CHIROPRACTIC CLINICAL COMPASS ©

Produced by CCGPP

# *CHIROPRACTIC MANAGEMENT OF THORACIC SPINE CONDITIONS*

## A Literature Synthesis

**FINAL SECTION EDIT v 1.2**


**Team Lead**

***Jeffrey R. Cates, DC, MS***

**Team Members**

***Daniel S. Bowerman, DC***
***Norman W. Kettner, DC***
***Harry J. Morgan, DC***
***Brian D. Justice, DC***
***John J. Triano, DC, PhD***
***David N. Young, PhD, DC***


**A Literature Synthesis by the Research Commission of the Council on Chiropractic Guidelines and Practice Parameters**


***"A wise man . . . proportions his belief to the evidence."***

*- David Hume, An Enquiry Concerning Human Understanding, Section X, Part I.*

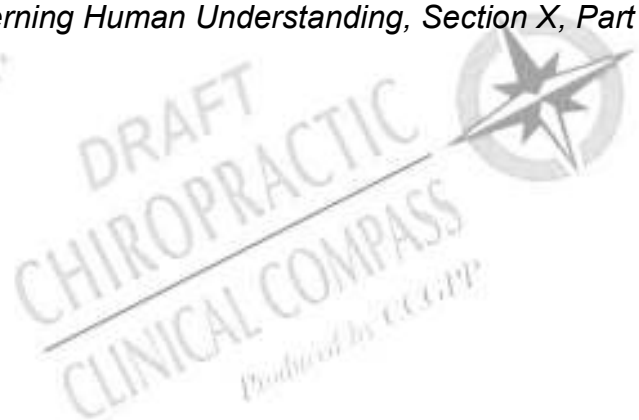


**Table of Contents** **Pg No.**

# QUICK REFERENCE SOURCE

**Process and Procedures**

A schematic of the best practice development process followed by the CCGPP teams is given in Figure 1. Process development was guided by experience of Commission members with the RAND consensus process, Cochrane collaboration, AHCPR, SIGN, and published recommendations modified to the needs of the Council. Additional details of the best practice construction procedure utilized by the CCGPP can be reviewed in the methods section available online at http://www.ccgpp.org/methodology.pdf .

***The objective and purpose motivating this work:***

The purpose of the work presented here is to provide an informed and balanced evidence based interpretation of the literature for appropriate treatment of the thoracic spine and related disorders by chiropractors.

***The methods used for this work:***

The following 4 strategies were used to enhance a patient-centered and evidence based perspective and limit sources of interpretation bias in the literature.

1. The literature was reviewed by a panel of experts including those who do use and those who do not use the methods under review.
2. Standardized and validated structured instruments were used for rating the quality of and results from the literature.
3. A formal consensus process, based on Delphi and Nominal Group Process, was used to adjudicate differences in professional opinion on the literature or to address important areas where literature is weak or lacking.
4. A wide stakeholder review with opportunity for critical comment was offered to all stakeholder groups, including patients, professionals, policymakers, and third party payers.

***Scope*:** Thoracic spine and related pain.
Chronicity range: acute, subacute, chronic, and recurrent
Applicable ICD codes: 720.0, 353.0, 721.9, 722.11, 722.72, 724.01, 724.4, 724.8, 728.85, 737.1, 737.2, 737.3, 739.2, 782.0, 786.5, 839.21, 848.3, 905.7, 953.1,

***Objective details*:**

1. To review the literature as a team and determine the most common and unique thoracic clinical disorders, diagnostic methods, and treatments concerning chiropractors.

2. To present rated evidence including guidelines, meta-analyses, systematic reviews, randomized controlled trials, cohort studies, and case series.

Particular attention will be given to sources that provide data regarding outcome measures, diagnosis, technology assessment, natural/treatment history, prognosis, and risk stratification.

3. To create a systematic summary of the evidence regarding the effectiveness of chiropractic management of musculoskeletal conditions of the thoracic spine and related disorders including a summary of the quantity, quality, and conclusions.

***Intended audience:***

- Chiropractors
- Chiropractic students and prospective students
- Chiropractic educators/educational institutions
- Chiropractic organizations/agencies
- Third-party payers/reviewers
- Governmental agencies
- Referring professionals
- Patients and prospective patients

# SUMMARY OF PRACTICE OPTIONS

***CCGPP Grades of Practice Options:***

- **GRADE A** Evidence including at least 1 meta-analysis, systematic review, or RCT rated as 1 + + and directly applicable to the target population; or a systematic review of RCTs, or a body of evidence consisting principally of studies rated as 1 + directly applicable to the target population and demonstrating overall consistency of results.
- **GRADE B** Evidence including studies rated as 2 + + directly applicable to the target population and demonstrating overall consistency of results; *or* extrapolated evidence from studies rated as 1 + + or 1 +.
- **GRADE C** Evidence including studies rated as 2 + directly applicable to the target population and demonstrating overall consistency of results; *or* extrapolated evidence from studies rated as 2 + +.
- **GRADE I (D)** Evidence level 3 or 4; *or* extrapolated evidence from studies rated as 2 +.

## *Literature on Manipulation/ Mobilization as a Treatment*

**Clinical Questions / Graded Practice Options**

***1. Is spinal manipulative therapy an effective treatment option for mechanical thoracic pain?***

**GRADE A** Yes - There are high quality data (1++) supporting the use of manipulative therapies for mechanical thoracic pain.

***2. Is spinal manipulative therapy an effective treatment option for mechanical neck and/or shoulder-and/or arm pain?***

**GRADE A** Yes - There are high quality data (1++/1-) supporting the use of manipulative therapies to the thoracic spine for neck and/or shoulder-and/or arm pain.

***3. Is spinal manipulative therapy an effective treatment for trapezius weakness?***

**GRADE C** Yes - There are moderate quality data (1+) that can be extrapolated to support the use of manipulative therapies to the thoracic spine for trapezius weakness and associated postural alterations.

**Key Point Summary:**

The literature supports that spinal manipulative therapy is a reasonable treatment option for primary mechanical thoracic pain, as well as neck, shoulder, and/or arm pain that might be referred in nature or secondary to kinetic chain alterations. Additional research is warranted.

## *Literature on Diagnostic Issues*

### Palpation

***1. Is motion palpation a valid/reliable diagnostic procedure?***

**GRADE B** No - There is high quality literature (1++) indicating that motion palpation has poor reliablity and thus questionable validity as a diagnostic procedure.

**Key Point Summary:** The available literature indicates that motion palpation lacks inter-observer reliability. The value of motion palpation as a stand-alone diagnostic method is called into question. Additional research is warranted.

***2. Is static palpation for pain and/or joint end play a valid/reliable diagnostic procedure?***

**GRADE B** Yes for reliability - There is high quality literature (1++) indicating that static palpation has established reliability as a diagnostic procedure. Equivocal for validity.

**Key Point Summary:** Simple static palpation has long been utilized for diagnostic purposes. The literature supports the continued utilization of static palpation for pain, tenderness, and joint end-play assessment. Additional research regarding its validity is warranted.

### Other Diagnostic Issues

***1. Is paraspinal scanning EMG a valid tool for diagnosing thoracic disorders in a clinical setting?***

> **Grade A** No – There is high level literature of sufficient quality (1+) indicating that scanning EMG use is not valid for routine clinical diagnosis and should be considered an investigational procedure.

**Key Point Summary:** The current literature indicates that scanning EMG use is not valid for routine clinical diagnosis and should be considered an investigational procedure.

***2. Is skin surface instrumentation a valid clinical diagnostic tool for the measurement of spinal curves?***

> **Grade B** No - There is mid-level literature (2++) indicating that surface instrumentation, specifically the "Spinal Mouse", is not a valid clinical diagnostic tool for the measurement of spinal curves.

**Key Point Summary:** Surface instrumentation, such as the "Spinal Mouse", is not a valid clinical diagnostic tool for the measurement of spinal curves. Additional refinement and assessment are warranted.

***3. Is thoracic discography a valid clinical diagnostic tool?***

> **Grade C** Yes **-** There is mid-level literature of moderate quality (2+) indicating that discography may demonstrate disc pathology not seen on magnetic resonance imaging.

