there is uncertainty as to which components in terms of frequency, duration, or techniques, of an intervention, provide the effectiveness of the treatment.

For the current study, the odds ratio analysis (table 15) displays strong evidence that osteopaths were apply interventions to the thoracic region more often than physiotherapists ($p<0.01$). The evidence from this study indicates that both practitioner groups utilised a combination of interventions, with a moderate to high percentage of the practitioners applying mobilisation, manipulation, soft-tissue techniques, and stretching and strengthening exercise interventions to the cervical region. Frequent use of a multimodal care approach by both osteopaths and physiotherapists is demonstrated in the results of this study, albeit tempered by the regionally interdependent structure preferences indicated. The nature of the survey design allows these results to be directly attributed to typical clinical practice.

5.4 Limitations

5.4.1 Sample size

The participants in this investigation, 26 osteopathic and 22 physiotherapy practitioners, reported information about their management of neck pain patients using a web-based questionnaire. Due to the low number of respondents to the item relating to years in practice, no meaningful comparisons could be made about the relationship between years in practice and management strategies. MacDermid et al. (2013) have previously reported the years in practice did not affect practice patterns in terms of outcome measures employed in the management of neck pain. The 26 osteopathic practitioners reported data on a subset of 51 neck pain patients, and the 22 physiotherapy practitioners reported data on a subset of 58 neck pain patients. The small sample size erodes the extent to which the findings of this study can be generalised to the respective professions, but the findings are of value for hypothesis generation in future studies.

5.4.2 The patient subset

For the whole group of practitioners, patients reported as seeking help for neck pain were predominantly female, which matches similar findings from epidemiological surveys on neck pain (Hoy et al., 2010). The age bracket of highest frequency for the patient subset was 36 to 45 years old. This accords with a previous epidemiological study reporting on the most frequently reported age group for neck pain (Hoy et al., 2010).

5.4.3 Information on single session only

The potential differences in the types of interventions used by practitioners in the two groups were not able to be captured due to the nature of the survey questionnaire. This survey did not set out to investigate other modalities such as TENS or acupuncture. As this survey sought to capture data on a single session from a clinical interaction between a neck pain patient and practitioner in order to investigate management practices, information was not available about any follow-up interventions. The changes that occur in application of interventions over time in terms of frequency, dosage, and selection of intervention were not able to be reported. Similarly, from the aspect of exercise interventions applied it was not possible to comment on the frequency, intensity, duration or type of exercises prescribed. In order to gain a better understanding of the natural course of a patient's complaint, information was needed on the duration of the complaint, including whether it was of an intermittent nature, a new episode, or a chronic recurring problem.

Another limitation when assessing the effectiveness of an intervention is the lack of information on the specific levels of applied interventions. Slaven, Goode, Coronado et al. (2013) have suggested there is evidence to support the necessity of specification in application of cervical mobilisation. The effect of biopsychosocial factors on the interventions applied were not measured in this study, nor were long-term outcomes of each individual patient within the subset of neck pain patients under consideration. Whilst these issues could have provided beneficial insights into the course and responsiveness of various presentations of neck pain, the time constraints associated with the survey administration prevented this from occurring (MacDermid, Walton, Cote, et al., 2013). In an overview study by Gross et al. (2013) the authors reported moderate evidence in support of some mind-body work for chronic neck pain, and moderate evidence against psychosocial interventions.

5.5 Clinical importance

In an evidence-based healthcare system, gaps between knowledge and action can place an unnecessary burden of cost onto the individuals and community (MacDermid, Miller, & Gross, 2013). The dosage, selection, and timing of interventions are paramount for the management of NSNP.

There is some support for selection of interventions (Bertozzi et al., 2013; Southerst et al., 2014; Young et al., 2014), although evidence on the optimal dosage and timing of interventions is limited (O'Riordan et al., 2014). With the extent of available evidence from RCTs, there is a foundation for evidence-based practice (MacDermid, Miller, et al., 2013). Patient dissatisfaction with the current models of care need to be addressed using an evidence-based practice approach.

5.6 Recommendations for future research

There is a need for further research that is directed at assessing the patient management practices of osteopaths and physiotherapists in Australia and New Zealand. The skills required of practitioners to integrate research evidence, clinical observations, and patient circumstances and preferences, could be enhanced with the following future research:

- A large sample (n=150) of practitioners completing a neck pain questionnaire assessing patients on a case-by-case basis to characterise the practice-evidence gap identified in this study. The questionnaire could be expanded to capture more information about the interventions applied in terms of frequency, duration, and intensity. The questionnaire could also include items that allow the reporting of patient progress over the course of treatment, rather than a snap-shot. This would produce information about the profile of recovery using a multimodal management approach.
- A qualitative research project could be directed at investigating whether the apparent differences in regional application of techniques are driven by practitioner interpretations of the requirements of external funding agencies (such as Accident Compensation Corporation in New Zealand), or from practitioner or patient centred preferences.
- A qualitative study that allows comparisons between the clinical reasoning process of the practitioner and the lived experience of the patient.
- A qualitative study investigating the teaching practices and protocols in osteopathic and physiotherapy schools in New Zealand and Australia in regard to best-evidence guidelines and current curriculum. This study could be expanded to explore where the challenges exist for practitioners, so that tools and methods can be developed to bridge the knowledge translation practice-research gap.

5.7 Summary

Walton et al., (2013) demonstrated a gap in the management practices of therapists between current best-evidence and actual practice in their overview investigation of practitioner practices. A similar gap is found in the present study, with the practitioners providing an array of matched multimodal interventions, alongside a selection of interventions not supported in the literature for the patient's subgroup classification. Unlike previous research which sought to investigate the management practices of manual therapists (physical therapists, chiropractors, osteopaths, and physiotherapists) by utilising a survey questionnaire that asked questions on theoretical clinical practice styles, this research has analysed the management approach of osteopaths and physiotherapists from actual clinical interactions. Evidence-based practice requires a flexibility and willingness on the part of the practitioner to change the way they practice in light of new evidence which may highlight their old ways of doing things are not in the best interests of the patient, although it may suit their personal style (G. Bronfort et al., 2010; Walker et al., 2013). In accordance with previous research (Carlesso et al., 2014), this study highlights that some differences exist in the utilisation of interventions between osteopaths and physiotherapists. The differences in application of manipulation may be explained by personal preferences (of practitioner or patient), as the data reported in this study is from actual clinical practice, where informed choice has primacy in the decision making in regards to intervention selection. Overall the practice patterns demonstrated by this study suggest that osteopaths and physiotherapists utilise a multimodal approach to the management of patients presenting with neck pain, employing a range of interventions widely supported in the literature. In clinical practice, practitioners are required to customise intervention to suit the presentation of the individual patient, and whilst this sort of practice approach is evident from the results of this study, it is also apparent that practitioners were not subgrouping their patients along the lines of a known classification system.

APPENDICES

Appendix 1 Ethics Approval

MEMORANDUM

Auckland University of Technology Ethics Committee (AUTEC)

To:	Duncan Reid
From:	Rosemary Godbold, Executive Secretary, AUTEC
Date:	28 August 2012
Subject:	Ethics Application Number **11/260 Observational case series for the derivation of a neck pain classification system for musculoskeletal therapists.**

Dear Duncan

Thank you for your request for approval of amendments to your ethics application, which was approved by Auckland University of Technology Ethics Committee (AUTEC) on 25 October 2011. I am pleased to advise that the Chair of AUTEC and I have approved minor amendments to your ethics application allowing modifications to the questionnaire and for it to be used through Survey Monkey. We also confirm that Consent from the patient is not required.. This delegated approval is made in accordance with section 5.3.2 / of AUTEC's *Applying for Ethics Approval: Guidelines and Procedures* and is subject to endorsement by AUTEC at its meeting on 10 September 2012.

I remind you that as part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 25 October 2014;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. This report is to be submitted either when the approval expires on 25 October 2014 or on completion of the project, whichever comes sooner;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are reminded that, as applicant, you are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all written and verbal correspondence with us. Should you have any further enquiries regarding this matter, you are welcome to contact me by email at ethics@aut.ac.nz or by telephone on 921 9999 at extension 6902. Alternatively you may contact your AUTEC Faculty Representative (a list with contact details may be found in the Ethics Knowledge Base at http://www.aut.ac.nz/research/research-ethics/ethics).

