Development of aspects of Mechanical Diagnosis and Therapy

Stephen May

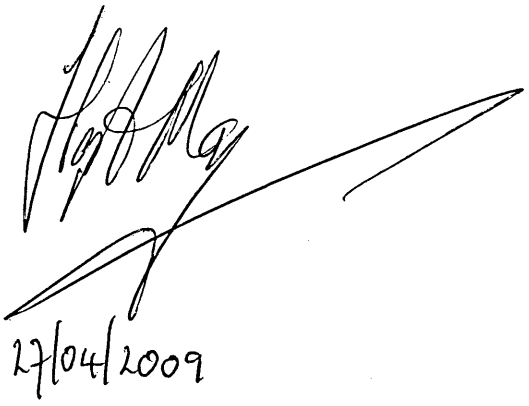
Published works submitted in partial fulfilment of the requirements of Sheffield Hallam University for the degree of Doctor of Philosophy on the basis of published work

April 2009

Declaration

I, Stephen May, hereby declare that this submission is my own work and that it contains no work published or written by another person except where acknowledged in the text. Nor does it contain material that has been accepted for another degree at this or any other university.

Much of the work submitted here was co-authored; all collaborating authors signed consent forms for the use of this material and my majority contribution to that work. These signed forms were in in the initial submission, but are not included here.



27/04/2009

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Abstract

Mechanical Diagnosis and Therapy is a system of classification, assessment and management applied to all musculoskeletal problems that is used by clinicians worldwide. The first section concerns the up-dating and contextualising of Mechanical Diagnosis and Therapy (MDT). The books, co-authored with the founder of MDT, Robin McKenzie, applied the principles to extremity musculoskeletal problems, and then set MDT in the contemporary evidence-based background for lumbar, cervical and thoracic problems. This involved an up-dating of the classification system, as well as synthesis and analysis of aspects of musculoskeletal medicine.

The second section presents a patient perspective on musculoskeletal problems. This involves an exploration of patient opinions about back pain and its management, and an audit of outcomes in a clinical setting in which an active exercise-based treatment approach was applied.

The third section relates to a number of publications that sought to validate aspects of MDT. Centralisation is a key finding during the assessment of spinal patients and work on this included a systematic review of the relevant literature and an analysis of centralisation in patients with sciatica. In another study we conducted a secondary analysis of a published trial to see what happened if patients were crossed-over from exercises that were unmatched with directional preference to matched exercises. We published a case-control study that validates the postural syndrome and measured the prevalence rates of MDT classifications in the patient population. Reliability is a key

component of any musculoskeletal assessment system in which clinicians are making management decisions based on physical examination procedures – a systematic review that detailed the reliability of MDT compared to other commonly used examination procedures was an important contribution to the literature. Overall these works have led to a significant independent and original contribution to knowledge and understanding of MDT.

¶ 1 Table 1. List of publications submitted

N	Details of the Published Work
#1	McKenzie R, May S (2000). *The Human Extremities: Mechanical Diagnosis and Therapy.* Spinal Publications New Zealand Ltd.
#2	McKenzie R, May S (2003). *The Lumbar Spine: Mechanical Diagnosis and Therapy (Volumes 1 and 2).* Spinal Publications New Zealand Ltd (2nd Edition).
#3	McKenzie R, May S (2006). *The Cervical and Thoracic Spine: Mechanical Diagnosis and Therapy (Volumes 1 and 2).* Spinal Publications New Zealand Ltd (2nd Edition).
#4	Aina A, May S (2005). A shoulder derangement. Manual Therapy 10.159-163.
#5	Littlewood C, May S (2007). A contractile dysfunction of the shoulder. Manual Therapy 12.80-83.
#6	May S (2007). Patients' attitudes and beliefs about back pain and its management after physiotherapy for low back pain. Physiotherapy Research International 12.126-135.
#7	May S (2003). Implementation of outcome measures for musculoskeletal physiotherapy in primary care: an audit. Physiotherapy Theory and Practice 19.189-198.
#8	Aina A, May S, Clare H (2004). The centralisation phenomenon of spinal symptoms – a systematic review. Manual Therapy 9.134-143.
#9	Sytte L, May S, Petersen P (2005). Centralisation - its prognostic value in patients with referred symptoms and sciatica. Spine 30.E293-E299.
#10	Long A, May S, Fung T (2008). Specific directional preference exercises for patients with low back pain: A case series. Physiotherapy Canada 60.307-317.
#11	Womersley L, May S (2006). Sitting posture of subjects with postural backache. Journal of Manipulative and Physiological Therapeutics 29.213-218.
#12	May S, Littlewood C, Bishop A (2006). Reliability of procedures used in the physical examination of non-specific low back pain: a systematic review. Australian Journal of Physiotherapy 52.91-102.
#13	May S (2006). Classification by McKenzie's Mechanical Syndromes: A survey of McKenzie-trained faculty. Journal of Manipulative and Physiological Therapeutics 29.637-642.
#14	May S. Rosedale R (2007). A case study of a potential manipulation responder whose back pain resolved with flexion exercises. Journal of Manipulative and Physiological Therapeutics 30.539-542.

¶ 2 Rationale for choosing submitted work

In selecting which works to submit for the award of PhD by previous publications I have been guided by certain principles inherent in any such work, namely the need for:

- Consistency
- Common themes
- Originality and impact
- International dimensions.

The underpinning works are a number of co-authored books (McKenzie and May 2000, 2003, 2006). These books were written over a number of years, with the latter two being second editions of McKenzie's earlier works (McKenzie 1981, 1990); and were firmly grounded in the contemporary evidence base relating to musculoskeletal problems.

Mechanical Diagnosis and Therapy is a system of classification, assessment and management applied to all musculoskeletal problems that is used by clinicians worldwide. The first section of the PhD by previous publications concerns the up-dating and contextualising of Mechanical Diagnosis and Therapy (MDT). The books, co-authored with the founder of MDT, Robin McKenzie, applied the principles to extremity musculoskeletal problems (#1, McKenzie and May 2000), and then set MDT in the contemporary evidence-based background for lumbar (#2, McKenzie and May 2003), and cervical and thoracic problems (#3, McKenzie and May 2006). This involved an up-dating of the classification system, as well as synthesis and analysis of aspects of

musculoskeletal medicine. As these volumes comprise more than 1,500 pages in total, which were all freshly written for these new editions, the focus here will be on just a few chapters of the books as examples of this process.

The second section presents a patient perspective on musculoskeletal problems. This involves an exploration of patient opinions about back pain and its management (#6, May 2007), an audit of outcomes in a clinical setting in which an active exercise-based treatment approach was applied (#7, May 2003), and a chapter from one of the books on patient management.

The third section relates to a number of publications that sought to validate different aspects of MDT. Centralisation is a key finding during the assessment of spinal patients and work on this included the first ever systematic review of this clinical phenomenon (#8, Aina, May, Clare 2004) and the first ever analysis of centralisation in patients with sciatica (#9, Sytte, May, Petersen 2005). Following a landmark trial (Long et al. 2004) in which patients were matched or unmatched to their directional preference exercise group we conducted a secondary analysis to see what happened if patients crossed-over from unmatched to matched exercises (#10, Long, May, Fung, *In Press*).

There was no published work validating the postural syndrome, one of the MDT mechanical syndromes, until our recent case-control study (#11, Womersley and May 2006). There was also limited direct measurement of the prevalence rates of MDT classifications in the patient population of interest until a recent international survey (#13 May 2006). Reliability is a key component of any musculoskeletal assessment system in

which clinicians are making management decisions based on physical examination procedures – a systematic review that detailed the reliability of MDT compared to other commonly used examination procedures was an important contribution to the literature (#12, May, Littlewood, Bishop 2006). Besides these works three case studies are also included (#4, Aina and May 2005; #5, Littlewood and May 2007; #14, May and Rosedale 2007).

In selecting the works for submission it will be observed that they represent a wide range of different types of work, including text books, case studies, systematic reviews and studies with qualitative and quantitative analysis, but all will hopefully demonstrate a grasp of theoretical and evidence-based issues, underpinned by clinical relevance. The theme to which they all relate, namely Mechanical Diagnosis and Therapy, is principally a well established tool for clinicians that is used worldwide, but the underpinning science behind MDT continues to develop, and these submissions are part of that on-going process.

As these works were written for clinical practitioners and for peer-reviewed journals they do not conform to the normal format of a PhD thesis, a use for which they were not intended at the time of writing. They are distinguished by the requirements of different journals and publication requirements, but they are linked by authorship and by theme, and by a knowledge base founded in evidence-based clinical practice.

Most of the works submitted here were co-authored. This reflects my commitment to a collective approach to research, scholarship and writing. My collaborations include a

number that are with international colleagues, and reflects the international dimensions of the work and this particular approach to musculoskeletal problems. However this collective approach to work is in distinction from the normal approach to the submission of a PhD with its emphasis on clearly defined single ownership of intellectual copyright. Given this divergence from the standard PhD my specific contributions will be defined in section ¶ **9**, as far as this can be done, and letters of confirmation from co-authors will be provided. However given the complexities and multiple drafting that is involved with collaborative work these will at times be estimates of my contributions.

Sections will address my commitment to research and publication, and the international dimensions of my work on MDT; the submitted works will then be described and appraised, references will follow, then statements from collaborating authors, then copies of the articles (numbered as on page 8), and finally the appendices. Other published work will be referenced as appropriate, but the submission relates to the books and articles listed on page 8 (identified as #1-14, Harvard reference). The textbooks are provided separately (numbered as on page 8).