**Key Point Summary:** The literature supports that clinical situations arise where it could be deemed appropriate to follow up on a suspected occult disc lesion by utilizing discography.

***4. What components might be included in a clinical history and exam?***

The Guidelines for Chiropractic Quality Assurance and Practice Parameters note that, depending on the presentation of the patient and the judgment of the practitioner, any or all of the following components might be considered in a history: (1)

1. Data - age, sex, etc.

2. Chief complaint

3. Hist/present complaint
   a. Hist. / trauma.
   b. Description of CC.
   c. Quality/character
   d. Intensity
   e. Frequency
   f. Location/radiation
   g. Onset
   h. Duration
   i. Palliative/provocation

4. Family history

5. Past Health History
   a. General health
   b. Prior illness
   c. Surgical hist.
   d. Previous injury
   e. Past Hospitalization
   f. Prior Dx. tests & Tx
   g. Medication
   h. Allergies

6. Psycho-social history
   a. Occupation
   b. Activities
   c. Recreation
   d. Exercise

7. Social history
   a. Marital status
   b. Education
   c. Social habits

8. Review of systems
   a. Musculoskeletal
   b. Cardiovascular
   c. Respiratory
   d. Gastrointestinal
   e. Genitourinary
   f. CNS
   g. EENT
   h. Endocrine
   i. Peripheral vascular
   j. Psychiatric

The Guidelines for Chiropractic Quality Assurance and Practice Parameters note that all or some of the following components may be included in a thoracic examination: (1)

- Vitals: BP, pulse, height, weight & temp
- Cranial Nerves
- Inspection-observations & posture
- Vascular exam
- Palpation
- ROM active & passive
- Neurologic exam
- Muscle strength
- Provocation tests
- Auscultation/Percussion:
  - Chest
  - Heart
  - Abdomen

## ACUTE THORACIC PAIN

### Acute Musculoskeletal Pain Guideline Recommendations

The following is a summary of the Acute Musculoskeletal Pain Guidelines Group key messages on acute thoracic spine pain management. (2) An expanded summary is included in the Appendix. The Guideline evidence rating system is reported below.

**Rating System**

The following is the rating system utilized by the Acute Musculoskeletal Pain Guidelines Group:

- **LEVEL I** Evidence obtained from a systematic review of all relevant randomized controlled trials.
- **LEVEL II** Evidence obtained from at least 1 properly designed randomized controlled trial.
- **LEVEL III-1** Evidence obtained from well-designed pseudo-randomized controlled trials (alternate allocation or some other method).
- **LEVEL III-2** Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomized (cohort studies), case control studies, or interrupted time series with a control group.
- **LEVEL III-3** Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without parallel control group.
- **LEVEL IV** Evidence obtained from case series, either post-test, or pre-test and post-test.
- **CONSENSUS** In the absence of scientific evidence and where the executive committee, steering committee, and review groups are in agreement, the term "consensus" has been applied.

SIGN equivalent evidence grades have been provided so that the reader might interpret the above guideline recommendations in comparison and context with the scoring mechanism utilized in this document. Equivalent grades were created by using comparative evidence level assessments between SIGN and the Acute Musculoskeletal Pain Guidelines Group's rating system.

**Management Plan**

The Acute Musculoskeletal Pain Guidelines Group recommends that the clinician and patient develop a management plan for acute musculoskeletal pain comprising the elements of assessment, management, and reassessment/review.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

**DIAGNOSIS**

**Etiology and Prevalence**

The Acute Musculoskeletal Pain Guidelines Group notes that pain may be referred to the upper thoracic spine from visceral structures and cervical spinal structures or arise in the thoracic interspinous ligaments, paravertebral muscles and zygapophyseal joints
Evidence: LEVEL IV; SIGN equivalent Grade: C

Patients over 60 years of age are at risk for spontaneous osteoporotic fractures of the thoracic spine; extent of vertebral deformity and multiple fractures appear linked with pain intensity.
Evidence: LEVEL IV; SIGN equivalent Grade: C

Most cases of thoracic spinal pain are of mechanical origin; however, clinicians should be alert to the potential for rare, serious conditions presenting as acute thoracic spinal pain.
Evidence: LEVEL IV; SIGN equivalent Grade: C

**History**

The Acute Musculoskeletal Pain Guidelines Group notes that while the patient history serves to differentiate sources of acute thoracic spinal pain to identify features of potentially serious conditions, it carries little diagnostic weight.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

**Physical Examination**

The Acute Musculoskeletal Pain Guidelines Group reports that:

- The reliability of palpation for tenderness of the thoracic spine is good, but its validity is unknown.
  Evidence: LEVEL IV; SIGN equivalent Grade: C

- The reliability of motion palpation of the thoracic spine is marginal.
  Evidence: LEVEL IV; SIGN equivalent Grade: C

- Following blunt trauma, a negative clinical examination in the presence of a clear sensorium makes a thoracic spinal fracture unlikely.
  Evidence: LEVEL IV; SIGN equivalent Grade: C

- Despite the absence of supportive, scientific data on the utility of physical examination of the thoracic spine, such examination provides an important opportunity to identify features of serious conditions.
  Evidence: LEVEL IV; SIGN equivalent Grade: C

**Ancillary Investigations**

In the absence of trauma, plain radiography is of limited use in defining the cause of pain.
Evidence: LEVEL IV; SIGN equivalent Grade: C

Fractures are more likely to occur in people over age 60 with a history of blunt trauma; a lower threshold for radiographic investigation is warranted in this group.
Evidence: LEVEL IV; SIGN equivalent Grade: C

In the presence of trauma, x-ray of the thoracolumbar spine is not indicated in those who are awake, alert, and have no clinical evidence of injury; however, those with equivocal or positive clinical findings or with an altered level of consciousness should undergo thoracolumbar spine evaluation.
Evidence: LEVEL IV; SIGN equivalent Grade: C

CT scanning is only indicated for the evaluation of the neural canal and posterior elements of the thoracic spine when fractures have been detected with plain films.
Evidence: LEVEL IV; SIGN equivalent Grade: C

There is no research to inform ancillary investigations for acute thoracic spinal pain; investigations should be selected on the basis of clinical features suggesting the presence of serious conditions.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

## INTERVENTION

### Non-Pharmacological Interventions

Simple interventions (providing information, assurance, and encouraging reasonable maintenance of activity) may be used alone or in combination with other interventions for the successful management of acute musculoskeletal pain.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

There is evidence that spinal manipulation is effective in the management of thoracic spinal pain, compared to placebo.
Evidence: LEVEL II; SIGN equivalent Grade: A

### Pharmacological Interventions

While many chiropractic physicians do not prescribe medication, the following is reported for those who do and/or those who co-manage care.

Simple analgesics are recommended for relief of mild to moderate acute musculoskeletal pain and can be used in conjunction with non-pharmacological interventions.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

Non-steroidal anti-inflammatory (NSAID) medication may be used, unless contraindicated.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

Oral opioids may be necessary to relieve severe musculoskeletal pain, but ongoing need for opioid analgesia is an indication for reassessment.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

Benefits from muscle relaxants may be outweighed by their adverse effects, therefore they cannot be routinely recommended.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

The Acute Musculoskeletal Pain Guidelines Group does not recommend anticonvulsants and antidepressants.
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

**Terminology Issues**

The appropriate labels for non-specific "mechanical" thoracic spinal pain are "thoracic spinal pain of unknown origin" or "somatic thoracic spinal pain".
Evidence: CONSENSUS; SIGN equivalent Grade: D (I)

There is a lack of published data on the natural history and influence of prognostic risk factors for acute thoracic spinal pain.
Evidence: NO EVIDENCE; SIGN equivalent Grade: D (I)

***LITERATURE ON RISK FACTORS***

There are no high quality data regarding risk factors as noted in the summary above. However, the Acute Musculoskeletal Pain Guidelines Group notes that age is a factor, with those over 60 having a higher risk for spontaneous osteoporotic fractures of the thoracic spine. Increased pain appears to be linked to greater deformity and fracture frequency.
Evidence: LEVEL IV SIGN equivalent Grade: C

**Key Point Summary:** The Guidelines produced by the Acute Musculoskeletal Pain Guidelines Group are of high quality and suitable for use in clinical practice.