On behalf of AUTEC and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

Dr Rosemary Godbold
Executive Secretary
Auckland University of Technology Ethics Committee
Cc: James Hutchinson james@totalosteo.co.nz

Appendix 2

Search Strategy Terms and Results

PubMed

Filters activated: Randomized Controlled Trial, Clinical Trial, Publication date from 2012/01/01 to 2014/09/30, Humans, Adult: 19+ years.

	Search Term	Results	Retrieved for abstract review
1	Migraine	201	3
2	Tension-type Headache	28	3
3	Cervicogenic Headache	10	2
4	Neck pain	337	
5	Cervical spine pain	115	
6	Mechanical neck pain	23	
7	Non-specific neck pain	6	
8	Spinal manipulation	63	
9	Spinal mobilization	177	
10	Cervical spine manipulation	26	
11	Cervical spine mobilization	87	
12	Thrust manipulation	12	
13	High velocity low amplitude	9	
14	Exercise	5482	
15	Exercise AND (strengthening OR stretching OR endurance)	732	
16	Massage OR myofascial release	233	
17	Manual therapy	784	
18	Thoracic spine manipulation	15	
19	Thoracic spine mobilization	18	
20	Osteopathic	47	
21	Physiotherapy	3844	
22	Chiropractic	32	
23	Physical therapy	5578	
24	1 OR 2 OR 3	225	
25	4 OR 5 OR 6 OR 7	369	
26	8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 15 OR 16 OR 17 OR 18 OR 19	1832	
27	20 OR 21 OR 22 OR 23	5813	
28	24 & 26 & 27	10	
29	25 & 26 & 27	59	
	1 & 26	6	
	2 & 26	6	
	3 & 26	5	

	24 & 26	15	8
	4 & 26	53	
	5 & 26	31	
	6 & 26	9	
	7 & 26	4	
	25 & 26	63	37

(neck pain OR mechanical neck pain OR cervical spine pain OR non-specific neck pain)
(spinal manipulation OR spinal mobilization OR cervical spine manipulation OR cervical spine mobilization OR thrust manipulation OR high velocity low amplitude OR (exercise AND (strengthening OR stretching OR endurance)) OR massage OR myofascial release OR manual therapy OR thoracic spine manipulation OR thoracic spine mobilization)
(osteopathic OR physiotherapy OR chiropractic OR physical therapy)

CINAHL Plus Full Text via EBSCO
Limiters: Published date 20120101-20140930, English language, Human, Randomized Controlled Trials, Age groups Adult 19-44, 45-64, 65+ years

	Search Term	Results	Retrieved for abstract review
1	Migraine	65	
2	Tension-type Headache OR Tension Headache	1323	
3	Cervicogenic Headache	129	
4	Neck pain	2333	
5	Cervical spine pain	2410	
6	Mechanical neck pain	2448	
7	Non-specific neck pain	3736	
8	Spinal manipulation	438	
9	Spinal mobilization	381	
10	Cervical spine manipulation	402	
11	Cervical spine mobilization	332	
12	Thrust manipulation	133	
13	High velocity low amplitude	2781	
14	Exercise	1752	
15	Exercise AND (strengthening OR stretching OR endurance)	378	
16	Massage OR myofascial release	335	
17	Manual therapy	9707	
18	Thoracic spine manipulation	354	
19	Thoracic spine mobilization	287	
20	Osteopathic	25	
21	Physiotherapy	79	
22	Chiropractic	22	
23	Physical therapy	10435	
24	1 OR 2 OR 3	76	

25	4 OR 5 OR 6 OR 7	3984	
26	8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 15 OR 16 OR 17 OR 18 OR 19	12121	
27	20 OR 21 OR 22 OR 23	10442	
28	24 & 26 & 27	1	
29	25 & 26 & 27	25	
30	1 & 26	57	
31	2 & 26	12	
32	3 & 26	1	
33	24 & 26	68	9
34	4 & 26	85	
35	5 & 26	0	
36	6 & 26	9	
37	7 & 26	5	
38	25 & 26	85	37

(migraine OR tension headache OR tension-type headache OR cervicogenic headache)

SPORTDiscus with Full Text via EBSCO

Published date 20120101 – 20140930, English, randomized controlled trials

	Search Term	Results	Retrieved for abstract review
1	Migraine	23	
2	Tension-type Headache OR Tension Headache	5	
3	Cervicogenic Headache	3	
4	Neck pain	52	
5	Cervical spine pain	5	
6	Mechanical neck pain	8	
7	Non-specific neck pain	6	
8	Spinal manipulation	13	
9	Spinal mobilization	6	
10	Cervical spine manipulation	3	
11	Cervical spine mobilization	3	
12	Thrust manipulation	5	
13	High velocity low amplitude	4	
14	Exercise	1576	
15	Exercise AND (strengthening OR stretching OR endurance)	293	
16	Massage OR myofascial release	48	
17	Manual therapy	74	
18	Thoracic spine manipulation	5	
19	Thoracic spine mobilization	1	
20	Osteopathic	16	

21	Physiotherapy	293	
22	Chiropractic	7	
23	Physical therapy	698	
24	1 OR 2 OR 3	30	
25	4 OR 5 OR 6 OR 7	54	
26	8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 15 OR 16 OR 17 OR 18 OR 19	410	
27	20 OR 21 OR 22 OR 23	844	
28	24 & 26 & 27	4	
29	25 & 26 & 27	29	
30	1 & 26	0	
31	2 & 26	2	
32	3 & 26	3	
33	24 & 26	5	3
34	4 & 26	29	
35	5 & 26	4	
36	6 & 26	6	
37	7 & 26	3	
38	25 & 26	31	12

PEDro

	Search Parameters	Results	Retrieved
1	Abstract & Title: migraine Method: clinical trial New records added since: 01/01/2012	30	1
2	Abstract & Title: tension-type headache Method: clinical trial New records added since: 01/01/2012	12	3
3	Abstract & Title: cervicogenic headache Method: clinical trial New records added since: 01/01/2012	8	4
4	Abstract & Title: neck pain Method: clinical trial New records added since: 01/01/2012	143	47
5	Abstract & Title: cervical spine pain Method: clinical trial New records added since: 01/01/2012	36	17

6	Abstract & Title: mechanical neck pain Method: clinical trial New records added since: 01/01/2012	24	17
7	Abstract & Title: non-specific neck pain Method: clinical trial New records added since: 01/01/2012	12	5

Summary

Database	Complaint	Retrieved	Duplicates Removed	Rejected	Added	Selected
PubMed	Headache	8				
	Neck Pain	37				
CINAHL	Headache	9				
	Neck Pain	37				
SPORTDiscus	Headache	3				
	Neck Pain	12				
PEDro	Headache	8				
	Neck Pain	86				
Headache		29	17		(Espí-López et al., 2014)	9
Neck Pain		172	88	6 - date before 2012	(Maiers et al., 2014a)	34

Appendix 3

Criteria for PEDro Scale.

2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)

3. Allocation was concealed.

4. The groups were similar at baseline regarding the most important prognostic indicators.

5. There was blinding of all subjects.

6. There was blinding of all therapists who administered the therapy.

7. There was blinding of all assessors who measured at least one key outcome.

8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups.

9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"

10. The results of between-group statistical comparisons are reported for at least one key outcome.

11. The study provides both point measures and measures of variability for at least one key outcome.

Appendix 4

Questionnaire Algorithm.

Neck Pain Questionnaire
Consent Information

Approved by the Auckland University of Technology Ethics Committee on 25th October 2011 AUTEC Reference number 11/260.
It might be helpful to ask other practice staff to remind you to fill in the questionnaire when a patient complaining of neck pain attends your practice.

Each new patient you can provide data on will need to be entered through the embedded link in the information email. You could save the link (https://www.surveymonkey.com/s/Neck_Pain_Question) to your bookmarks to make it easy to access for subsequent neck pain patients.

If you have already completed the questionnaire for a previous patient, we will require you to again give consent and complete your details to move through the questionnaire.