¶ 3 Commitment to research and publication over time

Since starting to write for the then UK McKenzie Newsletter in 1993, which has now been superseded by the International Journal of Mechanical Diagnosis and Therapy, I have contributed over 20 reviews to these journals on a number of topics, as well as numerous reviews of individual articles (Appendix 11.1). Besides the books and articles already mentioned I have contributed chapters to 3 books and contributed to about 20 articles published in peer review journals in total (Appendix 11.2). I have also been involved in a number of other research and review projects, including being involved in the development of a number of guidelines (Appendix 11.3). I continue to contribute to peer reviewed journals and to the International Journal of Mechanical Diagnosis and Therapy, and I provide peer review for a number of international journals: Physiotherapy Theory and Practice, Physiotherapy, Manual Therapy, Spine, Journal of Manipulative and Physiological Therapeutics, Physical Therapy, and Pain. I continue to be involved in a number of on-going research projects; and in most instances this is collaborative work with UK or international colleagues. On-going projects involve an analysis of clinical reasoning in experts and novice clinicians, a trial with chronic back pain patients investigating the role of directional preference exercises, and two reliability studies on the use of Mechanical Diagnosis and Therapy in the extremities. I also have a number of additional articles accepted for publication and *In Press* (Appendix 11.2).

The three text books and publications submitted for consideration for this PhD by publication thus represents a proportion of my overall output, but these works have been selected as they cluster around several key themes that relate to Mechanical Diagnosis

and Therapy. I trust that the chosen works and the rest of my portfolio demonstrate commitment to scholarship; research, writing and a sustained ability to publish.

¶ 4 international dimensions

Robin McKenzie first conducted educational courses in the USA in the early 1970s; since then the educational programme has extended its reach considerably. The McKenzie Institute International Educational Programme has now held courses in 45 countries in all continents of the globe and there are branches in 24 of these countries. The McKenzie approach has become widely used around the world as demonstrated by surveys of physical therapy practice in the USA (Battie et al. 1994, Sullivan et al. 1996), Canada (Poitras et al. 2005), the UK and Ireland (Turner et al. 1999, Foster et al. 1999, Jackson 2001, Gracey et al. 2002, Byrne et al. 2006), Denmark (Hamm et al. 2003), and Australia (Turner 2002).

The text books that are being used as part of this submission are on sale in about 20 countries, and worldwide sales to date (15/05/2008)[1] are as follows:

Table 2. Sale of textbooks included in submission

Text	Sales[1]
#1, McKenzie R, May S (2000). *The Human Extremities: Mechanical Diagnosis and Therapy.* Spinal Publications New Zealand Ltd.	4,525
#2, McKenzie R, May S (2003). *The Lumbar Spine: Mechanical Diagnosis and Therapy (Volumes 1 and 2).* Spinal Publications New Zealand Ltd (2nd Edition).	4,602
#3, McKenzie R, May S (2006). *The Cervical and Thoracic Spine: Mechanical Diagnosis and Therapy (Volumes 1 and 2).* Spinal Publications New Zealand Ltd (2nd Edition).	1,491

[1] Data from Spinal Publications New Zealand Ltd.

¶ 5 Coherent themes

¶ 5.1 Introduction

Mechanical Diagnosis and Therapy (MDT) is a system of classification, assessment and management applied to all musculoskeletal problems that is used by clinicians worldwide. It was founded on the ideas of Robin McKenzie a New Zealand physiotherapist who wrote textbooks for clinicians (McKenzie 1981, 1990) as well as self help manuals for patients (McKenzie 1980, 1983). With these publications a logical system of assessment and management directed at mechanical syndromes was presented. It provided a structured system that is patient-centred and affects the psychological aspects of a spine pain episode, as demonstrated in trials using psychometric outcome measures (Long et al. 2004, Klaber-Moffett et al. 2006). It may achieve this by offering patients a method to control and abolish their symptoms. It is a system that is alert to the epidemiological aspects of spine pain as it emphasised self-management, with the ability to help with secondary prevention of back pain illustrated by Larssen et al. (2002). And a system that permits early recognition of non-responders and 'red flags', when classification into a mechanical syndrome fails to be made (McKenzie and May 2004, May 2006b).

My involvement with the McKenzie approach began formally in 1993 when I began taking the post-graduate training courses in the approach and then completed a Diploma in Mechanical Diagnosis and Therapy, the highest educational attainment in the training programme, in 1995. I made numerous contributions to the UK McKenzie Newsletter

and International Journal of Mechanical Diagnosis and Therapy as detailed already (appendix 1). It was through this work that Robin McKenzie got to know me and eventually asked me to be involved in co-authoring a new series of books.

¶ 5.2 Development of Mechanical Diagnosis and Therapy (MDT)

This section will detail the changes that have occurred to Mechanical Diagnosis and Therapy (MDT) with the publication of the books (#1-3, McKenzie and May 2000, 2003, 2006). Much more relevant literature was available when the new textbooks came to be written. It was important that MDT responded to potential weaknesses and limitations that had emerged since the original publications (table 3). It was also important that MDT was contextualised and set into a contemporary and more general understanding of musculoskeletal medicine, and that the application of MDT was extended to the extremities. I was heavily involved in all these changes; in reviewing, analysing and constructing our evidence-based interpretation of the relevant literature, and also in facilitating changes to MDT examination and classification.

Table 3. Adaptations to Mechanical Diagnosis and Therapy

Aspect of MDT	Problem	Adaptation
1. MDT in the extremities	McKenzie (1981) said concepts could also be applied to extremity problems, but this was not being done in practice	Formal description of MDT principles as they might be applied to extremity musculoskeletal problems (#1, McKenzie and May 2000)
2. Dysfunction – originally referred to articular problems	Did not account for tendon problems commonly encountered in extremity patients (May 2006c, May and Watson 2007)	Introduction of term contractile dysfunction (#1, McKenzie and May 2000)
3. Original description of derangements included system of numbering according to extent of pain referral and presence	Poor reliability of observational examination for lateral shift. Focus on lateral shift, rather than the more common lateral component. Thus sub-dividing derangement reduced reliability without improving clinical reasoning as numbering	Numbering system for derangement was subsumed in single mechanical syndrome of derangement (#2-3, McKenzie and May 2003, 2006)

/ absence of a lateral shift	system did not always mean different treatments.	
4. Conceptual model for derangement was intervertebral disc	Therapists mistakenly suggested MDT was only suitable for 'disc problems'.	Clear cut clinically-based operational definitions for all MDT syndromes highlighting symptomatic and mechanical responses (#2-3, McKenzie and May 2003, 2006)
5. Definitions	Lack of clarity in definitions of mechanical syndromes and associated concepts (Riddle 1998)	Clear cut operational definitions for all MDT syndromes (McKenzie and May #2-3, 2003, 2006)
6. MDT classification system	MDT system criticised for not being exhaustive in nature, for instance limited consideration of serious spinal pathology (Riddle 1998)	Explicit recognition of other categories including operational definitions for 'red flag' pathology and for 'Other' categories beyond the mechanical syndromes (McKenzie and May #2-3, 2003, 2006)
7. Centralisation	Different researchers had used slightly different definitions of centralisation (Werneke et al. 1999)	Clear cut operational definitions for centralisation and other MDT terms (McKenzie and May 2003, 2006)
8. Clinical reasoning with MDT	Some therapists were staying with extension principle even though patients were not improving	Earlier use of force progressions and/or force alternatives if classification is unclear was emphasised (#2-3, McKenzie and May 2003, 2006)
9. Clinical reasoning with MDT	Some therapists were rushing through force progressions and force alternatives without allowing time for therapeutic effect of initial exercises	More emphasis on exhausting sagittal plane before trying alternative directions (#2-3, McKenzie and May 2003, 2006)
10. Headache syndrome	Separate classification of headache symptoms not using MDT terminology	Description of cervicogenic headaches using MDT syndromes and recognition of multiple causes of headaches, including serious pathology (#3, McKenzie and May 2006)
11. Vertebral artery problems	In the 1990s it was received wisdom in the manual therapy world that a series of tests should be conducted prior to performing cervical manipulation to identify patients for whom such procedures might be dangerous	However the assumption that these tests were able to perform this function was not supported in the literature and the limitations of the well-established approach to 'vertebral artery testing' was made clear (#3, McKenzie and May 2006)

This new edition of ***The Lumbar Spine*** *has become a tome. It still describes the original concept, albeit updated and revised, but the edition provides students and other readers with a compendium of all the literature pertaining to the lumbar intervertebral disc and the massive literature that now pertains to the McKenzie system.....****The Lumbar Spine*** *provides an exhaustive but honest and responsible appraisal of studies of the efficacy of McKenzie treatment* (Bogduk N, Foreword in The Lumbar Spine Mechanical Diagnosis and Therapy, page iv-v).

¶ 5.3 Contextualisation of MDT

This section presents an introduction to some of the background material that was written for the new textbooks. This was material that was not directly relevant only to MDT, but provided the setting to understand major issues related to spinal pain. This material summarised contemporary issues, such as the epidemiology, diagnosis and classification of spine pain. Some examples will be highlighted in this section, but as the evidence base was reviewed and incorporated throughout the text books these should be seen as examples of this contextualising of MDT into contemporary evidence. Three aspects of the textbooks will be considered, namely, the epidemiology of spine pain (#2, McKenzie and May 2003: chapters 1 and 2; #3, 2006, chapters 1 and 2), the diagnosis and classification of spine pain (#2, McKenzie and May 2003: chapters 7, 12, 13 and appendix 4; #3, 2006, chapters 5, 8, 9 and appendix 4), and the introduction of MDT principles to extremity musculoskeletal problems (#1, McKenzie and May 2000, chapters 1 and 10).