***LITERATURE ON ADJUSTING, MANIPULATION, AND MOBILIZATION FOR ACUTE SPINE CONDITIONS***

**Clinical Questions / Graded Practice Options**

***1. Is there evidence supporting the utilization of manual therapies to the thoracic spine for acute neck pain?***

**Grade A** Yes - A high quality guideline and literature (1 ++) support the utilization of manipulation to the thoracic spine for the treatment of acute mechanical neck pain.

**Key Point Summary:** High quality literature supports the use of thoracic manipulation for acute neck pain. This pain may be referred or related to mechanical kinetic chain dysfunction. Additional research might assist in the identification of mechanisms leading to these findings. Low level literature suggests that chiropractors may assist in the

diagnosis and possibly late treatment of more serious osseous injuries. Additional research would be needed to define what role, if any, chiropractors might have in managing serious trauma.

## CHRONIC PAIN

***1. Can manipulation provide relief for chronic pain/ conditions?***

> **Grade B** Yes **-** There is literature (2++) supporting the use of spinal manipulation for chronic pain and, to a lesser degree, postural weakness (2+).

**Key Point Summary:** The literature supports that manipulation can provide better short-term improvement than acupuncture or medication in patients suffering from chronic spinal pain. There is some weaker evidence that manipulation can affect trapezius muscle strength; however, the mechanism of how this occurs is unclear.

***2. Can pain threshold assessment identify chronic back pain?***

> **Grade C** Yes - There is mid-level literature (2+) supporting the use of pain threshold assessment as an option for identifying chronic back pain.

**Key Point Summary:** While pain threshold assessment might be an option for identifying chronic back pain, its routine clinical utilization is uncommon and of questionable utility.

***3: Does chronic pain relate to depression?***

> **Grade B** Yes - There is mid-level literature (2++) of high quality that indicates that chronic pain is related to clinical depression, and that depression may magnify chronic pain.

**Key Point Summary:** Considering the interrelationship between pain and depression, a clinician might wish to consider referring chronic pain sufferers for mental health assessment and/or treatment when appropriate.

***4. Is there a relationship between an increase in the thoracic kyphosis and chronic pain and/or disability?***

> **Grade B** No - There are high quality data (2++) indicating that an increased kyphotic curve has not been shown to be related to chronic pain or disability.

**Key Point Summary:** With the exception of advanced spinal deformity, an accentuated kyphosis has no known correlation with chronic pain. Additional research is warranted.

## SCOLIOSIS / KYPHOSIS

### ITALIAN SCOLIOSIS GUIDELINES GRADED RECOMMENDATIONS

**Rating System**

The following is a summary of the Italian Guideline evidence rating system:

- **A)** Very strong - More than 1 randomized controlled study with comparable result.
- **B)** Strong - At least 1 randomized controlled study with results comparable with other published studies.
- **C)** Fair - No randomized studies but various controlled studies with comparable results.
- **D)** Poor - 1 controlled nonrandomized study or various studies with divergent results.
- **E1)** Strong scientific consensus - General consensus on a procedure or treatment.
- **E2)** Fair scientific consensus - Prevalent but not general consensus on the procedure or treatment.
- **E3)** Commission opinion where a general consensus was absent.

***Recommendations – Assessment***

- School screening programs for the early diagnosis of idiopathic scoliosis should be conducted (E2). SIGN equivalent Grade: D (I)
- During general physical examination, pediatricians, internal physicians and sports physicians should perform the Adam's test on children aged from 8 to 15 years (E2). SIGN equivalent Grade: D (I)
- The Adam's test should be conducted under a physician's guidance (E1). SIGN equivalent Grade: D (I)
- Assessment of scoliotic patients should be carried out by a physician specialized in spinal deformities (E1). SIGN equivalent Grade: D (I)
- Patients with idiopathic scoliosis should always be examined by the same physician. When this is not possible, validated assessment methods and standard clinical data collection forms should be used (E2). SIGN equivalent Grade: D (I)
- A clinical diagnosis of scoliosis should be established, and the assessment of patients with idiopathic scoliosis should be comprehensive, including clinical and radiographic information (E1). SIGN equivalent Grade: D (I)
- Assessment of patients with idiopathic scoliosis should comprise pathologic, cosmetic, psychological, functional, and family aspects (E2). SIGN equivalent Grade: D (I)
- History taking should be performed during physical examination (E2). SIGN equivalent Grade: D (I)

- During examination, sagittal alignment of the spine should be evaluated (E2). SIGN equivalent Grade: D (I)
- Bunnel's Scoliometer should be used (E1). SIGN equivalent Grade: D (I)
- When the Scoliometer is used, the cut-off point should be 5° (E2). SIGN equivalent Grade: D (I)
- The back hump should be measured using a hump-meter, level protractor, or other instrument in the clinical evaluation of the patient during specialist examination (E3). SIGN equivalent Grade: D (I)
- Clinical evaluation should be accurate; radiographic study of leg length discrepancy should be performed only when needed (E3). SIGN equivalent Grade: D (I)
- Sequential collection of clinical and diagnostic data should be recorded on specific forms (E2). SIGN equivalent Grade: D (I)
- Clinical follow-up examinations should be performed twice yearly in patients with idiopathic scoliosis or more often in patients at risk (E3). SIGN equivalent Grade: D (I)
- Radiographic studies should not be ordered when the Adam's test is negative (E3). SIGN equivalent Grade: D (I)
- An ATI angle 5° or 5 mm of back hump should be taken as the significant cut-off points for ordering a radiographic study at initial examination (E3). SIGN equivalent Grade: D (I)
- The decision whether to perform a radiographic study should be made by a specialist (E3). SIGN equivalent Grade: D (I)
- Radiographic studies should be made using centimetered films with a ratio of 1:1 in relation to real dimensions (even when digital), including visualization of the femoral heads and protection of the gonads, in any standing position without the use of support aids or indication of correct posture (E1). SIGN equivalent Grade: D (I)
- Curve magnitude should be measured using the Cobb method on the radiographic film (E1). SIGN equivalent Grade: D (I)
- Vertebral rotation should be measured using Raimondi tables or ruler or a Perdriolle torsionmeter on the radiographic film (E2). SIGN equivalent Grade: D (I)
- The first radiographic evaluation should include a lateral view (E2). SIGN equivalent Grade: D (I)
- On radiographic lateral projection, the patient's upper extremities should be placed at a 45° angle to the shoulder, with elbows extended and hands resting on a support to preserve the sagittal curvature of the spine (E1). SIGN equivalent Grade: D (I)
- To reduce the invasiveness of follow-up, no more than 1 radiographic study per year should be performed, or as decided by a clinician specialized in spinal diseases (E3). SIGN equivalent Grade: D (I)
- The least number of projections should be made on radiographic study (E1). SIGN equivalent Grade: D (I)

- In daily clinical routine, complex and costly studies should not be ordered, unless otherwise justified in the opinion of a clinician specialized in spinal pathology (E1). SIGN equivalent Grade: D (I)