The survey monkey questionnaire is an algorithm based system for inputting some brief data on the clinical reasoning process for each individual neck pain patient.
For each practitioner we would ideally like to have 10 (or more if you have the time) individual patient's data entered into the questionnaire – unfortunately with the way survey monkey works this requires you to complete the survey separately for each individual. Each patient only needs to be entered once.

We do not mind whether you enter returning patients or new patients we are interested in the management aspects of the individual patients and a moment in time (we appreciate that patient management changes over time). For the purpose of data collection we would prefer to collect information on the different individual patients presenting over a three month period from when you enter your first Neck Pain Patient.

I have read and understood the information provided about this research project in the email invitation. I have had the opportunity to ask questions and to have them answered. I understand that the information I provide for the Neck Pain Questionnaire for the purpose of this research will have all personal identifiers removed, so that my anonymity is preserved. I understand that I may withdraw myself or any information I provided for this project at any time prior to the completion of data collection, without being disadvantaged in any way. If I withdraw, I understand all relevant information will be destroyed.

I understand that by clicking “Yes”, I am agreeing to take part in this research project.

1. I understand that by clicking “Yes”, I am agreeing to take part in this research project.

Practitioner Information on Neck Pain Patients

Thank you for taking the time to complete the following short questionnaire on your neck pain patient. Your time and input is greatly appreciated.

Please Complete the Following
Practitioner Name:
Clinic Name:
Address 1:
Address 2:
City/Town:
Postal Code:
Country:
Email Address:
Phone Number:

I wish to receive a copy of the report from this research.

Please select your professional status.
Osteopath
Physiotherapist
Chiropractor

Patient Information

For the patient concerned please record their Gender.
Male
Female

How old was the patient?
<15 years
16-25 years
26-35 years
36-45 years
46-55 years
56-65 years
66-75 years
76-85 years
86-95 years
> 96 years

For this patient please describe their presenting complaint from the following list.
Neck Pain Only
Neck Pain with Headache
Neck Pain with Shoulder and Arm symptoms
Neck Pain with Headache, and Shoulder and Arm symptoms

The algorithm allowed the following sequences of questions.

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? YES

Has the patient had their current symptoms for less than 30 days? YES

On a pain scale of 0 to 10 is the patient's initial pain rating greater than 7? Or if you use the Neck Disability Index does the patient have an initial score greater than 52 YES

Pain Control

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? No

Has the patient had their current symptoms for less than 30 days? Yes

Is the patient over 60 years old? NO

Mobility

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? YES

Is the patient's headache affected by neck movement? YES

Has the patient a diagnosis or symptoms of migraines?

NO

Cervicogenic Headache

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? YES

Is the patient's headache affected by neck movement? YES

Has the patient a diagnosis or symptoms of migraines?

YES

Non-Cervicogenic Headache

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? YES

Is the patient's headache affected by neck movement? NO

Non-Cervicogenic Headache

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? NO

Has the patient had their current symptoms for less than 30 days? NO

Exercise

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? NO

Was the patient's chief complaint headaches with neck pain? NO

Has the patient had their current symptoms for less than 30 days? YES

Is the patient over 60 years old? YES

Exercise

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? YES

Has the patient had their current symptoms for less than 30 days? YES

On a pain scale of 0 to 10 is the patient's initial pain rating greater than 7? Or if you use the Neck Disability Index does the patient have an initial score greater than 52 NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. YES

Centralisation

Was the mode of onset for the patient from a motor vehicle accident or other whiplash mechanism? YES

Has the patient had their current symptoms for less than 30 days? YES

On a pain scale of 0 to 10 is the patient's initial pain rating greater than 7? Or if you use the Neck Disability Index does the patient have an initial score greater than 52 NO

Did the patient have any sharp shooting pain that appears to travel down the course of a nerve? The pain may have been accompanied by prickling, tingling, numbness, or muscle weakness. NO

Does the patient have any symptoms distal to the elbow(s) that appear to spread down the limb? YES

Centralisation

REFERENCES

Aas Randi, W., Tuntland, H., Holte Kari, A., Røe, C., Lund, T., Marklund, S., & Moller, A. (2011). Workplace interventions for neck pain in workers. *Cochrane Database of Systematic Reviews*, (4). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD008160/frame.html doi:10.1002/14651858.CD008160.pub2

Andersen, C. H., Andersen, L. L., Gram, B., Pedersen, M. T., Mortensen, O. S., Zebis, M. K., & Sjogaard, G. (2012). Influence of frequency and duration of strength training for effective management of neck and shoulder pain: a randomised controlled trial. *British Journal of Sports Medicine, 46*(14), 1004-1010. doi: 10.1136/bjsports-2011-090813

Andersen, L. L., Saervoll, C. A., Mortensen, O. S., Poulsen, O. M., Hannerz, H., & Zebis, M. K. (2011). Effectiveness of small daily amounts of progressive resistance training for frequent neck/shoulder pain: randomised controlled trial. *Pain, 152*(2), 440-446. doi: 10.1016/j.pain.2010.11.016

Anderson-Peacock, E., Blouin, J. S., Bryans, R., Danis, N., Furlan, A., Marcoux, H., . . . White, E. (2005). Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. *Journal of the Canadian Chiropractic Association, 49*(3), 158-209.

Aoyagi, M., Mani, R., Jayamoorthy, J., & Tumilty, S. (2014). Determining the level of evidence for the effectiveness of spinal manipulation in upper limb pain: A systematic review and meta-analysis. *Man Ther*. doi: 10.1016/j.math.2014.11.004

Beattie, P., & Nelson, R. (2006). Clinical prediction rules: What are they and what do they tell us? *Australian Journal of Physiotherapy, 52*(3), 157-163. doi: 10.1016/s0004-9514(06)70024-1

Beneciuk, J. M., Bishop, M. D., & George, S. Z. (2009). Clinical Prediction Rules for Physical Therapy Interventions: A Systematic Review. *Physical Therapy, 89*(2), 114-124. doi: 10.2522/ptj.20080239

Berggreen, S., Wiik, E., & Lund, H. (2012). Treatment of myofascial trigger points in female patients with chronic tension-type headache - a randomized controlled trial. *Advances in Physiotherapy, 14*(1), 10-17.

Bertozzi, L., Gardenghi, I., Turoni, F., Villafane, J. H., Capra, F., Guccione, A. A., & Pillastrini, P. (2013). Effect of therapeutic exercise on pain and disability in the management of chronic nonspecific neck pain: systematic review and meta-analysis of randomized trials. *Physical Therapy, 93*(8), 1026-1036. doi: 10.2522/ptj.20120412

Binkley, J., Finch, E., Hall, J., Black, T., & Gowland, C. (1993). Diagnostic Classification of Patients with Low Back Pain: Report on a Survey of Physical Therapy Experts. *Physical Therapy, 73*(3), 138-150.

Bogduk, N. (2003). The anatomy and pathophysiology of neck pain. *Physical Medicine and Rehabilitation Clinics of North America, 14*(3), 455-472. doi: http://dx.doi.org/10.1016/S1047-9651(03)00041-X

Borghouts, J., Janssen, H., Koes, B., Muris, J., Metsemakers, J., & Bouter, L. (1999). The management of chronic neck pain in general practice: A retrospective study. *Scandinavian Journal of Primary Health Care, 17*(4), 215-220. doi: doi:10.1080/028134399750002430

Borisut, S., Vongsirinavarat, M., Vachalathiti, R., & Sakulsriprasert, P. (2013). Effects of Strength and Endurance Training of Superficial and Deep Neck Muscles on Muscle Activities and Pain Levels of Females with Chronic Neck Pain. *Journal of Physical Therapy Science, 25*(9), 1157-1162. doi: 10.1589/jpts.25.1157

Boyles, R., Toy, P., Mellon, J., Hayes, M., & Hammer, B. (2011). Effectiveness of manual physical therapy in the treatment of cervical radiculopathy: a systematic review. *Journal of Manual & Manipulative Therapy, 19*(3), 135-142. doi: 10.1179/2042618611y.0000000011

Broberg, C., Aars, M., Beckmann, K., Emaus, N., Lehto, P., Lähteenmäki, M.-l., . . . Vandenberghe, R. (2003). A Conceptual Framework for Curriculum Design in Physiotherapy Education – an International Perspective. *Advances in Physiotherapy, 5*(4), 161-168. doi: 10.1080/14038190310017598

Bronfort, G., Evans, R., Anderson, A. V., Svendsen, K. H., Bracha, Y., & Grimm, R. H. (2012). Spinal manipulation, medication, or home exercise with advice for acute and subacute neck pain: a randomized trial. *Annals of Internal Medicine, 156*(1 Pt 1), 1-10. doi: 10.7326/0003-4819-156-1-201201030-00002

Bronfort, G., Evans, R., Nelson, B., Aker, P., Goldsmith, C., & Vernon, H. (2001). A randomized clinical trial of exercise and spinal manipulation for patients with chronic neck pain. *Spine, 26*(7), 788 - 797; discussion 798-789.