¶ 5.3.1 *Epidemiology of spine pain*

The high prevalence of back pain is well known and from a range of large international population-based studies mean point, year and lifetime prevalence of 22%, 44% and 61% were estimated respectively (Brown et al. 1994, Dodd 1997, Heliovaara et al. 1989, Hillman et al. 1996, Leboeuf-Yde et al. 1996, Linton et al. 1998, McKinnon et al. 1997, Papageorgiou et al. 1995, Skovron et al. 1994, Toroptsava et al. 1995, Walsh et al. 1992, Waxman et al. 2000).

From a range of studies an average relapse or recurrence rate of 58% was estimated, with another episode in the same year as the original episode of back pain (Brown et al. 1998, Carey et al. 1999, Heliovaara et al. 1989, Klenerman et al. 1995, Linton et al. 1998, Toroptsova et al. 1995, Van den Hoogen et al. 1998). Persistent symptoms lasting several months appeared to affect on average 42% of the study populations, with several studies indicating no further improvement between 3 and 12 months (Croft et al. 1998, Hillman et al. 1996, Linton et al. 1998, Miedema et al. 1998, Philips and Grant 1991, Szpalski et al. 1995, Thomas et al. 1999, Toroptsova et al. 1995, Van den Hoogen et al. 1998, Waxman et al. 2000). Not surprisingly, the other message gained from these studies about the natural history of back pain in the general population and amongst those seeking care, was that the strongest risk factor for an episode of back pain was a previous episode. A similar pattern of high prevalence rates, recurrences and persistent symptoms was also found in the neck epidemiology literature that we reviewed (#3, McKenzie and May 2006).

The inference from these figures is clear – an individual's experience of back pain may well encompass their life history. The high rate of recurrences, episodes and persistence of symptoms seriously challenges the myth of acute/chronic dichotomy…….Back pain should be viewed from the perspective of the sufferer's lifetime- and given such a perspective , the logic of self-management is overwhelming (#2, McKenzie and May 2003, p12).

¶ 5.3.2 *Diagnosis and Classification of spine pain*

The difficulty of making a specific patho-anatomical diagnosis for the symptom of back pain has been recognised for some time. In one of the first major reviews of the literature done by the Quebec Task Force (Spitzer et al. 1987) the problem was clearly spelt out. *It is difficult to identify precisely the origin of the pain .....This mainly explains why terminology varies with the setting.....The literature is therefore replete with diagnostic terms.....Frequently, one finds in a patient's medical chart two or three of these diagnoses, made by different physicians.* (Spitzer et al. 1987, p16) In response to this diagnostic confusion the Task Force proposed an original classification system, based not on patho-anatomical diagnoses, but on non-specific pain patterns in most and on para-clinical investigation for some. In the majority of instances we are no nearer a patho-anatomical cause of back pain than 20 years ago. Radiographically controlled and double diagnostic injections can be used to diagnose zygapophyseal or sacro-iliac joint or discogenic pain, but identification of these pathologies from clinical findings was not possible (Dreyfuss et al. 1994, 1996, Laslett et al. 2004, 2005, Manchikanti et al. 2000, Maigne et al. 1996, Schwarzer et al. 1994a, 1994b, 1995a, 1995b, Slipman et al. 1998, van der Wurff et al. 2000b).

There are limitations to diagnostic imaging, their excellent ability to identify abnormal morphology, is matched by an inability to link pathology to symptoms (van Tulder et al. 1997). When any of these abnormalities are found on radiography 40-50% will be a false positive finding that is found in those with no back pain (Roland and van Tulder 1998). Equally disc herniations and spinal stenosis can be found in at least half of

asymptomatic individuals on MRI (Boden et al. 1990, Boos et al. 1995, Jensen et al. 1994, Weinreb et al. 1989,). Although the Quebec Task Force review was published over 20 years ago little has changed in between, as apparent from another recent review entitled *Non-specific low back pain – are we any nearer a structural diagnosis?* (May 2006a).

Our desire as clinicians to diagnose and label back pain should be circumspect with a natural humility in light of the above. Using unproven pathological labels may not only be a fraudulent attempt to augment our professional credibility, it may also lead to exaggerated illness behaviour by patients and abnormal treatment patterns by clinicians (#2, McKenzie and May 2003, p124).

In the absence of clear diagnostic labels classification systems provide several advantages in aiding clinical decision making, establishing prognosis and management and in aiding communication between clinicians (Spitzer et al. 1987, Fairbank and Pynsent 1992, Delitto et al. 1995). Most clinicians do in deed use sub-groups when describing non-specific low back pain, but there is little consensus amongst different clinicians and most use labels that imply putative patho-anatomy, however the evidence for the validity of these labels is scant and controversial (Kent and Keating 2005). Over 30 classification systems for back pain now exist (McCarthy et al. 2004). A common start point for a number of classification systems is distinguishing serious spinal pathology from nerve root problems and simple mechanical spine pain (Spitzer et al. 1987, CSAG 1994, AHCPR 1994).

McKenzie (1981, 1990) had described non-specific mechanical syndromes, which although having underlying conceptual models in an attempt to explain clinical observations, were based on symptomatic and mechanical responses to the assessment process. The later publications refined and provided clear operational definitions for the mechanical syndromes, serious pathology and other specific categories of spine pain (McKenzie and May 2003, 2006).

¶ 5.3.3 *MDT and extremity musculoskeletal problems*

Initially McKenzie (1981) had stated that the principles of MDT could equally be applied to extremity musculoskeletal problems, but this was not being done in practice. So a formal text was written (#1, McKenzie and May 2000), which described how the assessment and physical examination could be conducted for extremity musculoskeletal problems using MDT principles. It also discussed assessment of symptomatic and mechanical responses and principles of management. It then described how these principles might be applied to a range of common disorders, and how these common disorders would be classified using the mechanical syndromes. As this application of MDT principles was relatively new there was no reference to this aspect of the McKenzie approach in the scientific literature, until the appearance of two case studies (#4, Aina and May 2005; #5, Littlewood and May 2007).

Two surveys of McKenzie Institute International Faculty members were used to explore the prevalence of MDT mechanical syndrome classifications in spinal and non-spinal patients (May 2004, #13, 2006b, 2006c), and the proportion of patients classified will be described later.

¶ 5.4 The patients' perspective

Given the epidemiology of back pain as discussed above, and therefore the clear rationale for advocating self-management strategies, the need for gaining an understanding of the patients' perspective on back pain and its management appeared to be overwhelming.

A qualitative study was conducted with patients who had received physiotherapy in the previous year to ask about aspects of management of back pain that were relevant to the patients themselves (#6, May 2007). Thirty-two patients were interviewed using semi-structured interviews, which were transcribed and analysed using framework analysis (Ritchie and Spencer 1994). Not surprisingly back pain impacted on the individual's lifestyle and restricted normal activity, but varying degrees of functional limitations had come to be accepted quite commonly. Most individuals were interested in finding out what they could do to help themselves, and a wide range of strategies were used, most commonly exercises and postural and ergonomic awareness (Table 4).

Table 4. Patients' opinions about back pain and its management (#6, May 2007)

Themes	Definitions	Examples
Perspectives on LBP	Beliefs and attitudes about LBP	Learning to live with it, Not expecting a cure
Perspectives on management	Experience and attitudes relating to management of LBP	Unsatisfactory management, slow referral to physiotherapy
Impact of LBP	Impact of LBP on lifestyle	Enforced rest, restriction of activity
Patient involvement	Patients' attitude to active involvement in managing LBP	Learning to live with it, Active involvement in management
Tools for self-management	Self-management strategies that patients use	Back 'awareness', Exercises, Postural stresses/ergonomics
Previous therapy	Critical comparison between episodes of care	Effective versus ineffective care, Personalised versus impersonalised care
Expectations	Expectations about physiotherapy	No expectations, Involve exercises

LBP = Low back pain

Following the introduction of local practice guidelines, which generally recommended active treatment interventions (May 2000, appendix 3), outcome data was gathered from clinical practice using validated outcome measures (#7, May 2003). Measures of pain and functional disability were collected at initial and final treatment session. Overall the mean change in pain was 32% (95% confidence interval (CI), 29%, 33%) and the mean

change in function was 21% (95% CI, 19%, 22%). These changes were all statistically significant over time for musculoskeletal symptoms from all sites ($P<0.0001$). The audit recorded a relatively low number of treatment sessions, mean 3.7, compared to previous audits in other countries.

As patient education and involvement is such a key component of MDT a chapter that specifically addressed the principles of patient management was included in the new text (#2, McKenzie and May 2003, chapter 18). This reviewed aspects of education and back pain, patient compliance, information provision, communication and patient satisfaction with the specific aim of trying to improve clinician-patient interaction.