***General Recommendations***

- The choice of therapeutic options should be made by a clinician specialized in spinal diseases on the basis of information from history taking, objective, and diagnostic procedures (E1). SIGN equivalent Grade: D (I)
- A nonstructural scoliotic curve and scoliosis with a Cobb angle <10 (±5°) should not be treated specifically, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). SIGN equivalent Grade: D (I)
- Scoliosis with a Cobb angle <10 (±5°) and a prominent nonstructural scoliotic curve should be regularly examined until the pubertal growth spurt, unless otherwise justified per the opinion of a clinician specialized in spinal diseases (E2). SIGN equivalent Grade: D (I)
- In treating minor curves, specific exercises should be initiated as a first step in the approach to treating idiopathic scoliosis to prevent progression of the deformity (C). SIGN equivalent Grade: B
- Specific treatment teams (not necessarily working directly together) should be constituted, with close cooperation between the physician and the rehabilitationist (E3). SIGN equivalent Grade: D (I)
- Exercise programs should be designed and carried out by a specifically trained rehabilitation therapist experienced in scoliosis treatment (E2). SIGN equivalent Grade: D (I)
- Exercises should be performed individually or, even better, in small groups, according to a personalized exercise program (E3). SIGN equivalent Grade: D (I)
- Exercises should be performed regularly until the end of treatment (E2). SIGN equivalent Grade: D (I)
- Exercises should be customized to the patient's needs (E2). SIGN equivalent Grade: D (I)
- The goals of an exercise program should be to improve neuromotor and postural control of the spine, balance, and proprioception, and to strengthen thoracic muscle tone (E2). SIGN equivalent Grade: D (I)
- Exercises should not increase joint freedom or spinal mobility, except in the preparatory phase for brace treatment (E2). SIGN equivalent Grade: D (I)
- In specific exercise, the use of single methods, none of which are adapted to all therapeutic phases, should be avoided in children with idiopathic scoliosis (E2). SIGN equivalent Grade: D (I)
- In each treatment phase, the best methods, techniques, and exercises should be employed to achieve the treatment objectives established for the patient (E2). SIGN equivalent Grade: D (I)
- Manual mobilization and manipulation of the spine should be avoided, except in the preparatory phase for brace treatment (D). SIGN equivalent Grade: C

- Correction of leg length discrepancy, if needed, should never be total and should be decided by a clinician specialized in spinal diseases (E3). SIGN equivalent Grade: D (I)
- Plantar insets (not lifts), bytes, conventional and homeopathic medicines, acupuncture, or specific dietary regimens should not be used to correct a spinal deformity (E1). SIGN equivalent Grade: D (I)

***Recommendations – Specific Respiratory Exercises***

- Where needed, exercises to improve respiratory function are recommended in patients with idiopathic scoliosis (D). SIGN equivalent Grade: C
- Training in regional respiratory strategies is recommended to promote the expansion and ventilation of a specific lung compartment (E2). SIGN equivalent Grade: D (I)
- Exercises performed in brace or assisted pushing on the back hump are recommended to promote chest expansion of the concave side of the thorax (E2). SIGN equivalent Grade: D (I)

***Recommendations – Specific Exercises During Brace Treatment and Surgical Therapy***

- Specific exercises should be performed in combination with brace treatment (C). SIGN equivalent Grade: B
- Mobilization exercises should be performed to improve joint freedom of the spine braced full time, but not during the release phase (B). SIGN equivalent Grade: A
- Mobilization exercises are recommended as preparation for brace treatment (E2)
- Exercises to strengthen muscle tone during brace treatment are recommended (E1). SIGN equivalent Grade: D (I)
- Exercises and posture training to recover sagittal pattern during brace treatment are recommended (E2). SIGN equivalent Grade: D (I)
- Exercises in posture and function training are recommended, particularly during weaning off the brace and the postsurgical period (E2). SIGN equivalent Grade: D (I)

***Recommendations – Sports Activities***

- Sports should not be prescribed as treatment for idiopathic scoliosis (E2). SIGN equivalent Grade: D (I)
- General sports activities that offer patients specific benefits in terms of psychological, neuromotor and general organic well-being are recommended (E2). SIGN equivalent Grade: D (I)
- During all treatment phases, physical education at school should be continued. Based on the severity of the curve, and progression of the deformity, and the opinion of a clinician specialized in spinal disease, restrictions may be placed on practicing certain types of sports activities (E2). SIGN equivalent Grade: D (I)

- Sports activities should also be continued during brace treatment because of the physical and psychological benefits these activities provide (E3). SIGN equivalent Grade: D (I)
- Swimming should not be used to treat pathologic curves (E2). SIGN equivalent Grade: D (I)
- Competitive activities that greatly mobilize or stretch the spine should be avoided in patients with scoliosis at high risk of progression (D). SIGN equivalent Grade: C

***Recommendations – Brace Treatment***

- Brace treatment is recommended in the conservative therapy of idiopathic scoliosis (C). SIGN equivalent Grade: B
- Brace treatment is not recommended in treating curves with a Cobb angle <15 (±5°), unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). SIGN equivalent Grade: D (I)
- Brace treatment is recommended in treating patients curves with a Cobb angle >20 (±5°), future growth potential, and demonstrated progression of deformity or elevated risk of worsening, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (C). SIGN equivalent Grade: B
- A fixed brace (plaster or fiberglass) is recommended in treating curves with a Cobb angle >40 (±5°), unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). SIGN equivalent Grade: D (I)
- Braces should be worn full-time or no less than 18 hours at the beginning of treatment, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E3). SIGN equivalent Grade: D (I)
- Braces should be worn and the wearing time gradually reduced until the end of vertebral bone growth (E2). SIGN equivalent Grade: D (I)
- The brace system should be specifically designed for the curve to be treated (E1). SIGN equivalent Grade: D (I)
- Brace systems proposed for treating scoliotic deformity on the frontal and horizontal planes should take into account the sagittal plane as far as possible (E3). SIGN equivalent Grade: D (I)
- The least invasive brace in relation to the clinical situation should be used to reduce its psychological impact and to ensure better patient compliance (E1). SIGN equivalent Grade: D (I)
- Braces should not so restrict thorax excursion that they reduce respiratory function (E1). SIGN equivalent Grade: D (I)
- The specialist should accurately inform the patient about the length of time the prescribed brace is to be worn (E1). SIGN equivalent Grade: D (I)
- Removable braces should be prescribed, constructed, and fitted on an ambulatory basis (E1). SIGN equivalent Grade: D (I)
- A specific treatment team should be constituted (not necessarily directly working together), with close cooperation between the prescribing physician and the brace

examiner, the orthotist constructing the brace, and the rehabilitationist (E3). SIGN equivalent Grade: D (I)

- Braces should be constructed by an orthotist specialized in the construction of the prescribed brace system (E1). SIGN equivalent Grade: D (I)
- The brace system should be examined by the prescribing physician, who should personally verify the validity of the brace constructed by the orthotist, and propose (and verify) all necessary corrections to ensure major brace efficacy and tolerability (E1). SIGN equivalent Grade: D (I)
- The construction and testing of a fixed plaster or fiberglass brace should be performed in a specialized setting (E1). SIGN equivalent Grade: D (I)
- A fixed plaster or fiberglass brace should be constructed *manu medica* (E1). SIGN equivalent Grade: D (I)

***Recommendations - Sagittal Plane Deformities***

- On screening and general physical examination of children 10 to 17 years old, pediatricians, internists, and sports physicians should also evaluate the spine sagitally (E3). SIGN equivalent Grade: D (I)
- Evaluation of patients with spinal deformities on the sagittal plane should be performed by a physician specialized in spinal diseases (E1). SIGN equivalent Grade: D (I)
- Patients with spinal deformities on the sagittal plane should be examined by the same physician. When this is not possible, the use of validated methods and standardized data collection forms is recommended (E2). SIGN equivalent Grade: D (I)
- Evaluation of patients with spinal deformities on the sagittal plane should be comprehensive, including clinical and radiographic assessment (E1). SIGN equivalent Grade: D (I)
- A comprehensive evaluation of the patient should comprise pathologic, cosmetic, psychological, functional, and familial aspects (E2). SIGN equivalent Grade: D (I)
- History taking should be conducted during visits (E3). SIGN equivalent Grade: D (I)
- A non-invasive method of surface measurement should be used to document patient follow-up (E3). SIGN equivalent Grade: D (I)
- Sequential collection of clinical and diagnostic data should be recorded on specific forms (E2). SIGN equivalent Grade: D (I)
- Follow-up visits should be conducted every 6 months, or more often in at-risk patients (E3). SIGN equivalent Grade: D (I)
- The decision to order radiographic studies should be left to the specialist (E3). SIGN equivalent Grade: D (I)
- Deformities should be measured using the Cobb method on the radiograph (E1). SIGN equivalent Grade: D (I)
- To reduce the invasiveness of follow-up procedures, no more than 1 radiographic study per year should be performed (E3). SIGN equivalent Grade: D (I)