Bronfort, G., Haas, M., Evans, R., Leininger, B., & Triano, J. (2010). Effectiveness of manual therapies: the UK evidence report. *Chiropr Osteopat, 18*, 3. doi: 10.1186/1746-1340-18-3

Bryans, R., Decina, P., Descarreaux, M., Duranleau, M., Marcoux, H., Potter, B., . . . White, E. (2014). Evidence-Based Guidelines for the Chiropractic Treatment of Adults With Neck Pain. *Journal of Manipulative and Physiological Therapeutics, 37*(1), 42-63. doi: 10.1016/j.jmpt.2013.08.010

Bryans, R., Descarreaux, M., Duranleau, M., Marcoux, H., Potter, B., Ruegg, R., . . . White, E. (2011). Evidence-based guidelines for the chiropractic treatment of adults with headache. *Journal of Manipulative and Physiological Therapeutics, 34*(5), 274-289. doi: 10.1016/j.jmpt.2011.04.008

Buchbinder, R., Goel, V., Bombardier, C., & Hogg-Johnson, S. (1996). Classification systems of soft tissue disorders of the neck and upper limb: Do they satisfy methodological guidelines? *Journal of Clinical Epidemiology, 49*(2), 141-149. doi: 10.1016/0895-4356(95)00519-6

Cai, C., Ming, G., & Ng, L. Y. (2011). Development of a clinical prediction rule to identify patients with neck pain who are likely to benefit from home-based mechanical cervical traction. *European Spine Journal, 20*(6), 912-922.

Carlesso, L., MacDermid, J., Gross, A., Walton, D., & Santaguida, P. (2014). Treatment preferences amongst physical therapists and chiropractors for the management of neck pain: results of an international survey. *Chiropractic & Manual Therapies, 22*(1), 11.

Carroll, L. J., Hogg-Johnson, S., van der Velde, G., Haldeman, S., Holm, L. W., Carragee, E. J., . . . Cassidy, J. D. (2008). Course and Prognostic Factors for Neck Pain in the General Population: Results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine, 33(4S)*(Supplement), S75-S82.

Casanova-Méndez, A., Oliva-Pascual-Vaca, Á., Rodriguez-Blanco, C., Heredia-Rizo, A. M., Gogorza-Arroitaonandia, K., & Almazán-Campos, G. (2014). Comparative short-term effects of two thoracic spinal manipulation techniques in subjects with chronic mechanical neck pain: A randomized controlled trial. *Manual Therapy, 19*(4), 331-337.

Cheng, Y. H., & Huang, G. C. (2014). Efficacy of massage therapy on pain and dysfunction in patients with neck pain: a systematic review and meta-analysis. *Evidence-Based Complementary and Alternative Medicine, 2014*, 204360. doi: 10.1155/2014/204360

Childs, J., Fritz, J., Piva, S., & Whitman, J. (2004). Proposal of a classification system for patients with neck pain. *Journal of Orthopaedic & Sports Physical Therapy, 34*(11), 686-700.

Childs, J. D., Cleland, J. A., Elliott, J. M., Teyhen, D. S., Wainner, R. S., Whitman, J. M., . . . Flynn, T. W. (2008). Neck pain: Clinical practice guidelines linked to the international classification of functioning, disability, and health from the orthopaedic section of the american physical therapy association. *Journal of Orthopaedic and Sports Physical Therapy, 38*(9), A1-A34.

Childs, J. D., Fritz, J. M., Flynn, T. W., Irrgang, J. J., & et al. (2004). A Clinical Prediction Rule To Identify Patients with Low Back Pain Most Likely To Benefit from Spinal Manipulation: A Validation Study. *Annals of Internal Medicine, 141*(12), 920-928.

Clair, D. A., Edmondston, S. J., & Allison, G. T. (2006). Physical therapy treatment dose for nontraumatic neck pain: a comparison between 2 patient groups. *Journal of Orthopaedic and Sports Physical Therapy, 36*(11), 867-875. doi: 10.2519/jospt.2006.2299

Cleland, J., Childs, J., Fritz, J., Whitman, J., & Eberhart, S. (2007). Development of a clinical prediction rule for guiding treatment of a subgroup of patients with neck pain: use of thoracic spine manipulation, exercise, and patient education. *Physical Therapy, 87*(1), 9-23.

Cleland, J., Mintken, P., Carpenter, K., Fritz, J., Glynn, P., Whitman, J., . . . Hancock, M. (2010). Examination of a Clinical Prediction Rule to Identify Patients With Neck Pain Likely to Benefit From Thoracic Spine Thrust Manipulation and a General Cervical Range of Motion Exercise: Multi-Center Randomized Clinical Trial. *Physical Therapy, 90*(9), 1239-1253.

Cook, C., & Hegedus, E. (2011). Diagnostic utility of clinical tests for spinal dysfunction. *Manual Therapy, 16*(1), 21-25. doi: 10.1016/j.math.2010.07.004

Costa, L. d. C. M., Koes, B., Pransky, G., Borkan, J., Maher, C., & Smeets, R. (2013). Primary Care Research Priorities in Low Back Pain: An Update. *Spine, 38*(2), 148-156.

Cote, P., Cassidy, J. D., & Carroll, L. (1998). The Saskatchewan Health and Back Pain Survey: The Prevalence of Neck Pain and Related Disability in Saskatchewan Adults. *Spine, 23*(15), 1689-1698.

Côté, P., Cassidy, J. D., & Carroll, L. (2003). The epidemiology of neck pain: what we have learned from our population-based studies. *Journal of the Canadian Chiropractic Association, 47*(4), 284-290.

Cote, P., Cassidy, J. D., Carroll, L. J., & Kristman, V. (2004). The annual incidence and course of neck pain in the general population: a population-based cohort study. *Pain, 112*(3), 267-273. doi: 10.1016/j.pain.2004.09.004

Cote, P., van der Velde, G., Cassidy, J. D., Carroll, L., Hogg-Johnson, S., Holm, L., . . . Peloso, P. (2008). The Burden and Determinants of Neck Pain in Workers: Results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine, 33(4S)*(Supplement), S60-S74.

Cramer, H., Lauche, R., Hohmann, C., Lüdtke, R., Haller, H., Michalsen, A., . . . Dobos, G. (2013). Randomized-controlled Trial Comparing Yoga and Home-based Exercise for Chronic Neck Pain. *Clinical Journal of Pain, 29*(3), 216-223. doi: 10.1097/AJP.0b013e318251026c

Cross, K. M., Kuenze, C., Grindstaff, T. L., & Hertel, J. (2011). Thoracic spine thrust manipulation improves pain, range of motion, and self-reported function in patients with mechanical neck pain: a systematic review. *Journal of Orthopaedic and Sports Physical Therapy, 41*(9), 633-642. doi: 10.2519/jospt.2011.3670

D'Sylva, J., Miller, J., Gross, A., Burnie, S. J., Goldsmith, C. H., Graham, N., . . . Hoving, J. L. (2010). Manual therapy with or without physical medicine modalities for neck pain: a systematic review. *Manual Therapy, 15*(5), 415-433. doi: 10.1016/j.math.2010.04.003

Delitto, A., Erhard, R. E., & Bowling, R. W. (1995). A Treatment-Based Classification Approach to Low Back Syndrome: Identifying and Staging Patients for Conservative Treatment. *Physical Therapy, 75*(6), 470-485.

Driever, M. J. (2002). Are evidenced-based practice and best practice the same? *Western Jounal of Nursing Research, 24*(5), 591-597.