¶ 5.5 Validating the classification system

MDT is a system of classification and management of musculoskeletal disorders, which is based on the initial assessment of patients that aims to classify patients with a mechanical syndrome or 'other' classification (#1-3, McKenzie and May 2000, 2003, 2006). To have clinical utility any classification system needs to exhibit certain characteristics (Riddle 1998). Firstly different clinicians must be able to reliably classify patients into the different subgroups so that we can be certain that they actually exist; this requires reliability studies. Secondly it must be verified that the classification system has clinical application in a significant proportion of the patient population; which requires prevalence studies. Finally the value of the classification system needs to be tested out by undertaking efficacy studies with and without classification. Reliability is necessary to ensure consistent identification between clinicians. However if reliability were perfect, but the classification system only applied to a small proportion of all potential patients it would lack clinical utility. For a system to be clinically useful it must be able to incorporate a substantial proportion of all potential patients.

¶ 5.5.1 *Centralisation and Directional Preference*

A key assessment finding during the physical examination is the centralisation phenomenon of pain. This was first described as a decrease and reduction of referred symptoms in response to exercises that was associated with a good prognosis (McKenzie 1981). Centralisation means classification in derangement syndrome; the most prevalent of the mechanical syndromes in spine pain patients (Kilpikoski et al. 2002, Razmjou et al. 2000, May 2006b). Since the first description of centralisation based on clinical experience it has begun to be documented in the scientific literature, consequently a study undertook the first ever systematic review to examine its importance (#8, Aina et al. 2004).

Thirteen studies were identified and the review (#8, Aina et al. 2004) considered six aspects of centralisation: the definition, its prevalence, its prognostic significance, reliability of assessment, therapeutic loading, and criterion validity. There had been some inconsistencies in the definitions used, but strict operational definitions had recently been developed (#2, McKenzie and May 2003). According to this strict definition centralisation occurred less frequently than previous studies had suggested. However another group with partial centralisation was identified, whose outcome was the same as the complete centralisation group, but took more treatment sessions (Werneke et al. 1999). The importance of centralisation was confirmed and lay in its high prevalence rate, reliability of classification and prognostic validity. The prevalence rate of centralisers and partial centralisers was high, and overall centralisation occurred in 70% of 731 sub-acute back pain patients and 52% of 325 chronic pain patients, with data

gathered from 11 studies (#8, Aina et al. 2004). Five studies considered the reliability of clinicians' ability to detect centralisation (Kilby et al. 1990, Sufka et al. 1998, Werneke et al. 1999, Fritz et al. 2000, Kilpikoski et al. 2002); % agreement was > 88%, and kappa values ranged from 0.51 to 1.0, with 5 of 6 analyses giving kappa ≥ 0.70. Reliability will be considered in more detail later, but these are considered 'good' levels of reliability by some statisticians (Altman 1991).

Six studies considered centralisation and prognosis and found that centralisation was consistently correlated with good/excellent overall outcomes, greater reduction in pain intensity, higher return to work rates, greater functional improvement, and less continued healthcare usage (Donelson et al. 1990, Karas et al. 1997, Long 1995, Sufka et al. 1998, Werneke et al. 1999, Werneke and Hart 2001). Equally non-centralisation was equated with a worse outcome, and in one study predicted this better than a range of work related and psychosocial issues (Werneke and Hart 2001). The review also considered the loading strategies that induced centralisation, which were shown to be repeated movements or sustained postures in the sagittal plane (Donelson et al. 1990, 1991, Williams et al. 1991).

This symptom response thus has important therapeutic and prognostic implications. In light of the reliability with which centralization can be assessed, and its common occurrence and clinical importance it is recommended that it should be monitored routinely during spinal assessments and be used to guide treatment strategies (#8, Aina et al. 2004, p141).

A number of additional studies have largely confirmed these conclusions since that review were published, which included a study of centralisation in patients with sciatica (#9, Skytte et al. 2005). Centralisation was monitored at baseline and then patient outcomes were observed over the following year; with significantly better improvements in leg pain and disability in the centralisation group, for instance at two months $P = 0.007$ and $P < 0.001$ respectively. There was significantly less surgery in the centralisation group ($P = 0.01$) and in the non-centralisation group the odds ratio for surgery was 6.2 (#9, Skytte et al. 2005).

Directional preference (DP) is an allied but separate term, which refers to directional specific movements that cause symptoms to centralise, or abolish or decrease in intensity. The value of this was confirmed in a landmark trial, in which patients with a baseline DP were randomised to exercises matched to DP, opposite exercises, or general non-specific exercises (Long et al. 2004). There were a number of statistical differences favouring the matched group. A secondary analysis was conducted in which patients who received unmatched treatment and did not improve were crossed-over to receive matched treatment (#10, Long et al., *In Press*). In this case series those who reported improvement or resolution of symptoms increased from 22% in the first two weeks of unmatched care during the original trial to 84% after two weeks of matched care. There were statistically significant and clinically meaningful changes in five of seven outcomes (P<.001) after the alternate treatment compared to clinically unimportant changes documented in the two weeks during the RCT.

¶ 5.5.2 *Reliability*

Another important aspect of a system of physical examination is reliability amongst examiners. There are numerous components that might be included in the physical examination of back pain patients. Some methods are based mostly on observation and palpation, whereas MDT relies predominantly on symptom response and classification. The physical examination of the lumbar spine is thus conducted in different ways, but the tests that are being applied will decide future management. Such tests need to have certain measurement properties, validity and reliability, to be of clinical value (Streiner and Norman 1996). Most physical examination procedures for the lumbar spine have not been validated, but establishing reliability in the tests that are being used to determine management is equally important. If intertester reliability is poor then management decisions following the physical examination are based on unsound judgements.

With this in mind a systematic review of the reliability properties of physical examination procedures used in the examination of the lumbar spine was conducted (#12, May et al. 2006). Forty eight relevant and appropriate studies were identified, involving a range of professions and a range of types of physical examination. Four broad types of reliability study were identified: palpation (24 studies), symptom response (23 studies), observation (18 studies) and classification systems (12 studies). Overall judgements about different palpation procedures were mostly conflicting evidence for reliability or moderate evidence for low reliability. For symptom response there was conflicting evidence about symptom response to repeated movements and strong evidence for low reliability in response to movement, palpation or trigger point assessment. There was

moderate evidence for high reliability of timed muscle endurance. For other observational, but non-instrumented, procedures these varied from conflicting evidence to strong evidence for low reliability. For most classification systems examined there was either conflicting evidence for reliability or moderate evidence for low reliability. For the McKenzie classification system of 3 high quality studies, 2 reported kappa values > 0.85, and one did not. The 2 positive studies used well trained and experienced McKenzie clinicians (Clare et al. 2005, Razmjou et al. 2000), the other study (Riddle and Rothstein 1993) used therapists with no or minimal experience of the system.

When the cut-off point was altered from kappa 0.85 to 0.7 only one clear cut change occurred in the conclusions. Evidence regarding symptom response to repeated movements changed from conflicting evidence to moderate evidence for reliability in 2 high quality and 2 other studies. The discussion noted that there were similar conclusions in other systematic reviews in the field, discussed some of the properties of reliability coefficients and suggested how reliability studies might be improved in the future given the moderate quality of many studies to date.

¶ 5.5.3 *Prevalence of classification system in population of interest*

For a classification system to be clinically useful it must be comprehensive in the population of interest (Riddle 1998). For instance, at least being able to offer assessment possibilities and directions for further investigations if not able to provide actual management strategies. Lack of comprehensiveness of the McKenzie system was one of criticisms directed at it by Riddle (1998) in his review. Reliability studies have generally shown high prevalence of the mechanical syndromes in the populations examined, of 68%, 88%, 92%, 93% and 96% respectively (Kilby et al. 1990, Clare et al. 2005, Kilpikoski et al. 2002, Razmjou et al. 2000, Riddle and Rothstein 1993). As already mentioned centralisation has been reported in 70% of 731 patients with sub-acute back pain and 52% of 325 patients with chronic back pain (#8, Aina et al. 2004). However only one study had looked directly at classification prevalence; in this 58% of 522 patients received a mechanical syndrome classification at the initial assessment (Pinnington et al. 2000), but this was only published as an abstract.

In my survey data collection occurred after patients were discharged and when classification category was confirmed (#13, May 2006). Data was only collected from McKenzie Institute International Teaching Faculty with a high level of training, use and experience in the system. Furthermore data was gathered from multiple sites and on consecutive patients to improve the validity of the findings. A pilot study was carried out using European McKenzie Institute Teaching Faculty (N = 30) being asked to complete a data collection form providing details on the subsequent 15 patients to be discharged

(May 2004). Classification was provided on 265 patients, nearly 200 of which were spinal patients.

A number of points were learnt from the pilot study. The return rate was disappointingly low (57%), so multiple mailings were performed the next time; some of the data collection was unclear so changes were made to the data collection forms; and the pattern in spinal and non-spinal classification was so different that separate data description seemed appropriate. In the main study (#13, May 2006b, 2006c) International McKenzie Institute Teaching Faculty (N = 70) in 20 countries received up to 3 repeat e-mailings between October 2003 and March 2004, and responses were received from 81% of total and 89% of those who were contactable and still in position. Detail was received about 607 patients with spine pain and 242 patients with extremity pain. Therapists saw a mean of 11 (SD 3.3) spine patients and a mechanical syndrome was recorded in a mean of 9 (SD 3.8) of them, mean 82%. Of the 607 spine patients 504 (83%) were classified in one of the mechanical syndromes (Table 5) (#13, May 2006b). Strikingly these figures were consistent with earlier data (May 2004, Clare et al. 2005).