***Recommendations – Treatment***

- The choice of therapeutic options should be made by a clinician specialized in spinal diseases on the basis of information from history taking, physical examination and diagnostic studies (E1). SIGN equivalent Grade: D (I)
- Kyphosis with a Cobb angle <45 (±5°) should not be treated with specific therapy, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). SIGN equivalent Grade: D (I)
- Thoracolumbar and lumbar kyphosis should always be treated with specific therapy (E1). SIGN equivalent Grade: D (I)
- Specific exercises are recommended as a first step in the therapeutic approach to hyperkyphosis, and also in functional forms (postural), since they may progress to stiffness and structuring (E2). SIGN equivalent Grade: D (I)
- Exercise programs should be proposed and conducted by a specialized rehabilitationist (E2). SIGN equivalent Grade: D (I)
- Exercises should be performed individually or, even better, in small groups, with personalized programs (E3). SIGN equivalent Grade: D (I)
- Exercises should be practiced regularly (E2). SIGN equivalent Grade: D (I)
- Exercise programs should be personalized according to patient needs (E2). SIGN equivalent Grade: D (I)
- The goals of the exercise program are to improve postural control of the spine, balance, and proprioception, and to strengthen muscle tone of the back muscles (E2). SIGN equivalent Grade: D (I)
- Patients should be trained to maintain a correct posture in activities of daily living and involved in a comprehensive ergonomic training program (E1). SIGN equivalent Grade: D (I)
- Brace treatment is recommended in the conservative treatment for hyperkyphosis (E1). SIGN equivalent Grade: D (I)
- Brace treatment is recommended for hyperkyphosis with Cobb angle >55 (±5°), good but incomplete curve corrigibility, and future growth potential, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). SIGN equivalent Grade: D (I)
- The use of a preliminary fixed brace (plaster or fiberglass) is recommended in treating hyperkyphosis with a Cobb angle >65 (±5°), reduced curve corrigibility, and future growth potential, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). SIGN equivalent Grade: D (I)
- Braces should be specifically designed for the curve to be treated (E1). SIGN equivalent Grade: D (I)
- The least invasive brace in relation to the clinical situation should be used, to reduce the psychological impact of the device on the patient and to improve patient compliance (E1). SIGN equivalent Grade: D (I)
- The specialist should accurately inform the patient about the number of hours the brace should be worn, in relation to the type of system prescribed and extent of the deformity (E1). SIGN equivalent Grade: D (I)

- Removable braces should be prescribed, constructed, and tested on an ambulatory basis (E1). SIGN equivalent Grade: D (I)
- A specific treatment team should be constituted (not necessarily directly working together), with close cooperation between the prescribing physician and the brace tester, the orthotist constructing the brace, and the rehabilitationist (E2). SIGN equivalent Grade: D (I)
- Braces should be constructed by an orthotist specialized in the construction of the prescribed brace system (E1). SIGN equivalent Grade: D (I)
- The brace system should be examined by the prescribing physician, who shall personally verify the validity of the brace constructed by the orthotist and propose (and verify) all necessary corrections to ensure major brace efficacy and tolerability (E2). SIGN equivalent Grade: D (I)
- Construction and testing of a fixed plaster or fiberglass brace should be performed in a specialized setting (E1). SIGN equivalent Grade: D (I)
- A fixed plaster or fiberglass brace should be constructed *manu medica* (E1). SIGN equivalent Grade: D (I)
- Brace treatment should always be combined with a specific exercise program (C). SIGN equivalent Grade: B
- Mobilization exercises should be practiced in preparation for brace treatment (E1). SIGN equivalent Grade: D (I)
- In brace exercises should be performed to strengthen muscle tone (E1). SIGN equivalent Grade: D (I)
- Exercises in posture and function training are recommended, particularly during weaning off the brace and the postsurgical period (E1). SIGN equivalent Grade: D (I)
- Sports activities should not be prescribed as treatment for sagittal plane deformities (E2). SIGN equivalent Grade: D (I)
- General sports activities that offer patients specific benefits in terms of psychological, neuromotor, and general organic well-being are recommended (E2). SIGN equivalent Grade: D (I)
- During all treatment phases, physical education at school should be continued (E2). SIGN equivalent Grade: D (I)
- Sports activities should be also continued during brace treatment because of the physical and psychological benefits these activities provide (E3). SIGN equivalent Grade: D (I)
- A sedentary lifestyle should be discouraged, as it constitutes a negative factor for the pathomechanics of hyperkyphosis (E2). SIGN equivalent Grade: D (I)
- In atypical Scheuermann's lumbar disease, particularly in the presence of severe lumbar pain, excessive mechanical stress on the spine should be avoided, as with several competitive types of sports (E2). SIGN equivalent Grade: D (I)

**Clinical Questions / Graded Practice Options**

***1. Are the Italian scoliosis Guidelines suitable for use in clinical practice?***

**Grade B** Yes - The Italian scoliosis Guidelines are of high quality and evaluate literature of sufficient quality (2++) to warrant their utilization in clinical practice.

**Key Point Summary:** The CCGPP Thoracic team found the Italian scoliosis Guidelines to be well constructed and suitable for clinical application.

***2. Are sagittal spinal curve configurations a notable health concern?***

**GRADE B** No - There is high quality literature reviewing mid level data (2++) indicating that sagittal spinal curve configurations are not currently a notable health concern.

**Key Point Summary:** The best evidence currently available indicates that clinicians should downplay the significance of sagittal spinal curves configurations and, pending additional higher quality evidence, assure patients that sagittal spinal curves do not appear to be associated with health or pain.

***3. Is manipulation/manual mobilization an effective treatment option for AIS scoliosis?***

**Grade B** No - There is no strong evidence that manipulation/manual mobilization is an effective primary treatment for AIS.

**Key Point Summary:** The literature does not support the use of manipulation as an effective primary treatment for AIS. Chiropractic physicians might still monitor, manage, or co-manage AIS using other more effective strategies. Manipulation/manual mobilization might be warranted to increase flexibility prior to brace treatment. Additional research is warranted.

***4. Is bracing an effective treatment option for AIS?***

**Grade B** Yes - There is literature of sufficient quality (2++) that indicates that bracing may reduce, halt, or reverse the progression of scoliotic curves associated with AIS.

**Key Point Summary:** Newer bracing strategies are being developed that may provide an effective treatment for AIS.

***5. Are electrical muscle stimulation (EMS) strategies an effective treatment for AIS?***

**Grade B** No - There is literature (2++) indicating that EMS is ineffective as a treatment for AIS.

**Key Point Summary:** There is a body of evidence indicating that EMS is not a suitable treatment option for AIS.

***6. Is digital assessment of radiographs an effective diagnostic too for scoliosis assessment?***

> **Grade C** Yes - There is evidence (2+) to support the utilization of digitized assessment methods for standard roentgenmetric evaluation and proxy torsion assessment of scoliosis.

**Key Point Summary:** Literature trends indicate that digitization may be a valuable tool for scoliosis curve assessment.

***7. Is there an optimum patient position for scoliometer assessment?***

> **Grade D (I)** Yes - There is limited evidence (2+) to support the use of a scoliometer for AIS in the seated forward bending position.

**Key Point Summary:** Examination of patients with a scoliometer in the seated forward bending position may increase the test's accuracy.

***8. Should adults be monitored for curves progression and/or biomechanical dysfunction?***

> **Grade D (I)** Yes - There is limited evidence (2+) that clinical symptoms may be associated with radiographic findings in adult patients with scoliosis.

**Key Point Summary:** Problems associated with scoliosis are not limited to the immature spine.

## THORACIC OUTLET SYNDROME

***1. Are orthopedic tests helpful in the diagnosis of thoracic outlet syndrome (TOS)?***

> **i. Grade D (I)** Yes - There is limited literature (2+) indicating that Adson's and hyperabduction pulse tests correlate with a TOS diagnosis. Paired provocative tests that include the Adson test also correlate with the TOS diagnosis. Wright's test combined with the Roo's or Hyperabduction with symptoms tests also correlate significantly.
>
> **ii. Grade D (I)** Yes - There is limited literature (2+) indicating that the Cyriax Release test correlates with a diagnosis of TOS.
>
> **iii. Grade D (I)** Yes - There is limited literature (2+) indicating that the cervical rotation lateral flexion test (CRLF test) correlates with a diagnosis of TOS.