Dunning, J. R., Cleland, J. A., Waldrop, M. A., Arnot, C., Young, I., Turner, M., & Sigurdsson, G. (2012). Upper Cervical and Upper Thoracic Thrust Manipulation Versus Nonthrust Mobilization

in Patients With Mechanical Neck Pain: A Multicenter Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy, 42*(1), 5-18. doi: 10.2519/jospt.2012.3894

Eden, K., de Vries, P., Moss, J., Richards, C., & Oliver, C. (2014). Self-injury and aggression in tuberous sclerosis complex: cross syndrome comparison and associated risk markers. *Journal of Neurodevelopmental Disorders, 6*(1), 10.

Ellis, R., Hing, W., & Reid, D. (2007). Iliotibial band friction syndrome--a systematic review. *Manual Therapy, 12*(3), 200-208. doi: 10.1016/j.math.2006.08.004

Eriksen, W., Natvig, B., Knardahl, S., & Bruusgaard, D. (1999). Job Characteristics as Predictors of Neck Pain: A 4-Year Prospective Study. *Journal of Occupational & Environmental Medicine, 41*(10), 893-902.

Espi-Lopez, G., & Gomez-Conesa, A. (2014). Efficacy of manual and manipulative therapy in the perception of pain and cervical motion in patients with tension-type headache: a randomized, controlled clinical trial. *Journal of Chiropractic Medicine, 13*(1), 4-13.

Espí-López, G. V., Gómez-Conesa, A., Gómez, A. A., Martínez, J. B., Pascual-Vaca, Á. O., & Blanco, C. R. (2014). Treatment of tension-type headache with articulatory and suboccipital soft tissue therapy: A double-blind, randomized, placebo-controlled clinical trial. *J Bodyw Mov Ther*. doi: 10.1016/j.jbmt.2014.01.001

Evans, R., Bronfort, G., Schulz, C., Maiers, M., Bracha, Y., Svendsen, K., . . . Transfeldt, E. (2012). Supervised exercise with and without spinal manipulation performs similarly and better than home exercise for chronic neck pain: a randomized controlled trial. *Spine, 37*(11), 903-914.

Falla, D., Lindstrøm, R., Rechter, L., Boudreau, S., & Petzke, F. (2013). Effectiveness of an 8-week exercise programme on pain and specificity of neck muscle activity in patients with chronic neck pain: A randomized controlled study. *European Journal of Pain, 17*(10), 1517-1528. doi: 10.1002/j.1532-2149.2013.00321.x

Farrell, K. P., & Lampe, K. E. (2011). Implementation of a treatment based classification system for neck pain: a pilot study. *Orthopaedic Physical Therapy Practice, 23*(2), 91-96.

Fernández-de-las-Peñas, C., Cleland, J. A., Palomeque-del-Cerro, L., Caminero, A. B., Guillem-Mesado, A., & Jiménez-García, R. (2011). Development of a Clinical Prediction Rule for Identifying Women With Tension-Type Headache Who Are Likely to Achieve Short-Term Success With Joint Mobilization and Muscle Trigger Point Therapy. *Headache: The Journal of Head and Face Pain, 51*(2), 246-261. doi: 10.1111/j.1526-4610.2010.01789.x

Fernández-de-las-Peñas, C., & Courtney, C. A. (2014). Clinical reasoning for manual therapy management of tension type and cervicogenic headache. *Journal of Manual and Manipulative Therapy, 22*(1), 45-51.

Frank, A. O., De Souza, L. H., & Frank, C. A. (2005). Neck pain and disability: A cross-sectional survey of the demographic and clinical characteristics of neck pain seen in a rheumatology clinic. *International Journal of Clinical Practice, 59*(2), 173-182. doi: 10.1111/j.1742-1241.2004.00237.x

Fritz, J. M., & Brennan, G. P. (2007). Preliminary Examination of a Proposed Treatment-Based Classification System for Patients Receiving Physical Therapy Interventions for Neck Pain. *Physical Therapy, 87*(5), 513-524.

Fritz, J. M., Cleland, J. A., & Brennan, G. P. (2007). Does Adherence to the Guideline Recommendation for Active Treatments Improve the Quality of Care for Patients With Acute Low Back Pain Delivered by Physical Therapists? *Medical Care, 45*(10), 973-980.

Fritz, J. M., Cleland, J. A., & Childs, J. D. (2007). Subgrouping patients with low back pain: Evolution of a classification approach to physical therapy. *Journal of Orthopaedic and Sports Physical Therapy, 37*(6), 290-302.

Graham, N., Gross, A. R., Carlesso, L. C., Santaguida, P. L., Macdermid, J. C., Walton, D., & Ho, E. (2013). An ICON Overview on Physical Modalities for Neck Pain and Associated Disorders. *Open Orthop J, 7*, 440-460. doi: 10.2174/1874325001307010440

Gram, B., Andersen, C., Zebis, M. K., Bredahl, T., Pedersen, M. T., Mortensen, O. S., . . . Sjogaard, G. (2014). Effect of training supervision on effectiveness of strength training for reducing neck/shoulder pain and headache in office workers: cluster randomized controlled trial. *Biomed Res Int*.

Greening, J., & Lynn, B. (1998). Minor peripheral nerve injuries: an underestimated source of pain? *Manual Therapy, 3*(4), 187-194. doi: 10.1016/s1356-689x(98)80047-7

Gross, A., Miller, J., D'Sylva, J., Burnie Stephen, J., Goldsmith Charles, H., Graham, N., . . . Hoving Jan, L. (2010). Manipulation or Mobilisation for Neck Pain. *Cochrane Database of Systematic Reviews*, (1). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD004249/frame.html doi:10.1002/14651858.CD004249.pub3

Gross, A. R., Hoving, J., Haines, T. A., Goldsmith, C. H., Kay, T., Aker, P., & Bronfort, G. (2004). A Cochrane Review of Manipulation and Mobilization for Mechanical Neck Disorders. *Spine, 29*(14), 1541-1548.

Gross, A. R., Kaplan, F., Huang, S., Khan, M., Santaguida, P. L., Carlesso, L. C., . . . Hartvigsen, J. (2013). Psychological Care, Patient Education, Orthotics, Ergonomics and Prevention Strategies for Neck Pain: An Systematic Overview Update as Part of the ICON Project. *Open Orthop J, 7*, 530-561. doi: 10.2174/1874325001307010530

Guzman, J., Haldeman, S., Carroll, L. J., Carragee, E. J., Hurwitz, E. L., Peloso, P., . . . Hogg-Johnson, S. (2008). Clinical Practice Implications of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders: From Concepts and Findings to Recommendations. *Spine, 33(4S)*(Supplement), S199-S213.

Guzman, J., Hurwitz, E. L., Carroll, L. J., Haldeman, S., Cote, P., Carragee, E. J., . . . Cassidy, J. D. (2008). A New Conceptual Model of Neck Pain: Linking Onset, Course, and Care: The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine, 33(4S)*(Supplement), S14-S23.

Hancock, M. J., Maher, C. G., Latimer, J., Herbert, R. D., & McAuley, J. H. (2008). Independent evaluation of a clinical prediction rule for spinal manipulative therapy: a randomised controlled trial. *European Spine Journal, 17*(7), 936-943.

Hanney, W. J., Kolber, M. J., George, S. Z., Young, I., Patel, C. K., & Cleland, J. A. (2013). Development of a preliminary clinical prediction rule to identify patients with neck pain that may benefit from a standardized program of stretching and muscle performance exercise: a prospective cohort study. *Int J Sports Phys Ther, 8*(6), 756-776.