Table 5. Mechanical and non-mechanical syndromes in 607 consecutively discharged spine pain patients (%) (data from May 2006b)

N	Derangement	Dysfunction	Posture	ANR	Other
607	78%	3%	1%	1%	17%

ANR = adherent nerve root

Data on the 242 extremity patients was described in another paper (May 2006c). The distribution of mechanical syndromes was different from that in spinal problems; with roughly a quarter / quarter / quarter / quarter distribution between derangement / articular dysfunction / contractile dysfunction / and other (Table 6).

Table 6. Mechanical and non-mechanical syndromes in 242 consecutively discharged extremity patients (%) (data from May 2006c)

N	Derangement	AD	CD	Other
242	21%	21%	26%	32%

AD = articular dysfunction; CD = contractile dysfunction

In general the data from audits of spinal and extremity patents demonstrate reasonable consistency, with sizeable numbers being classified in one of the mechanical syndromes (Kilpikoski et al. 2002, Razmjou et al. 2000, Clare et al. 2005, May 2004, 2006b, 2006c, Melbye et al. 2006). The system would appear to have good clinical utility.

¶ 5.5.4 *Postural syndrome*

Most of the published literature to date has dealt with the commonest of spinal mechanical syndromes, namely derangement. In reliability studies and surveys mention of postural syndrome has been unusual; and description of the syndrome has been mostly limited to the textbooks. Briefly the syndrome describes spine pain that is brought on by relaxed, sustained postures, most typically sitting, in which the soft tissues are eventually loaded to the point of inducing discomfort that is abolished almost as soon as the position is changed. After this the individual is pain free and has full range of movement, *until* they resume that same relaxed and sustained posture that induced pain before. Because symptoms are benign, temporary and relatively trivial those who have pain from postural syndrome rarely seek healthcare and are not commonly seen in the clinical situation.

The role of sustained sitting and posture in spine pain has been somewhat controversial. Two systematic reviews failed to find evidence to support an association between back pain and sitting-while-at-work (Hartvigsen et al. 2000) or a convincing link between posture and back pain (Nachemson and Vingard 2000). In contrast reviews of optimal posture for sitting suggested maintaining lordosis plus regular movements is best for backs (Harrison et al. 1999, Pynt et al. 2001). Furthermore a number of studies have demonstrated that patients frequently find sitting aggravates back pain once it is present but rarely eases it (Boissonnault and Di Fabio 1996, Stankovic and Johnell 1990, Van Deursen et al. 1999, 2002, Williams et al. 1991). Individuals without back pain have found that sitting with a flexed posture is less comfortable and is more likely to provoke

discomfort (Eklund and Corlett 1987, Harms 1990, Knutsson et al. 1966, Mandal 1984). However these were mostly descriptive studies with weak study designs that did not accurately define the parameters of posture and time.

A study was conducted on a small group of students half of who reported postural back ache (the cases) the other became the controls (#11, Womersley and May 2006). Activity over 3 days was recorded in an activity diary and relaxed sitting posture was analysed using a computerised video analysis system. The postural backache group reported 46 backache episodes over the 3 days, all episodes triggered by sitting activity. Half of this young student population had postural backache, and also validated some of McKenzie's original (1981) ideas about this group. None of this group had sought healthcare for these minor symptoms and the postural backache group sat in more flexion. The study also suggested that it was not the length of time sitting that might be the provocative element, but rather sustained sitting without interruption.

¶ 6 Critical appraisal

The different works submitted here represent a range of study designs demonstrating a range of research skills.

¶ 6.1 The text books:

#1, McKenzie and May, The Human Extremities: Mechanical Diagnosis and Therapy (2000)

#2, McKenzie and May, The Lumbar Spine: Mechanical Diagnosis and Therapy (2003)

#3, McKenzie and May, The Cervical and Thoracic Spine: Mechanical Diagnosis and Therapy (2006)

Data collection methods

Search and review of electronic databases and extensive range of literature for the theoretical background. Clinical consultation and clinical experience regarding practical components of the books.

The primary aim of the text books was to present a clinical guide to the use of MDT, but one grounded in the relevant evidence-base. The background literature was searched for electronically, reviewed and collected over a number of years by myself; however as so many topics were covered in the five volumes a systematic evaluation of the literature could not be undertaken. The literature reviews were not as comprehensive as they might have been had these been done systematically, and though the quality of studies

was commented on at times there was no systematic attempt to evaluate the quality of all the literature included.

This does not mean however that quality was not considered. For example, when considering the epidemiology of back and neck pain the focus was on large scale patient population studies, which are deemed most appropriate for gathering data on overall disease impact (Crombie 1999). The analysis that was presented challenged the common perspective of the time, which generally stated that the prognosis for people with back pain was benign (Klaber Moffet et al. 1995, Evans and Richards 1996); 80-90% of attacks of low back pain were said to recover in about 6 weeks regardless of treatment or lack of it (Waddell 1987). From the review of the epidemiological literature it was apparent that such a portrayal of spine pain was over-optimistic and the real picture was more complex and protracted. Although not widely recognised at the time this more pessimistic outlook, that back pain is commonly both highly recurrent and frequently persistent, has now been more widely accepted (Haxby Abbott and Mercer 2002, Pengel et al. 2003, Hestbaek et al. 2003). These systematic reviews on the topic noted that after initial improvements there is little further improvement after 3 months, at which point approximately 50% are still experiencing activity limitation and that 66-75% of patients had at least one recurrence within 12 months (Haxby Abbott and Mercer 2002, Pengel et al. 2003).

One criticism of the original McKenzie classification system was that it was not exhaustive in nature (Riddle 1998). Patients whose symptoms were not affected by repeated movements, commonly accepted pathology-based diagnoses, such as

instability and spinal stenosis, and those with serious spinal pathology, for instance, were not accounted for in the system (Riddle 1998). In the up-dated and slightly altered later version of the classification system these apparent limitations were addressed, and the system was contextualised against the literature on spine pain classification (#2-3, McKenzie and May 2003, 2006). In the new description of the McKenzie classification system (#2-3, McKenzie and May 2003, 2006) the triage system was used; with the emphasis initially on ruling out 'red flags' that might indicate serious spinal pathology. Such patients should be referred on for further investigations and are not suitable for mechanical therapy. To this end, although this group is rare (<2% of back pain population, for instance), chapters detailing clinical presentations of serious spinal pathology, and operational definitions for each were included (#2, McKenzie and May 2003, chapter 12 and appendix; #3, 2006, chapter 8 and appendix).

The other two groups, nerve root pain and simple mechanical spine pain, are both suitable for an MDT assessment and mostly would be classified in one of the mechanical syndromes and appropriate for MDT management. The operational definitions for the non-specific mechanical syndromes emphasised their recognition through symptomatic and mechanical responses to repeated movement examination. A small proportion would not get an MDT classification and most of these would be classified in one of the 'other' syndromes. These 'other' classifications related to specific pathologies once a MDT classification had been excluded. Chapters related to these other groups, and had sections detailing prevalence, pathophysiology, clinical presentation, diagnosis and possible management as appropriate (#2, McKenzie and May 2003, chapter 13 and appendix; #3, 2006, chapter 9 and appendix). The

operational definitions for mechanical syndromes and 'other' classifications, including serious spinal pathologies are in appendix 11.4.

¶ 6.2 #4, Aina and May, A shoulder derangement (2005).

#5, Littlewood and May, A contractile dysfunction of the shoulder (2007).

#14, May and Rosedale, A case study of a potential manipulation responder whose back pain resolved with flexion exercises (2007).

Data collection method

Single case study with outcome data at several time points.

Though case studies are considered weak scientific evidence in the hierarchy of evidence, they can be useful for conveying information especially about new or unusual phenomenon (Greenhalgh 1997, Crombey 1996). They should always be considered preliminary observations only and subject to refutation; they should certainly not be used to evaluate efficacy. They are not a method for answering research questions, but they can challenge previously held opinions (Crombey 1996). So as MDT was generally considered only suitable for treatment of spinal problems a good starting point was some extremity case studies. Two case studies were published (#4, Aina and May 2005; #5, Littlewood and May 2006), both dealt with shoulder pain problems and both used the mechanical syndrome classification system. The case studies illustrated the way in which non-specific classifications could be used in extremity problems and how this then directed management. This was the first time that a shoulder derangement (#4, Aina and May 2005) and shoulder contractile dysfunction (#5, Littlewood and May 2006) had been described in the literature. So although the case study design is clearly a weak one in validating a treatment approach it is hoped that these initial papers had some educational effect.

A case study (#14, May and Rosedale 2007) was also used to challenge the assertion that there would be 'zero prevalence' of centralisation (George et al. 2005) in the manipulation and stabilisation sub-groups of the Treatment Based Classification (TBC) system (Delitto et al. 1995, Fritz and George 2000), as a preliminary to a more quantitative study design. The TBC system is well known in North America and has a number of similarities with MDT, including the use of directional preference exercises.

¶ 6.3 #6, May S (2007). Patient opinions about back pain and its management.

Data collection methods

Qualitative semi-structured interviews and data analysis using Framework Analysis (Ritchie and Spencer 1994).

Qualitative research is deemed appropriate for collecting data about patients' or clinicians' thoughts or opinions (Crombie 1996), however its limitations must be recognised and the process of data collection and analysis made rigorous enough to stand up to critique. Qualitative research cannot extrapolate issues of frequency or distribution of the themes presented in a single study to the general population. The population that this research was conducted in was mostly, though not entirely, patients with very prolonged histories of back pain or back pain episodes that may represent a very particular group. Issues of credibility, transferability, dependability and confirmability, which are the qualitative research equivalents of validity and reliability (Lincoln and Guba 1985), were addressed in an earlier article (May 2001).