**Key Point Summary:** There is no gold standard-available to evaluate TOS true/false negative/positives. This makes the sensitivity/specificity values reported in these studies

of dubious clinical value. Doing more than 1 test (stacking) may increase diagnostic accuracy.

## DISC DISEASE/NERVE ROOT LESIONS

***1. Is discography an effective diagnostic tool for routine clinical use?***

**Graded Options:**

> **Grade D (I)** Equivocal/No - There is insufficient evidence to support the routine use of discography as a diagnostic tool.

**Key Point Summary:** There are data indicating that asymptomatic disc and spinal deformities are common. Discography may be able to identify these types of occult disc lesions. The identification of an asymptomatic lesion is of questionable value.

## REFERRED PAIN AND SPECIAL CONDITIONS

### Musculoskeletal Referred Pain

***1. Is manipulative therapy an effective treatment for musculoskeletal referred pain to the neck and/or upper quadrant?***

> **Grade A** Yes - There are (1++/1+) data of sufficient quality to support the use of manipulative therapies for musculoskeletal referred pain to the neck and/or upper quadrant.

**Key Point Summary:** The clinician may find it useful to assess and address potential sources of referred pain from the thoracic spine.

### *Costovertebral/Costaltransverse Syndrome*

***1. Is manipulative therapy an effective treatment for costovertebral joint pain?***

> **Grade D (I)** Yes - There are (3/4) low level data supporting the consideration of manual therapies for the treatment of costovertebral joint.

**Key Point Summary:** There is a quantity of positive low level studies supporting additional research into the diagnosis and treatment of costovertebral dysfunction.

### *T4 Syndrome*

***1. Is manipulative therapy an effective treatment for T4 syndrome referred pain?***

> **Grade D (I)** Yes - There are (3/4) low level data supporting consideration of manual therapies for the treatment of T4 related pain.

**Key Point Summary:** Low level studies support additional research into the diagnosis and treatment of T4 syndrome. The clinician might consider referred pain patterns and kinetic chain assessment for the purpose of identification of upper thoracic pain generators as a source of referred pain.

### *Thoracolumbar junction syndrome*

***1. Is manipulative therapy an effective treatment for thoracolumbar-related referred pain?***

**Graded Options:**

> **Grade D (I)** Yes - There are (2-/3/4) low level data supporting consideration manual therapies for the treatment of thoracolumbar junction related pain.

**Key Point Summary:** Basic science and low level studies support additional research into the diagnosis and treatment of thoracolumbar junction syndrome. The clinician might consider kinetic chain assessment for the purpose of identification of a thoracolumbar pain generator causing referred pain.

## Organic Referred Pain and Conditions

### *Chest*

***1. Is manipulative therapy an effective treatment for non-cardiac pseudo-angina chest pain?***

> **Grade B** Yes - There is (1++/2+) a sufficient level of data supporting that chiropractic physicians can effectively participate in the diagnosis and treatment of non-cardiac pseudo-angina chest pain.

**Key Point Summary:** Inter-professional cooperation is essential when cardiac health is considered. Chiropractors should refer all patients with suspected cardiac problems for appropriate case management. Patients identified with non-cardiac pseudo-angina and persistent thoracic pain should be referred for evaluation for a somatic cause, which could include a therapeutic trial of manipulative therapy.

### *Cancer and Metastatic Disease: Organic Referred Pain*

***1. Does failure of a conservative treatment trial warrant additional testing for cancer/metastatic disease?***

> **Grade D (I)** Equivocal/Yes -There are low level data (3/4) indicating that a failure of conservative therapy may be an indication for additional testing.

**Key Point Summary:** There is no reliable high level evidence on directing chiropractic management of cancer/metastatic disease. Standard medical management, such as history/red flag assessment with appropriate diagnostic and/or referrals, would be a reasonable approach.

## Other Miscellaneous Conditions and Studies

### *Shoulder Pain*

***1. Is there evidence supporting the use of manipulative therapies for shoulder dysfunction?***

**Grade A** Yes - There is evidence (1++) that manipulation/mobilization of the cervical spine, thoracic spine, ribs, adjacent joints, and tissues may effectively hasten the resolution of shoulder/shoulder girdle dysfunction.

**Key Point Summary:** Manipulative therapy for the cervical and thoracic spine and shoulder girdle, in addition to usual medical care, accelerates recovery of shoulder symptoms, and is superior to corticosteroid injection and physical therapy for shoulder girdle dysfunction. There appears to be no difference between therapies in long-term outcome studies, and recurrent problems are common.

### *Flat-back syndrome*

In a low level paper, Wiggens et al. wrote that iatrogenic loss of lordosis is now recognized as a complication following placement of thoracolumbar instrumentation to correct scoliosis. (3) This is especially true with distraction instrumentation. Flat-back syndrome is characterized by forward inclination of the trunk, inability to stand upright, and back pain. Evaluation of the deformity should include a full-length lateral radiograph obtained with the patient's knees and hips fully extended.

**No recommendations**

**Key Point Summary:** Additional research is needed to document prevalence, significance, and treatment options for flat-back syndrome.

### *Ankylosing spondylitis*

***1. Are exercises an effective treatment for AS?***

**Grade A** Yes - There is evidence (1++) indicating that AS patients may benefit from structured exercise programs.

**Key Point Summary:** For treatment of AS, global posture re-education exercise protocols worked slightly better than conventional therapy; spa resort therapies worked better than supervised group exercise, which worked better than home exercise.

***2. Is high velocity low amplitude manipulation a suitable treatment option for AS?***

> **Grade D (I)** Insufficient data - While there is low level research (3) supporting the efficacy of a well designed and monitored trial of chiropractic care for AS, there is low level (3/4) literature indicating a potential risk of fracture and neurological compromise with minimal forces.

**Key Point Summary:** A chiropractic practitioner might be called upon to diagnose, refer, monitor, and/or co-manage patients with AS. Care should be taken to avoid application of forces that might induce fracture.

**Note to Healthcare Brokers**

Third-party healthcare fund management brokers should be aware that chiropractic physicians often provide a wide range of services beyond high velocity manual manipulation. Chiropractic treatment often consists of physiotherapy, low force techniques, massage, mobilization, exercise training, gait training, myofascial release work, neuromuscular re-education, casting, taping, splinting, and other physical therapies and orthopedic procedures. Diagnostic services can include any physician service allowable under the chiropractic physician's state scope of practice law.

# Forewords

**Team Lead: Jeffrey R. Cates, DC, MS**
**Team Members:**

***Brian D. Justice, DC***
***Daniel S. Bowerman, DC***
***Harry J. Morgan, DC***
***Norman W. Kettner, DC***
***John J. Triano, DC, PhD***
***David N. Young, PhD, DC***

After the extraordinary work put into this chapter by the thoracic team, I began to think of an appropriate introduction to the work; something perhaps witty and wise … but, it became clear to me that the occasion calls for a simple and direct approach. After reading this document we hope the reader will find the work interesting, valuable and applicable to daily practice.

We, as chiropractors, have all been charged with the task of assisting our patients in their quest for health. Understanding the current state of evidence in chiropractic literature is one of our primary obligations as chiropractors. It matters not what particular view one holds as a chiropractor; we will all be held to evidence-based standards of care for moral, legal, and reimbursement purposes. It matters not what one's chiropractic "belief system" is based on, what organization one might belong to, or what organization does, or does not "endorse" this document; we will still be held accountable for practicing in an evidence-based manner. This document does not create the evidence; it only summarizes and reports the evidence for the reader's convenience.