Hansson, E. K., & Hansson, T. H. (2005). The costs for persons sick-listed more than one month because of low back or neck problems. A two-year prospective study of Swedish patients. *European Spine Journal, 14*(4), 337-345. doi: 10.1007/s00586-004-0731-3

Hebert, J. J., & Fritz, J. M. (2012). Clinical decision rules, spinal pain classification and prediction of treatment outcome: A discussion of recent reports in the rehabilitation literature. *Chiropractic & Manual Therapies, 20*(1), n/a. doi: 10.1186/2045-709x-20-19

Heintz, M., & Hegedus, E. (2008). Multimodal Management of Mechanical Neck Pain Using a Treatment Based Classification System. *Journal of Manual & Manipulative Therapy, 16*(4), 217-224. doi: 10.1179/106698108790818260

Heredia Rizo, A. M., Pascual-Vaca, Á. O., Cabello, M. A., Blanco, C. R., Pozo, F. P., & Carrasco, A. L. (2012). Immediate Effects of the Suboccipital Muscle Inhibition Technique in Craniocervical Posture and Greater Occipital Nerve Mechanosensitivity in Subjects With a History of

Orthodontia Use: A Randomized Trial. *Journal of Manipulative and Physiological Therapeutics, 35*(6), 446-453. doi: 10.1016/j.jmpt.2012.06.006

Hopkins, W. G. P., Marshall, S. W. P., Quarrie, K. L., & Hume, P. A. P. (2007). Risk Factors and Risk Statistics for Sports Injuries. *Clinical Journal of Sport Medicine, 17*(3), 208-210.

Hoving, J. L., de Vet, H. C. W., Twisk, J. W. R., Devillé, W. L. J. M., van der Windt, D., Koes, B. W., & Bouter, L. M. (2004). Prognostic factors for neck pain in general practice. *Pain, 110*(3), 639-645. doi: 10.1016/j.pain.2004.05.002

Hoy, D. G., Protani, M., De, R., & Buchbinder, R. (2010). The epidemiology of neck pain. *Best Practice & Research Clinical Rheumatology, 24*(6), 783-792. doi: 10.1016/j.berh.2011.01.019

Huijbregts, P. (2007). Clinical Prediction Rules: Time to Sacrifice the Holy Cow. *Journal of Manual & Manipulative Therapy, 15*(1), 5-8. doi: 10.1179/106698107791090141

Huisman, P. A., Speksnijder, C. M., & de Wijer, A. (2013). The effect of thoracic spine manipulation on pain and disability in patients with non-specific neck pain: a systematic review. *Disability & Rehabilitation, 35*(20), 1677-1685. doi: 10.3109/09638288.2012.750689

Hurst, H., & Bolton, J. (2004). Assessing the clinical significance of change scores recorded on subjective outcome measures. *Journal of Manipulative and Physiological Therapeutics, 27*(1), 26-35. doi: 10.1016/j.jmpt.2003.11.003

Izquierdo Pérez, H., Alonso Perez, J. L., Gil Martinez, A., La Touche, R., Lerma-Lara, S., Commeaux Gonzalez, N., . . . Fernández-Carnero, J. (2014). Is one better than another?: A randomized clinical trial of manual therapy for patients with chronic neck pain. *Manual Therapy, 19*(3), 215-221. doi: http://dx.doi.org/10.1016/j.math.2013.12.002

Jette, A. M., Smith, K., Haley, S. M., & Davis, K. D. (1994). Physical Therapy Episodes of Care for Patients With Low Back Pain. *Physical Therapy, 74*(2), 101-110.

Jull, G., & Sterling, M. (2009). Bring back the biopsychosocial model for neck pain disorders. *Manual Therapy, 14*(2), 117-118. doi: 10.1016/j.math.2009.01.004

Karayannis, N. V., Jull, G. A., & Hodges, P. W. (2012). Physiotherapy movement based classification approaches to low back pain: Comparison of subgroups through review and developer/expert survey. *BMC Musculoskeletal Disorders, 13*.

Kay, T. M., Gross, A., Goldsmith, C. H., Rutherford, S., Voth, S., Hoving Jan, L., . . . Santaguida Pasqualina, L. (2012). Exercises for mechanical neck disorders. *Cochrane Database of Systematic Reviews*, (8). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD004250/frame.html doi:10.1002/14651858.CD004250.pub4

Klein, R., Bareis, A., Schneider, A., & Linde, K. (2013). Strain-counterstrain to treat restrictions of the mobility of the cervical spine in patients with neck pain: a sham-controlled randomized trial. *Complementary Therapies in Medicine, 21*(1), 1-7. doi: 10.1016/j.ctim.2012.11.003

Laupacis, A., Sekar, N., & Stiell, l. G. (1997). Clinical Prediction Rules: A Review and Suggested Modifications of Methodological Standards. *The Journal of the American Medical Association, 277*(6), 488-494. doi: 10.1001/jama.1997.03540300056034

Lidegaard, M., Jensen, R. B., Andersen, C. H., Zebis, M. K., Colado, J. C., Wang, Y., . . . Andersen, L. L. (2013). Effect of brief daily resistance training on occupational neck/shoulder muscle activity in office workers with chronic pain: randomized controlled trial. *BioMed Research International 2013;(262386):Epub*.

Lluch, E., Schomacher, J., Gizzi, L., Petzke, F., Seegar, D., & Falla, D. (2014). Immediate effects of active cranio-cervical flexion exercise versus passive mobilisation of the upper cervical spine on pain and performance on the cranio-cervical flexion test. *Manual Therapy, 19*(1), 25-31. doi: 10.1016/j.math.2013.05.011

MacDermid, J. C., Miller, J., & Gross, A. R. (2013). Knowledge Translation Tools are Emerging to Move Neck Pain Research into Practice. *Open Orthop J, 7*, 582-593. doi: 10.2174/1874325001307010582

MacDermid, J. C., Walton, D. M., Cote, P., Santaguida, P. L., Gross, A., & Carlesso, L. (2013). Use of outcome measures in managing neck pain: an international multidisciplinary survey. *Open Orthop J, 7*, 506-520. doi: 10.2174/1874325001307010506

MacDermid, J. C., Walton, D. M., & Miller, J. (2013). What is the Experience of Receiving Health Care for Neck Pain? *Open Orthop J, 7*, 428-439. doi: 10.2174/1874325001307010428

Mahajan, R., Kataria, C., & Bansal, K. (2012). Comparative Effectiveness of Muscle Energy Technique and Static Stretching for Treatment of Subacute Mechanical Neck Pain. *International Journal of Health and Rehabilitation Sciences, 1*(1), 16-24.

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro Scale for rating quality of randomized controlled trials. *Physical Therapy, 83*(8), 713-721.

Maiers, M., Bronfort, G., Evans, R., Hartvigsen, J., Svendsen, K., Bracha, Y., . . . Grimm, R. (2014a). Spinal manipulative therapy and exercise for seniors with chronic neck pain. *Spine J, 14*(9), 1879-1889. doi: 10.1016/j.spinee.2013.10.035

Maiers, M., Bronfort, G., Evans, R., Hartvigsen, J., Svendsen, K., Bracha, Y., . . . Grimm, R. (2014b). Spinal manipulative therapy and exercise for seniors with chronic neck pain. *The Spine Journal, 14*(9), 1879-1889. doi: 10.1016/j.spinee.2013.10.035

Martinez-Segura, R., de-la-Llave-Rincon, A. I., Ortega-Santiago, R., Cleland, J. A., & Fernandez-de-las-Penas, C. (2012). Immediate changes in widespread pressure pain sensitivity, neck pain, and cervical range of motion after cervical or thoracic thrust manipulation in patients with bilateral chronic mechanical neck pain: a randomized clinical trial [with consumer summary]. *The Journal of Orthopaedic and Sports Physical Therapy, 42*(9), 806-814.

Masaracchio, M., Cleland, J., Hellman, M., & Hagins, M. (2013). Short-Term Combined Effects of Thoracic Spine Thrust Manipulation and Cervical Spine Nonthrust Manipulation in Individuals With Mechanical Neck Pain: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy, 43*(3), 118-127. doi: 10.2519/jospt.2013.4221

McGinn, T. G., Guyatt, G. H., Wyer, P. C., Naylor, C. D., Stiell, I. G., & Richardson, W. S. (2000). Users' Guides to the Medical Literature. *JAMA: The Journal of the American Medical Association, 284*(1), 79-84. doi: 10.1001/jama.284.1.79

McLean, S. M., Klaber Moffett, J. A., Sharp, D. M., & Gardiner, E. (2013). A randomised controlled trial comparing graded exercise treatment and usual physiotherapy for patients with non-specific neck pain (the GET UP neck pain trial). *Manual Therapy, 18*(3), 199-205. doi: 10.1016/j.math.2012.09.005

McLean, S. M., Moffett, J. K., Sharp, D. M., & Gardiner, E. (2011). An investigation to determine the association between neck pain and upper limb disability for patients with non-specific neck pain: A secondary analysis. *Manual Therapy, 16*(5), 434-439.