¶ **6.4** #7, May S. Implementation of outcome measures for musculoskeletal physiotherapy in primary care: an audit (2003).

Data collection methods

Audit conducted in a clinical setting with analysis using SPSS.

The most effective way to clearly establish the efficacy of an intervention is through large randomised controlled trials, whereas observational cohort studies are accorded less validity as evidence of effectiveness (Gray 1997). Although this revealed the value of such an audit conducted in a clinical setting it also revealed some of the potential flaws. During a 7-month period 1,700 patients were discharged from the department, but before and after data were only available on 908 patients (53%). The commonest reasons for lack of follow-up data were patients failing to re-attend and forgetfulness of therapist to collect final data outcomes. Clearly these flaws limited the conclusions that could be drawn from this audit. However all changes were significant ($p< 0.0001$) over time and the effect size for pain and function were 1.06 and 1.05 respectively, denoting a large treatment effect (Streiner and Norman 2003). The weakness of such a study design must be recognised; with no control group it cannot be ruled out that change might be due to natural history, regression to the mean, placebo effect or sheer chance.

In this study changes in visual analogue scales and functional disability measures were analysed using mean and parametric data tests, if normally distributed. By convention measurement scales have been defined as either parametric or non-parametric. Parametric scales quantify true units of measurement, such as temperature or height. Non-parametric scales are ways of scaling an attribute to quantify that attribute, such as

pain or functional disability. These are not true units of measurement, but rather a definition of that attribute (Mawson 2007). Statistical theory informs how data derived from these different scales can be analysed: parametric tests for the first and non-parametric tests for the second. There is debate in the measurement literature about how ordinal data should be analysed, some advocate the use of parametric tests (Song et al. 2006; Gaito 1980), but others condemn the use of parametric tests as this defies measurement and statistical theory (Forrest and Andersen 1986; Jakobsson 2004). A parametric statistical test is based on the parameters of a normal distribution of the true unit of measurement, from which a mean and standard deviation can be derived. Non-parametric scales however are not true units of measurement and therefore normal distribution theory cannot be applied; this has implications for the presentation of central tendency and methods of analysis (Forrest and Andersen 1986, Jakobsson 2004). It is illogical to use parametric tests on data that does not represent a true unit of measurement, which therefore cannot be normally distributed and therefore cannot have a mean and standard deviation. Pain and functional disability scales should be regarded as ordinal data, which cannot be normally distributed and therefore medians as a measure of central tendency and non-parametric tests should always be used.

¶ 6.5 #8, Aina A, May S, Clare H. The centralisation phenomenon of spinal symptoms – a systematic review (2004).

#12, May S, Littlewood C, Bishop A (2006). Reliability of procedures used in the physical examination of non-specific low back pain: a systematic review.

Data collection methods

Systematic electronic data base searching, filtering abstracts and articles, assessing articles for quality and summarising overall findings.

Any systematic review has the possibility of being undermined by publication or selection bias. Studies with negative results are less likely to be published and the review may not achieve the comprehensiveness that was aimed at. In the earlier review (#8, Aina et al. 2004) all authors had extensive knowledge of the relevant literature base and so were reasonably confident that comprehensiveness was achieved. The review was the first published on the topic and found the literature in the area to be mostly weak or moderate in quality; however it was consistent in nature and consistent with two high quality studies. Further work has since been published and an up-date is planned.

Previous systematic reviews of reliability studies had been published, but the study differed in its breadth and application (#12, May et al. 2006). Previous studies dealt only with physical examination procedures used at the sacro-iliac joint (van der Wurff et al. 2000a), one only with chiropractic tests (Hestboek and Leboeuf-Yde 2000), one only with palpation procedures (Seffinger et al. 2004), and one only with passive assessment of intervertebral motion (van Trijffel et al. 2005). The review included reliability studies of all manual therapy professions and all types of physical examination; only included

studies whose participants included patients with back pain, but not studies using asymptomatic volunteers only, which were commonly included in the other reviews. The latter group did not reflect the population in which the tests would actually be used clinically. It has been common practice to interpret kappa and intraclass coefficients according to the guidelines of Landis and Koch (1977), which are as follows: 0.0-0.20 poor or slight agreement; 0.21-0.40 fair; 0.41-0.60 moderate; 0.61-0.80 substantial or good; 0.81-1.00 very good or almost perfect. Whilst those who have used this scale have thus suggested that kappa values above 0.4 are acceptable for clinical utility (Landis and Koch 1977, Altman 1991) others have consistently suggested that only higher values should be considered satisfactory (McDowell and Newell 1987, Streiner and Norman 2003). These latter authors suggested minimal values of 0.85 and 0.75 respectively for a useful instrument. Therefore a criterion of 0.85 for satisfactory reliability, with a sensitivity analysis at a lower level of 0.7, was set. Levels of evidence were used to shape the strength of conclusions related to the quality of the studies. To judge quality a previously used set of criteria (Van der Wurff et al. 2000) was adapted, and high quality studies were those that scored 60% or more. The somewhat arbitrary nature of such cut-off points was recognised, but this allowed clear cut conclusions about reliability based on the quality of the literature. These aspects made it one of the most robust reviews on the topic to date.

¶ 6.6 #9, Sytte L, May S, Petersen P (2005). Centralisation - its prognostic value in patients with referred symptoms and sciatica.

Data collection method

Cohort study with mechanical evaluation at baseline and outcomes reviewed at one year; data analysis using SAS software to determine predictors of outcome.

The importance of this research project was the evaluation of the prognostic value of centralisation to a specific patient group, namely those with leg pain / sciatica, who were a group that had not been specifically examined before regarding this issue. Some limitations must be recognised: the sample size was relatively small (N = 60) out of a consecutive sample size of 104; most exclusions related to chronic sciatica or previous surgery. More importantly we only conducted a repeated measurement of analysis of variance, in other words only a univariate analysis. To more fully evaluate the weight of prognostic factors multiple demographic, clinical, work-related, and psychosocial factors should be considered at baseline and a multivariate analysis conducted of factors found to be significant in the univariate analysis (Tabachnick and Fidell 2001).

Furthermore this was an observational study in that after the initial mechanical evaluation was conducted all patients were treated in the same non-specific way unless surgery seemed appropriate. So it cannot be known if with specific exercise treatment, based on the directional preference that had been exposed by the initial mechanical evaluation, results would have been even better for the centralisation group.

¶ 6.7 #10, Long A, May S, Fung T (2008). Specific directional preference exercises for patients with low back pain: A case series.

Data collection methods

Data was collected in two ways: first from patients who failed to improve in a randomised controlled trial (Long et al. 2004), then these patients were followed up for a further two weeks after being crossed over to receive alternate treatment.

There were several weaknesses to this study. Initially a cross-over study design was contemplated, but the numbers of patients in the matched group who did not improve in the original and were appropriate were so few that this was not feasible. Thus it meant that there was no control group and the study was forced to present a case series rather than a controlled cross-over study design. There was no blinding of therapists or patients, though this is often not practical in physical therapy trials. There was only short-term follow-up and the sample size calculation was done for the initial trial not for our secondary analysis. However despite these limitations there were substantial and clinically meaningful outcomes after the alternate treatment period, which were not evident in the initial two weeks when patients received unmatched treatment. The superiority of directional preference exercises to non-specific exercises was clearly supported, and this study adds to the literature supporting specific exercises.

¶ 6.8 #11, Womersley and May S (2006). Sitting posture of subjects with postural backache

Data collection methods

Case-control series collecting data on daily activity, relaxed sitting posture and postural backache with data analysis using SPSS.

Although the case-control study has a large number of potential threats to its validity and is not without controversy in establishing causation, it still is seen to have potential in linking possible causative factors with disease processes (Crombie 1996, 1999). This case-control study (#11, Womersley and May 2006) was conducted in a small student population. Despite the small numbers a type-II error was avoided as significant differences were found; not in the amount of time spent sitting ($P = 0.136$), but in sustained sitting time ($P = 0.024$) and in the angle of the lumbar spine in relaxed sitting ($P = 0.014$). These findings were supported by a larger case-control study, in which a range of variables were compared in patients with and without acute back pain (Bakker et al. 2007). Previous episodes of back pain and more intensive loading in flexed postures scores were significantly associated with acute LBP after multivariate analysis. This was the first published study to validate concepts underlying the postural syndrome (#11, Womersley and May 2006).

¶ 6.9 #13, May S (2006). Classification by McKenzie's Mechanical Syndromes: A survey of McKenzie-trained faculty.

Data collection methods

International survey of discharged patients with descriptive data.

This study used highly trained and experienced clinicians and therefore external validity might be challenged. There have been issues raised about poorer reliability amongst those with less training and experience in MDT system. In the studies using better trained raters (Razmjou et al. 2000, Kilpikoski et al. 2002, Clare et al. 2005) the proportion of classifications was consistent with derangement being the commonest classification (just under 90%). Whereas in studies that used raters with minimal or no training (Kilby et al. 1990, Riddle and Rothstein 1993) derangement was 50% or less. This suggested the need to use experienced and well trained MDT clinicians to determine the true clinical utility of the classification system even if this raised the question of external validity due to the specialist nature of the examiners.