Mahatma Gandhi said, "truth is god". Scientific evidence reflects "truth" to the extent we humans can observe and understand it. Science is a method that can help us reveal and accept truth, and those truths are recorded as "evidence". This work is offered as a summary of evidence for consideration by the chiropractic physician. An easy to read and reference format has been selected for presentation of this material so that the reader might find the presented information useful in daily practice. It is our sincere hope that this document is useful to those for whom it has been created. May you all find truth.

With warmest regards,
Jeffrey R. Cates, DC, MS

# *PROCESS DESCRIPTION*

## *Team selection and orientation training of team leaders*

Team members were selected by the team leader from selected nominees presented by the CCGPP Council. Individuals were nominated by the Council for their unique research skills and knowledge base. Once nominated, conflict of interest and other issues were considered before the nominees were approved by the Research Commission.

The team leader attended multiple orientation meetings with both the CCGPP Council and Research Commission. Thoracic team members were trained by the team leader, who was well versed in guideline quality and construction methods. Each team member was presented with an instruction package with a detailed methodology plan and description, plus appropriate literature evaluation instruments. The literature to be reviewed was randomly divided among the team members.

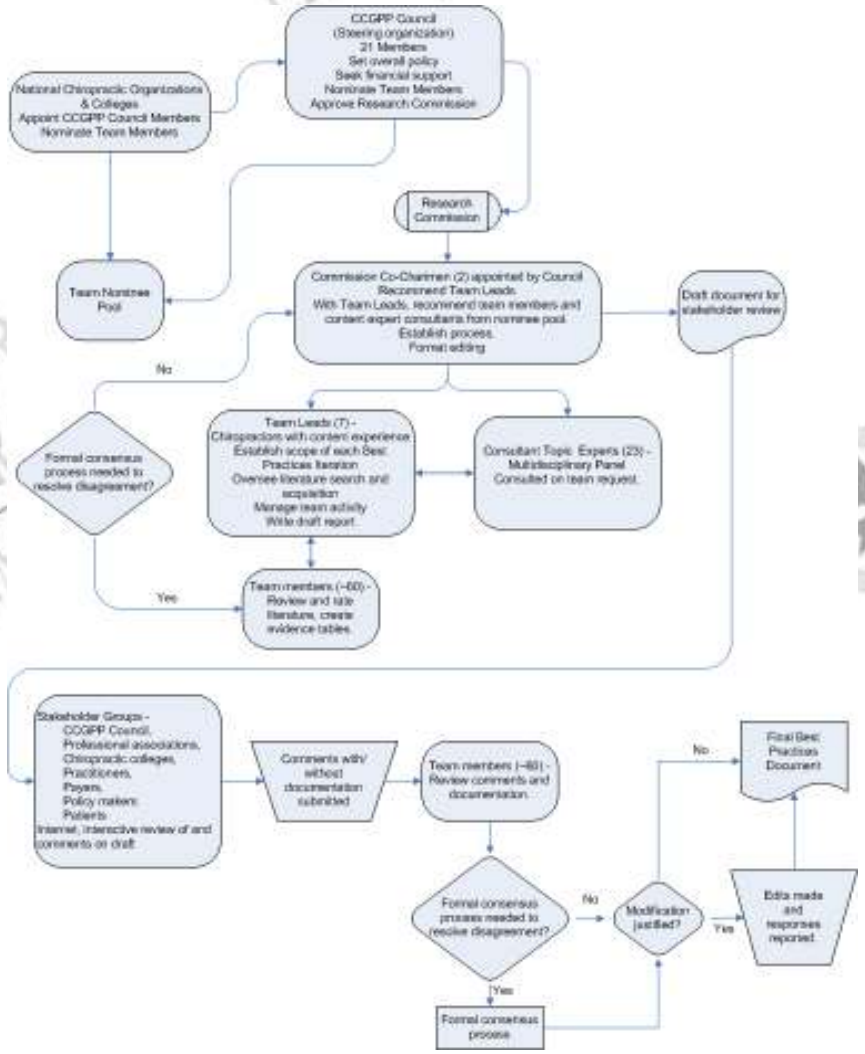



Figure 1. CCGPP Flow chart describing the process of best practices development.

# *Methods*

***Literature Evaluation - SIGN Methodology***

In the SIGN (4) approach to literature evaluation, there are 11 questions, separated into 2 parts: Part 1 has 10 questions and examines elements of internal validity, while Part 2 has a single question concerning overall assessment of the study. For Part 1, each question has 6 possible choices: well covered, adequately addressed, poorly addressed, not addressed, not reported, and not applicable. Criteria for evaluating the overall study in Part 2 are defined by 3 options: ++ (strong, most criteria fulfilled), + (neutral), or – (weak, few or no criteria fulfilled). The Part 1 considerations include:

- The study addresses an appropriate and clearly focused question;
- The assignment of subjects to treatment groups is randomized;
- An adequate concealment method is used;
- Subjects and investigators are kept "blind" about treatment allocation;
- The treatment and control groups are similar at the start of the trial;
- The only difference between groups is the treatment under consideration;
- All relevant outcomes are measured in a standard, valid, and reliable way;
- The percentage of dropouts is given for each treatment arm of the study;
- All the subjects are analyzed using an intention to treat analysis;
- Multisite studies have comparable reporting methods at all sites.

There are 4 points where a study might be categorically rejected: if there is no indication of randomization, if the groups are not treated equally, if the outcome measures are not stated, or if the study bases its conclusions on secondary outcomes.

The hierarchy of study design includes:

- Randomized controlled trials - including quasi-randomized processes.

- Non-randomized controlled trials - prospective studies with predetermined eligibility criteria and outcome measures.

- Observational studies with controls -includes retrospective, interrupted time series, case-control studies, cohort studies with controls, and research that includes adjustment for confounding variables.

- Observational studies without controls (e.g., cohort studies without controls and case series)

For Guideline evaluation the scoring tools included the AGREE instrument (5)

AGREE examines 6 domains:

- Scope and purpose (items 1-3)
- Stakeholder involvement (items 4-7)
- Rigor of development (items 8-14)
- Clarity and presentation (items 15-18)
- Applicability (items 19-21)
- Editorial independence (items 22-23)

AGREE scores are not aggregated across domains but are assessed individually.

Low level Literature:

Although we have summarized lower level literature, including interesting case series and notable case reports, the clinician should note that these lower level reports should not be weighed as heavily as higher quality research. That said, the findings and data contained in these studies are often valuable, in that they can help direct research direction and provide clinicians with a sense of where the evidence may be trending. Such knowledge may be helpful in a clinical setting, so long as the clinician understands the limits associated with interpreting and applying the data.

## *Topic Selection*

**Table 1. Conditions/Procedures Considered**

| | |
|---|---|
| 720.0 | Ankylosing spondylitis |
| 353.0 | Brachial plexus lesions |
| 721.9 | Spondylosis of unspecified site |
| 722.11 | Displacement of thoracic intervertebral disc without myelopathy |
| 722.72 | Intervertebral disc disorder with myelopathy, Thoracic region |
| 724.01 | Spinal stenosis, Thoracic region |
| 724.4 | Thoracic or lumbosacral neuritis or radiculitis, unspecified |
| 724.8 | Other symptoms referable to back |
| 728.85 | Spasm of muscle (Other disorders of muscle, ligament, and fascia) |
| 737.1 | Curvature of spine, Kyphosis (acquired) |
| 737.2 | Curvature of spine, Lordosis (acquired) |
| 737.3 | Kyphoscoliosis and scoliosis |
| 739.2 | Nonallopathic lesions, not elsewhere classified, Thoracic region |
| 782.0 | Disturbance of skin sensation |
| 786.5 | Chest pain |
| 839.21 | Other, multiple, and ill-defined dislocations, Thoracic vertebra, closed |
| 848.3 | Ribs (other and ill-defined sprains and strains) |
| 905.7 | Late effect of sprain and strain without mention of tendon injury |
| 953.1 | Injury to nerve roots and spinal plexus, Dorsal root |

## *Identifying the Question*

"Before beginning a hunt, it is wise to ask someone what you are looking for before you begin looking for it." - Winnie the Pooh

Because this is a best practice synthesis, designed to address the practical problem of care for individual patients, it was necessary to cast a wider net for literature collection than is generally used in pure guideline documents. Based on the extent and volume of the literature, as well as specific study of the practice of chiropractic from the National Board of Chiropractic Examiners Job Analysis and other focused references, topics for specific review were selected. The results apply to conditions that may be listed under various diagnostic terms. (See Table 2)

The central questions for management of thoracic spine and related conditions that were posed included:

1. Is there evidence for or against the effectiveness of common chiropractic treatment methods?

2. Is there evidence of clinical utility, sensitivity/specificity, validity and appropriateness for the common diagnostic methods used by chiropractors?