Miller, J., Gross, A., D'Sylva, J., Burnie, S. J., Goldsmith, C. H., Graham, N., . . . Hoving, J. L. (2010). Manual therapy and exercise for neck pain: A systematic review. *Manual Therapy*. doi: 10.1016/j.math.2010.02.007

Murphy, D. R., & Hurwitz, E. L. (2007). A theoretical model for the development of a diagnosis-based clinical decision rule for the management of patients with spinal pain. *BMC Musculoskeletal Disorders, 8*(1), 75.

Nagrale, A. V., Glynn, P., Joshi, A., & Ramteke, G. (2010). The efficacy of an integrated neuromuscular inhibition technique on upper trapezius trigger points in subjects with non-specific neck pain: a

randomized controlled trial. *Journal of Manual and Manipulative Therapy, 18*(1), 37-43. doi: 10.1179/106698110x12595770849605

Nee, R. J., & Coppieters, M. W. (2011). Interpreting research on clinical prediction rules for physiotherapy treatments. *Manual Therapy, 16*(2), 105-108. doi: 10.1016/j.math.2010.10.005

O'Leary, S., Jull, G., Kim, M., Uthaikhup, S., & Vicenzino, B. (2012). Training Mode–Dependent Changes in Motor Performance in Neck Pain. *Archives of Physical Medicine & Rehabilitation, 93*(7), 1225-1233. doi: 10.1016/j.apmr.2012.02.018

O'Riordan, C., Clifford, A., Van De Ven, P., & Nelson, J. (2014). Chronic neck pain and exercise interventions: frequency, intensity, time, and type principle. *Archives of Physical Medicine & Rehabilitation, 95*(4), 770-783. doi: 10.1016/j.apmr.2013.11.015

Patel, S., Psychol, C., Friede, T. P., Froud, R., Evans, D. W., & Underwood, M. Systematic review of randomised controlled trials of clinical prediction rules for physical therapy in low back pain. *Spine*.

Pavan, P. G., Stecco, A., Stern, R., & Stecco, C. (2014). Painful connections: densification versus fibrosis of fascia. *Curr Pain Headache Rep, 18*(8), 441. doi: 10.1007/s11916-014-0441-4

Petersen, T., Thorsen, H., Manniche, C., & Ekdahl, C. (1999). Classification of non-specific low back pain: a review of the literature on classifications systems relevant to physiotherapy. *Physical Therapy Reviews, 4*(4), 265-281. doi: 10.1179/108331999786821690

Puentedura, E. J., Cleland, J. A., Landers, M. R., Mintken, P., Louw, A., & Fernández-De-Las-Peñas, C. (2012). Development of a clinical prediction rule to identify patients with neck pain likely to benefit from thrust joint manipulation to the cervical spine. *Journal of Orthopaedic and Sports Physical Therapy, 42*(7), 577-592.

Racicki, S., Gerwin, S., Diclaudio, S., Reinmann, S., & Donaldson, M. (2013). Conservative physical therapy management for the treatment of cervicogenic headache: a systematic review. *Journal of Manual & Manipulative Therapy, 21*(2), 113-124. doi: 10.1179/2042618612Y.0000000025

Raney, N., Petersen, E., Smith, T., Cowan, J., Rendeiro, D., Deyle, G., & Childs, J. (2009). Development of a clinical prediction rule to identify patients with neck pain likely to benefit from cervical traction and exercise. *European Spine Journal, 18*(3), 382-391. doi: 10.1007/s00586-008-0859-7

Reid, D., Rydwanski, J., Hing, W., & White, S. (2012). The effectiveness of post-operative rehabilitation following partial meniscectomy of the knee. *Physical Therapy Reviews, 17*(1), 45-54. doi: 10.1179/1743288x11y.0000000046

Reilly, B. M., & Evans, A. T. (2006). Translating Clinical Research into Clinical Practice: Impact of Using Prediction Rules To Make Decisions. *Annals of Internal Medicine, 144*(3), 201-W236.

Rhee, J. M., Yoon, T., & Riew, K. D. (2007). Cervical Radiculopathy. *Journal of the American Academy of Orthopaedic Surgeons, 15*(8), 486-494.

Rose, S. J. (1989). Physical Therapy Diagnosis: Role and Function. *Physical Therapy, 69*(7), 535-537.

Saavedra-Hernández, M., Arroyo-Morales, M., Cantarero-Villanueva, I., Fernández-Lao, C., Castro-Sánchez, A. M., Puentedura, E. J., & Fernández-de-las-Peñas, C. (2013). Short-term effects of spinal thrust joint manipulation in patients with chronic neck pain: a randomized clinical trial. *Clinical Rehabilitation, 27*(6), 504-512. doi: 10.1177/0269215512464501

Saavedra-Hernández, M., Castro-Sánchez, A. M., Arroyo-Morales, M., Cleland, J. A., Lara-Palomo, I. C., & Fernández-de-las-Peñas, C. (2012). Short-Term Effects of Kinesio Taping Versus Cervical Thrust Manipulation in Patients With Mechanical Neck Pain: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy, 42*(8), 724-730. doi: 10.2519/jospt.2012.4086

Saavedra-Hernández, M., Castro-Sánchez, A. M., Fernández-de-las-Peñas, C., Cleland, J. A., Ortega-Santiago, R., & Arroyo-Morales, M. (2011). Predictors for Identifying Patients With Mechanical Neck Pain Who Are Likely to Achieve Short-Term Success With Manipulative Interventions Directed at the Cervical and Thoracic Spine. *Journal of Manipulative and Physiological Therapeutics, 34*(3), 144-152. doi: 10.1016/j.jmpt.2011.02.011

Salo, P., Ylönen-Käyr, N., Häkkinen, A., Kautiainen, H., Mälki, E., & Ylinen, J. (2012). Effects of long-term home-based exercise on health-related quality of life in patients with chronic neck pain: A randomized study with a 1-year follow-up. *Disability & Rehabilitation, 34*(23), 1971-1977.

Salom-Moreno, J., Ortega-Santiago, R., Cleland, J. A., Palacios-Cena, M., Truyols-Dominguez, S., & Fernandez-de-las-Penas, C. (2014). Immediate changes in neck pain intensity and widespread pressure pain sensitivity in patients with bilateral chronic mechanical neck pain: a randomized controlled trial of thoracic thrust manipulation versus non-thrust mobilization [with consumer summary]. *Journal of Manipulative and Physiological Therapeutics 2014 Jun;37(5):312-319*.

Schellingerhout, J. M., Verhagen, A. P., Heymans, M. W., Pool, J. J. M., Vonk, F., Koes, B. W., & de Vet, H. C. W. (2008). Which subgroups of patients with non-specific neck pain are more likely to benefit from spinal manipulation therapy, physiotherapy, or usual care? *Pain, 139*(3), 670-680. doi: 10.1016/j.pain.2008.07.015

Schroeder, J., Kaplan, L., Fischer, D. J., & Skelly, A. C. (2013). The Outcomes of Manipulation or Mobilization Therapy Compared with Physical Therapy or Exercise for Neck Pain: A Systematic Review. *Evid Based Spine Care J, 4*(1), 30-41. doi: 10.1055/s-0033-1341605

Shin, E. J., & Lee, B. H. (2014). The effect of sustained natural apophyseal glides on headache, duration and cervical function in women with cervicogenic headache. *Journal of Exercise Rehabilitation, 10*(2), 131-135.