Another point of consideration was when to collect the data on classification. Classification drives the management, but in the MDT system on the first day a provisional classification is made, which hopefully is confirmed on subsequent treatment sessions thus confirming management (#2-3, McKenzie and May 2003, 2006). If this confirmation is not forth coming then further analysis of force progressions and/or force alternatives is made. Studies had confirmed the clinical impression that day one categorisation cannot always be emphatic (Werneke and Hart 1999, 2003). Lack of a

clear cut mechanical response on day one, and therefore inability to classify a patient at that point, does not mean that the patient is ultimately unclassifiable. For this reason the classification data was gathered at the time of patient discharge. In hindsight a limitation of the survey was the failure to perform correlations between classification and patient characteristics, such as demographic and clinical factors, but this was the first published study to look specifically at prevalence rates of MDT syndromes.

¶ 7 Conclusions

The publications that have been described above and that make up the rest of this document are being submitted for a PhD by previous publications. They comprise textbooks and a variety of peer-reviewed study designs, some of which provide relatively weak evidence, such as the case studies, though these are important from an educational perspective. The textbooks are descriptive about a particular approach to musculoskeletal problems (MDT), but also sought to review, explore, analyse and synthesise the relevant literature-base in order to present an evidence-based context for MDT. Although this was not done in a systematic way the review-base was extensive and certain of the conclusions that were made, which were not in line with contemporary views, have since been supported. The text books provided not only an updated and more clearly defined description of MDT, but also a contemporary context for MDT within the relevant literature.

The other publications present a range of qualitative and quantitative study designs as well as two systematic reviews. The quantitative studies are observational rather than experimental in design. The peer-reviewed publications all added to the underlying science that underpins different aspects of Mechanical Diagnosis and Therapy. The systematic reviews summarised and graded the literature on two important topics regarding the physical examination, namely centralisation and the reliability of physical examination procedures. A cohort study showed the more favourable prognosis associated with centralisation in patients with sciatica. A secondary analysis from a trial showed that patients firstly treated by non-specific exercises and who do not improve,

but who are then treated by directional preference exercises can reverse their poor results. A case control study found that individuals with postural pain tended to sit uninterrupted for longer periods and sit in more flexion than asymptomatic controls. A survey of experienced McKenzie practitioners confirmed the high prevalence rate with which the MDT classification system is used in spinal and non-spinal patients. An outcomes audit was conducted in primary care to demonstrate statistically and clinically significant differences achieved in normal practice. An explorative quality study explored what patients thought about back pain and its management, and found an interest in self-management strategies was common. Despite the range of literature presented here there is one unifying theme, namely Mechanical Diagnosis and Therapy. Altogether these works demonstrate a substantial and on-going record of research and publication that have helped to develop the science underlying Mechanical Diagnosis and Therapy.

In essence my contribution to MDT has been in two main ways. Firstly to update, extend and contextualise the three textbooks. Secondly it has been to add to the evidence regarding MDT in the areas identified in this submission. Clearly this contribution has been modest in terms of limitations that still need to be addressed. A lot remains to be done in terms of that evidence and the limitations must be recognised and hopefully addressed in the future. There are many additional studies that could be performed, but the chief limitation is that most of the evidence relates to the lumbar spine, with few studies on the cervical spine and virtually nothing relating to the extremities. Specific issues that could be addressed are too numerous to identify, but urgent areas are centralisation and directional preference in the cervical spine, and reliability and properly designed efficacy studies in the extremities. The evidence for MDT has come a long way

since McKenzie first published in 1981, however it still has a long way to go before it can be said that all aspects of MDT are truly evidence-based.

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¶9 Appendices

Appendix 9.1

Work published in McKenzie UK Newsletter and International Journal of Mechanical Diagnosis and Therapy

Review of some recent ideas about intervertebral disc histology and herniations. McKenzie Institute (UK) Newsletter 1993 2.2.12-14.

Facet Syndrome - Myth or reality? A comparative essay on the zygapophyseal joint and the intervertebral disc as a source of pain. McKenzie Institute (UK) Newsletter 1994 3.2.3-12.

Lumbar disc herniations. A review of the literature. McKenzie Institute (UK) Newsletter 1995 4.2.3-14.

Commentary on Morphology of the cervical intervertebral disc. Implications for McKenzie's model of the disc derangement syndrome. Mercer & Jull. Manual Therapy 1996. .McKenzie Institute (UK) Newsletter 1996.5.1.10-12.

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Appendix 9.2

All peer-reviewed and international publications

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Appendix 9.3

Other publications

Synopsis of Literature relevant to the McKenzie approach. Available in McKenzie International Course Manuals and at www.mckenziemdt.org

An audit into patients' satisfaction with physiotherapy care for musculoskeletal problems. Walton Hospital. November 1999.

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CSP. Mercer C, Jackson A, Hettinga D, Barlos P, Ferguson S, Greenhalgh S et al. Clinical guidelines for the physiotherapy management of persistent low back pain, Part 1: exercise. London, Charted Society of Physiotherapy, 2006.

Appendix 9.4

Operational definitions for mechanical syndromes and 'other' classifications (McKenzie and May 2000, 2003, 2006, appendix)

Appendix: Classification and operational definitions

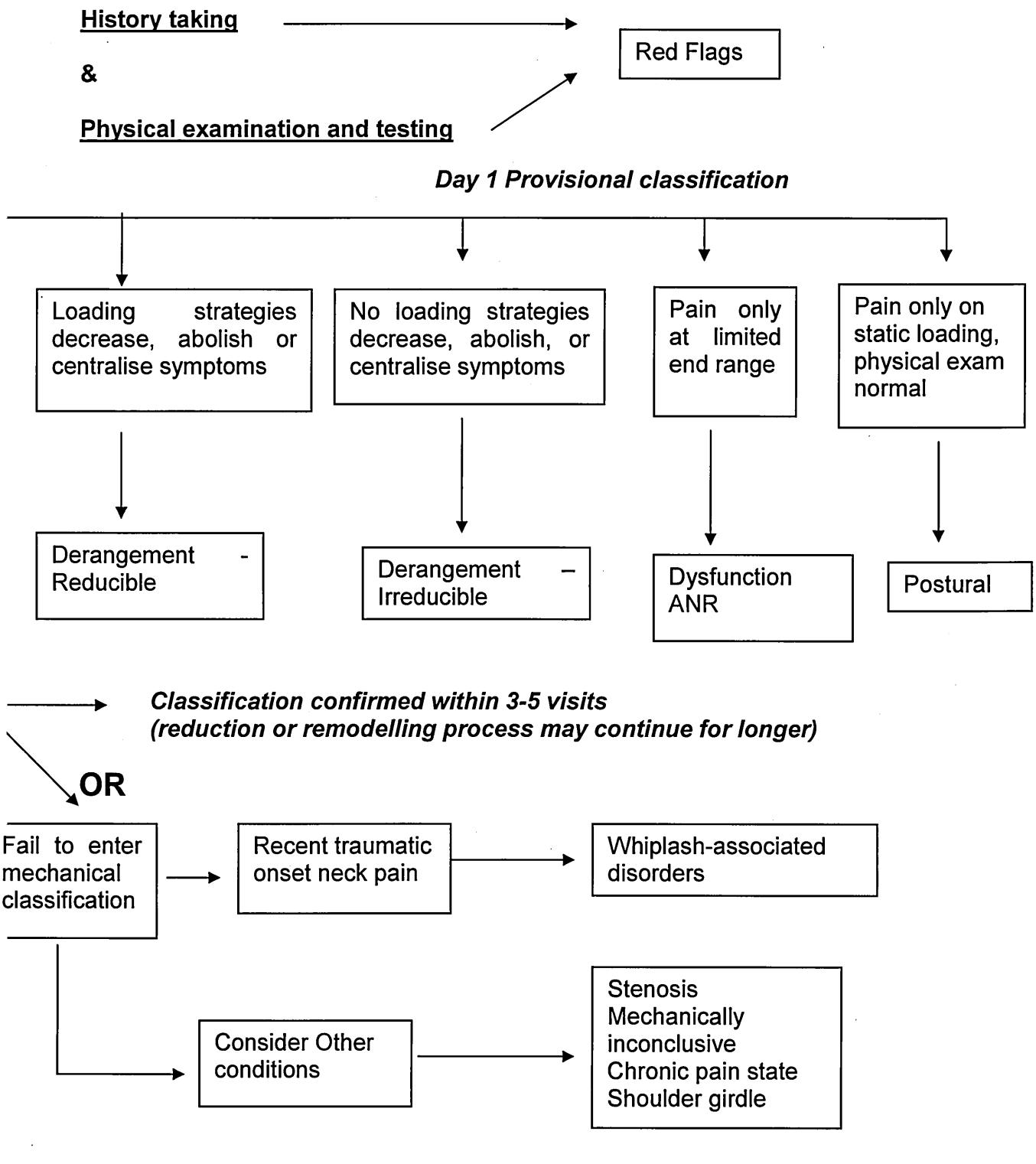
Category	Definition	Criteria**
Mechanical syndrome		**Symptom response**
Reducible derangement	Internal disc displacement with competent annulus	Centralisation Abolition Decrease
Irreducible derangement	Disc displacement with incompetent or ruptured annular wall	Peripheralisation Increase in peripheral pain No centralisation, reduction or abolition
Articular dysfunction	Soft tissue structural impairment affecting peri-articular structure	Intermittent pain when loading restricted end-range
Contractile dysfunction	Soft tissue structural impairment affecting contractile structure	Intermittent pain when loading musculotendinous unit
Adherent nerve root	Adhesions producing functional impairment of nerve root or dura	Intermittent pain when neural tissue placed under tension
Postural syndrome	Prolonged mechanical deformation of normal soft tissues	Pain only with prolonged loading Physical examination normal
OTHER	**Exclusion of above**	**Lack of above responses, plus the following**
Spinal stenosis	Extensive degenerative changes that cause narrowing of spinal or intervertebral canal	Signs / symptoms of upper or lower motor neurone lesion Increase on extension, decrease on flexion
Isthmic spondylolisthesis	Slippage of vertebral body	Sports-related injury in adolescence Worse with static loading
Hip	Pain-generating mechanism due to mechanical, inflammatory or degenerative changes in or around hip joint	History – pain on walking, eased on sitting Specific pain patterns Positive 'hip' tests
Sacro-iliac joint	Pain-generating mechanism due to mechanical, inflammatory or degenerative changes in or around sacro-iliac joint	Exclusion of hip Three or more positive 'SIJ' pain provocation tests
Mechanically inconclusive	Unknown intervertebral joint pathology	Inconsistent response to loading strategies No obstruction to movement
Chronic pain state	Pain generating mechanism	Persistent widespread pain