Slaven, E. J., Goode, A. P., Coronado, R. A., Poole, C., & Hegedus, E. J. (2013). The relative effectiveness of segment specific level and non-specific level spinal joint mobilization on pain and range of motion: results of a systematic review and meta-analysis. *Journal of Manual & Manipulative Therapy, 21*(1), 7-17. doi: 10.1179/2042618612Y.0000000016

Snodgrass, S. J., Rivett, D. A., Sterling, M., & Vicenzino, B. (2014). Dose Optimization for Spinal Treatment Effectiveness: A Randomized Controlled Trial Investigating the Effects of High and Low Mobilization Forces in Patients With Neck Pain. *Journal of Orthopaedic & Sports Physical Therapy, 44*(3), 141-152. doi: 10.2519/jospt.2014.4778

Southerst, D., Nordin, M. C., Cote, P., Shearer, H. M., Varatharajan, S., Yu, H., . . . Taylor-Vaisey, A. L. (2014). Is exercise effective for the management of neck pain and associated disorders or whiplash-associated disorders? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *The Spine Journal*. doi: 10.1016/j.spinee.2014.02.014

Stanton, T. R., Fritz, J. M., Hancock, M. J., Latimer, J., Maher, C. G., Wand, B. M., & Parent, E. C. (2011). Evaluation of a Treatment-Based Classification Algorithm for Low Back Pain: A Cross-Sectional Study. *Physical Therapy, 91*(4), 496-509. doi: 10.2522/ptj.20100272

Stanton, T. R., Hancock, M. J., Maher, C. G., & Koes, B. W. (2010). Critical Appraisal of Clinical Prediction Rules That Aim to Optimize Treatment Selection for Musculoskeletal Conditions. *Physical Therapy, 90*(6), 843-854. doi: 10.2522/ptj.20090233

Stecco, A., Gesi, M., Stecco, C., & Stern, R. (2013). Fascial components of the myofascial pain syndrome. *Curr Pain Headache Rep, 17*(8), 352. doi: 10.1007/s11916-013-0352-9

Stecco, A., Meneghini, A., Stern, R., Stecco, C., & Imamura, M. (2014). Ultrasonography in myofascial neck pain: randomized clinical trial for diagnosis and follow-up. *Surgical and Radiologic Anatomy, 36*(3), 243-253. doi: 10.1007/s00276-013-1185-2

Stecco, C., Stern, R., Porzionato, A., Macchi, V., Masiero, S., Stecco, A., & De Caro, R. (2011). Hyaluronan within fascia in the etiology of myofascial pain. *Surg Radiol Anat, 33*(10), 891-896. doi: 10.1007/s00276-011-0876-9

Stucki, G. (2005). International Classification of Functioning, Disability, and Health (ICF): A Promising Framework and Classification for Rehabilitation Medicine. *American Journal of Physical Medicine & Rehabilitation, 84*(10), 733-740.

Sueki, D. G., Cleland, J. A., & Wainner, R. S. (2013). A regional interdependence model of musculoskeletal dysfunction: research, mechanisms, and clinical implications. *Journal of Manual & Manipulative Therapy, 21*(2), 90-102. doi: 10.1179/2042618612y.0000000027

Sutton, D. A., Cote, P., Wong, J. J., Varatharajan, S., Randhawa, K. A., Yu, H., . . . Stupar, M. (2014). Is multimodal care effective for the management of patients with whiplash-associated disorders or neck pain and associated disorders? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *The Spine Journal*. doi: 10.1016/j.spinee.2014.06.019

Takasaki, H., & May, S. (2014). Mechanical Diagnosis and Therapy has similar effects on pain and disability as 'wait and see' and other approaches in people with neck pain: a systematic review. *Journal of Physiotherapy, 60*(2), 78-84. doi: 10.1016/j.jphys.2014.05.006

Thiel, H. W., & Bolton, J. E. (2008). Predictors For Immediate and Global Responses to Chiropractic Manipulation of the Cervical Spine. *Journal of Manipulative and Physiological Therapeutics, 31*(3), 172-183. doi: 10.1016/j.jmpt.2008.02.007

Tsakitzidis, G., Remmen, R., Peremans, L., Van Royen, P., Duchesnes, C., Paulus, D., & Eyssen, M. (2009). Non-specific neck pain: diagnosis and treatment *Good Clinical Practice (GCP)* (Vol. 119C). Brussels: Belgian Health Care Knowledge Centre (KCE).

Tsauo, J. Y., Jang, Y., Du, C. L., & Liang, H. W. (2007). Incidence and risk factors of neck discomfort: a 6-month sedentary-worker cohort study. *J Occup Rehabil, 17*(2), 171-179. doi: 10.1007/s10926-007-9076-1

Tseng, Y.-L., Wang, W. T. J., Chen, W.-Y., Hou, T.-J., Chen, T.-C., & Lieu, F.-K. (2006). Predictors for the immediate responders to cervical manipulation in patients with neck pain. *Manual Therapy, 11*(4), 306-315. doi: 10.1016/j.math.2005.08.009

Tsertsvadze, A., Clar, C., Court, R., Clarke, A., Mistry, H., & Sutcliffe, P. (2014). Cost-effectiveness of manual therapy for the management of musculoskeletal conditions: a systematic review and narrative synthesis of evidence from randomized controlled trials. *Journal of Manipulative & Physiological Therapeutics, 37*(6), 343-362. doi: 10.1016/j.jmpt.2014.05.001

Vincent, K., Maigne, J. Y., Fischhoff, C., Lanlo, O., & Dagenais, S. (2013). Systematic review of manual therapies for nonspecific neck pain. *Joint Bone Spine, 80*(5), 508-515. doi: 10.1016/j.jbspin.2012.10.006

Vonk, F., Pool, J. J. M., Ostelo, R. W. J. G., & Verhagen, A. P. (2009). Physiotherapists' treatment approach towards neck pain and the influence of a behavioural graded activity training: An exploratory study. *Manual Therapy, 14*(2), 131-137. doi: http://dx.doi.org/10.1016/j.math.2007.12.005

Walker-Bone, K., Reading, I., Coggon, D., Cooper, C., & Palmer, K. T. (2004). The anatomical pattern and determinants of pain in the neck and upper limbs: an epidemiologic study. *Pain, 109*(1–2), 45-51. doi: 10.1016/j.pain.2004.01.008

Walker, B., Stomski, N., Hebert, J., & French, S. (2013). A survey of Australian chiropractors' attitudes and beliefs about evidence-based practice and their use of research literature and clinical practice guidelines. *Chiropractic & Manual Therapies, 21*(1), 44.

Walton, D. M., Carroll, L. J., Kasch, H., Sterling, M., Verhagen, A. P., Macdermid, J. C., . . . Carlesso, L. (2013). An Overview of Systematic Reviews on Prognostic Factors in Neck Pain: Results from the International Collaboration on Neck Pain (ICON) Project. *Open Orthop J, 7*, 494-505. doi: 10.2174/1874325001307010494

Wang, W. T. J., Olson, S. L., Campbell, A. H. M., Hanten, W. P., & Gleeson, P. B. (2003). Effectiveness of Physical Therapy for Patients with Neck Pain: An Individualized Approach Using a Clinical Decision-Making Algorithm. *American Journal of Physical Medicine & Rehabilitation, 82*(3), 203-218.

Ward, R. (2003). *Foundations for Osteopathic Medicine* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins.

Werneke, M., Hart, D., & Cook, D. (1999). A Descriptive Study of the Centralization Phenomenon: A Prospective Analysis. *Spine, 24*(7), 676-683.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., Mannetje, A. t., . . . Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. *International Journal of Industrial Ergonomics, 41*(5), 561-572. doi: http://dx.doi.org/10.1016/j.ergon.2011.06.002

Widerström, B., Olofsson, N., Arvidsson, I., Harms-Ringdahl, K., & Larsson, U. E. (2012). Inter-examiner reliability of a proposed decision-making treatment based classification system for low back pain patients. *Manual Therapy, 17*(2), 164-171. doi: 10.1016/j.math.2011.12.009

Yalcinkaya, H., Ucok, K., Ulasli, A. M., Coban, N. F., Aydin, S., Kaya, I., . . . Tugrul Senay, T. (2014). Do male and female patients with chronic neck pain really have different health-related physical fitness, depression, anxiety and quality of life parameters? *International Journal of Rheumatic Diseases*, n/a-n/a. doi: 10.1111/1756-185X.12389

Young, J. L., Walker, D., Snyder, S., & Daly, K. (2014). Thoracic manipulation versus mobilization in patients with mechanical neck pain: a systematic review. *Journal of Manual & Manipulative Therapy, 22*(3), 141-153. doi: 10.1179/2042618613Y.0000000043

Youssef, E. F., & Shanb, A. S. (2013). Mobilization versus massage therapy in the treatment of cervicogenic headache: a clinical study. *J Back Musculoskelet Rehabil, 26*(1), 17-24. doi: 10.3233/bmr-2012-0344