	influenced by psychosocial factors or neurophysiological changes peripherally or centrally	Aggravation with all activity Exaggerated pain behaviour Inappropriate beliefs and attitudes about pain
Thoracic outlet syndrome	Compression of neurovascular bundle at the shoulder girdle causing diffuse arm pain and neurological symptoms	Symptoms with raised arm activity At least 2 pain provocation tests positive

Serious spinal pathology -suspected	**Definition**	**Criteria**
Cord lesions	Compression of spinal cord by bony or soft tissue due to degenerative, traumatic, or pathological changes	Hyper-reflexes Babinski positive Bilateral / quadrilateral paraesthesia Bilateral / quadrilateral weakness
Cancer	Growth of malignant tumour in or near vertebrae	Age > 55 History of cancer Unexplained weight loss Constant, progressive pain unrelated to loading strategy, not relieved by rest
Fracture	Bony damage to vertebrae caused by trauma or weakness due to metabolic bone disease	Significant trauma Trivial trauma in individual with osteopenia
Spinal infection	Infection affecting vertebrae or disc	Systemically unwell Febrile episode Constant severe neck pain unrelated to loading strategy
Ankylosing spondylitis	One of the systemic inflammatory arthropathies affecting spinal and other structures	Lumbar, thoracic and cervical Exacerbations and remissions Marked morning stiffness Persisting limitation all movements No directional preference, but better with exercise, not relieved by rest Systemic involvement Raised ESR, + HLA B27

** The operational definitions provided below present the criteria in more detail. These give the symptom responses and time scale by which classification should be recognised.

Classification algorithm for cervical spine



Operational definitions for mechanical syndromes and others (McKenzie and May 2000, 2003, 2006)

The operational definitions describe the symptom and mechanical behaviours and the time scale needed to document each category.

Reducible Derangement

- Centralisation: in response to therapeutic loading strategies pain is progressively abolished in a distal to proximal direction, and
- each progressive abolition is retained over time,
- until all symptoms are abolished, and
- if back pain only is present this moves from a widespread to a more central location and then is abolished.
- Or pain is decreased and then abolished during the application of therapeutic loading strategies.
- The change in pain location, or decrease or abolition of pain remain better, and
- should be accompanied or preceded by improvements in the mechanical presentation (range of movement and/or deformity).

Time scale

- A derangement responder can be identified on day one, or
- a derangement responder will be suspected on day one and a provisional diagnosis made. This will be confirmed, by a lasting change in symptoms after evaluating the response to a full mechanical evaluation within five visits.
- Decrease, abolition or centralisation of symptoms is occurring but the episode may not have completely resolved within five visits.
- Aggravating factors may precipitate a deterioration in symptoms and a longer recovery process.

Irreducible Derangement

- Peripheralisation of symptoms: increase or worsening of distal symptoms in response to therapeutic loading strategies, and/or
- no decrease, abolition, or centralisation of pain.

Time scale

- An irreducible derangement patient will be suspected on day one and a provisional diagnosis made. This will be confirmed after evaluating the response to a full mechanical evaluation within five visits.

Articular dysfunction

- Local pain only, and
- intermittent pain, and

- at least one movement is restricted, and the restricted movement consistently produces concordant pain at end-range, and
- there is no rapid reduction or abolition of symptoms, and
- no lasting production and no peripheralisation of symptoms.

Adherent nerve root

- History of sciatica, cervical radiculopathy or surgery in the last few months that has improved, but is now unchanging, and
- symptoms are intermittent, and
- symptoms in the leg and/or thigh or arm and/or forearm, including 'tightness', and
- straight leg raise, flexion in standing with knee in extension, or upper limb tension test is clearly restricted and consistently produces concordant pain or tightness at end-range, and
- there is no rapid reduction or abolition of symptoms, and no lasting production of distal symptoms.

Time scale

- A dysfunction/ANR category patient will be suspected on day one and a provisional diagnosis made. This will be confirmed after evaluating the response to a mechanical evaluation within five visits.
- If the patient fails to fit all criteria another category must be considered.
- Rapid change will not occur in this syndrome, and
- symptoms will gradually reduce over many weeks, as
- range of movement gradually improves.

Contractile dysfunction

- Local pain only, and
- intermittent pain, and
- one or two, but not all, isometric resisted tests are painful
- active range of movement is full but may be painful
- if active range is limited this is due to pain and passive range is full
- there is no rapid reduction or abolition of symptoms, and
- no lasting production and no peripheralisation of symptoms.

Time scale

- A contractile dysfunction category patient will be suspected on day one and a provisional diagnosis made. This will be confirmed after evaluating the response to a mechanical evaluation within five visits.
- If the patient fails to fit all criteria another category must be considered
- There may be early initial changes in symptomatic / mechanical presentations following repeated movements
- Initial response may be more rapid than articular dysfunction
- But ultimately a protracted course of progressive loading is necessary

Postural

- Spinal pain only, and
- concordant pain only with static loading, and
- abolition of pain with postural correction, and
- no pain with repeated movements, and
- no loss of range of movement, and
- no pain during movement.

Time scale

- A posture category patient will be suspected on day one and a provisional diagnosis made. This will be confirmed after evaluating the response to a mechanical evaluation within two/three visits.
- If the patient fails to fit all criteria another category must be considered.

'Other' categories are only considered on failure to enter a mechanical diagnosis within five treatment sessions. To be designated into 'Other' category patients will fulfil:

- **'Other' criteria, and**
- **criteria for specific other category as listed below.**

'Other'

- No centralisation, peripheralisation, or abolition of symptoms, or
- does not fit derangement, dysfunction or posture criteria.
- No lasting change in pain location or pain intensity in response to therapeutic loading strategies, and
- fulfils relevant criteria in suspected 'other' pathology listed below.

Indicators for possible Red flags
Possible cancer

- age (>55)
- history of cancer
- unexplained weight loss
- constant, progressive, pain not effected by loading strategies, worse at rest
- multiple, systemic symptoms

Other possible serious spinal pathology

one of the following

- systemically unwell
- or widespread neurology
- or history of significant trauma enough to cause fracture or dislocation (X-rays will not always detect fractures)
- or history of trivial trauma and severe pain in potential osteoporotic individual
- or sudden and persistent extremes of pain causing patient to 'freeze'

Possible inflammatory disorders

- gradual onset, and
- marked morning stiffness, and
- persisting limitation of movements in all directions
- peripheral joint involvement
- iritis, psoriasis, colitis, uretheral discharge
- family history

Stenosis (lumbar)

- history of leg symptoms when walking upright
- may be eased when sitting or leaning forward
- loss of extension
- possible provocation of symptoms in sustained extension, with relief on flexion
- age greater than 50
- possible nerve root signs and symptoms
- extensive degenerative changes on x-ray
- diagnosis confirmed by CT or MRI.

Stenosis (cervical)

- age greater than 50
- possible nerve root signs and symptoms
- extensive degenerative changes on x-ray
- extension provokes symptoms.

Hip

- exclusion of lumbar spine by mechanical evaluation, and
- pain worsened by weight bearing, eased by rest or worse first few steps after rest, and
- pain pattern – groin, anterior thigh, knee, anterior shin, lateral thigh, possibly buttock, and
- positive hip pain provocation test(s) – (concordant pain).

Symptomatic sacro-iliac joint

- exclusion of lumbar spine by extended mechanical evaluation, and
- exclusion of hip joint by mechanical testing, and
- positive pain provocation tests (concordant pain) – at least three tests.

Symptomatic spondylolisthesis

- suspect in young athletic person with back pain related to vigorous sporting activity
- worse with static loading.

Mechanically inconclusive

- symptoms affected by spinal movements
- no loading strategy consistently decreases, abolishes, or centralises symptoms, nor increases or peripheralises symptoms
- inconsistent response to loading strategies.

Chronic pain state

- persistent widespread symptoms
- all activity increases symptoms
- exaggerated pain behaviour
- mistaken beliefs and attitudes about pain and movement.

Thoracic outlet syndrome (TOS)

- diffuse neck/shoulder/arm symptoms of pain / paraesthesia
- provoked with raised arm activities
- positive concordant pain response to at least two TOS provocation tests.