3. Is there evidence to help risk stratify or estimate complaint complexity and to inform appropriate management and process of care?

The NBCE Job Analysis (6) and prior chiropractic guidelines (1) were reviewed for diagnostic and therapeutic terminology, which was then used to create a word matrix. The word matrix was used to generate PICO questions and search parameters.

**Table 2. Thoracic Conditions - NBCE Job Analysis (frequency: 0-4 scale)**

Neurological Conditions:
- Spinal stenosis 1.6

Articular/Joint Conditions:
- Spinal subluxation 3.9
- Sprain 3.1
- Kyphosis 2.4
- Vertebral facet syndrome 2.9
- Intervertebral disc syndrome 3.0
- Thoracic outlet syndrome 1.7
- Structural scoliosis 1.9
- Functional scoliosis 2.2
- Congenital anomaly 1.5
- Osteoarthritis DJD 3.3
- Systemic/rheumatoid arthritis or gout 1.4
- Infection of joint/disc 0.4

Muscular Conditions:
- Muscle strain/tear 3.0
- Tendonitis/ tenosynovitis 2.7
- Myofascitis 2.9
- Fibromyalgia 2.1
- Muscular atrophy 1.0

Skeletal conditions:
- Fracture 0.9
- Osteoporosis/osteomalacia 2.0
- Congenital developmental anomalies 1.4
- Endocrine or metabolic bone disorder 0.5
- Bone tumor/metastasis 0.5
- Osteomyelitis/infection 0.3

Respiratory conditions:
- Viral infection 1.4
- Bacterial infection 1.2
- Asthma, emphysema or COPD 1.4
- Occupational or environmental disorder 0.8
- Atelectasis or pneumothorax 0.2
- Tumor of lung or respiratory passages 0.3

Gastrointestinal conditions:
- Bacterial or viral infection 0.9
- Appendicitis 0.3
- Cholecystitis or pancreatitis 0.4
- Ulcer of stomach, small intestine, or colon 0.7
- Colitis or diverticulitis 0.9
- Tumor of gastrointestinal tract 0.2
- Hiatal hernia/esophageal reflux 1.3

Integument Conditions:
- Acne, dermatitis, or psoriasis 1.0
- Bacterial or fungal infection 0.7
- Herpes simplex 0.6
- Herpes zoster 0.6
- Pigment disorders 0.4
- Skin cancer 0.6

Renal/Urological Conditions:
- Kidney or urinary tract infection 1.0
- Kidney stones 0.7
- Chronic kidney disease or failure 0.3
- Kidney or bladder tumor 0.2
- Incontinence 0.8

Cardiovascular Conditions:
- High blood pressure 2.1
- Angina or myocardial infarct 0.6
- Arterial aneurysm 0.4
- Peripheral artery or vein disorder 0.6
- Murmur or rhythm irregularity 0.7
- Congenital anomaly 0.4
- Vascular claudication 0.5

Endocrine/Metabolic Conditions
- Obesity 2.1
- Thyroid or parathyroid disorder 1.1
- Adrenal disorders 0.7
- Pituitary disorder 0.4
- Thymus or pineal disorder 0.3
- Diabetes 1.6
- Endocrine tumor 0.2

Sexually transmitted diseases
- Hepatitis B, Herpes II, HIV/AIDS 0.3
- Other Sexually transmitted diseases 0.2

Eyes ears nose and throat:
- Throat or larynx disorder 0.4 – (remaining not pertinent to thoracic spine)

Hematological / Lymphatic conditions
- Anemia 0.7
- Immunological disorder 0.5
- Hereditary disorder 0.4
- Polycythemia 0.2
- Marrow or lymphatic system cancer 0.2

Female reproductive conditions:
- Pregnancy 1.4
- Non-cancerous breast disorders 0.4
- Breast or reproductive system tumor 0.3

Male reproductive conditions:
- (None relating to thoracic spine)

Childhood conditions:
- Upper respiratory or ear infection 1.4
- Colic 0.9

Miscellaneous conditions:
- Allergies 1.9
- Nutritional disorders 1.4
- Eating disorders 0.7

## *Searching the Literature and Selecting the Evidence*

Material for review was obtained through formal hand-searches of published literature and of electronic databases. Basic science or mechanistic information was included if directly relevant in foundation to the central questions listed above. Search materials, regardless of source, were routed to the team leader. Notices were extended to the profession by way of publications in widely distributed professional news and association media, with invitation to submit relevant scientific and clinical articles. Searches focused on identifying existing guidelines, meta-analyses, systematic reviews, randomized clinical trials, cohort studies, and case series. Professional librarians from several members of the Association of Chiropractic Colleges were available both to assist the team in literature search and to obtain copies of articles not available electronically.

SIGN methodology (4) was consulted and utilized in construction of the search strategy.

***Search Strategy***

Our starting point was a literature review and summaries supplied by the Work Loss Data Institute/Official Disability Guidelines group. This base literature search provided by the Work Loss Data Institute yielded 198 studies, of which 98 were assessed as appropriate for critical assessment. The literature summaries and list is provided in the appendix.

A second more in-depth literature review was performed by Russell Iwami, a professional research reference librarian at the National University of Health Sciences (NUHS). The search strategy and his credentials are included in the appendix. All relevant NUHS databases were reviewed, including Pub Med, CINAHL, and National Center for Biotechnology Information (NCBI) at the U.S. National Library of Medicine (NLM). Additional databases included Alt HealthWatch, AMED (Alternative Medicine), and Index to Chiropractic Literature, among others. The review was received on April 27, 2006, and 218 papers were assessed as potentially reviewable. The literature summaries and list are provided in the appendix.

Other data bases searched included the National Guideline Clearinghouse (NGC) online data base. The NGC was searched on March 28, 2006 using a PICO matrix terminology including chiropractic, thoracic, and spine. The Cochrane online data base was similarly searched. Neither data base provided data that were specific to the application of chiropractic to the thoracic spine. Several search engines, including Google and Metacrawler, were used to search for relevant data; two guidelines and several papers of interest were identified and added to the literature to be reviewed. Bibliographies of guidelines and citations in the identified literature were reviewed for additional studies. Several papers were added from 2006-2008. Author contact with Dr. Henrik Wulff Christensen from the Nordic Institute for Chiropractic and Clinical Biomechanics in Odense, Denmark resulted in the acquisition of unpublished chest pain data and a personal thesis material for consideration. Author contact with Dr. Hans Rudolph Weiss provided expanded understanding of the author's guideline construction methodology and additional scoliosis guidelines to consider, which were acquired though personal contact with Dr. Stefano Negrini. (7-10) An internet search located an un-indexed journal, the Journal of Manual Manipulative Therapy, which was not accessed in prior searches. Contact with the journal's Editor-in-Chief, Dr. Peter Huijbregts, resulted in electronic access to the journal and the identification of several papers of interest. (11-17)

All citations were cataloged with the EndNote software. Relevant papers were given ascension numbers for tracking purposes.

## *Rating the Evidence*

Two strategies were used in consolidating and rating the literature: a) Rate and accept /reject existing published reviews of the various types, independently reviewing the underlying literature if the rating was considered substandard, and b) independently

review and rate newer or previously unrated appropriate literature. A detailed search strategy can be found in the appendix.

A total of 441 source documents were obtained using the methods described above. Search results were sorted into related topic groups: randomized trials of thoracic spine pain and manipulation, randomized trials of other interventions for thoracic spine pain/disorders, guidelines, systematic reviews and meta-analyses, basic science, diagnostic-related papers, methodology, cognitive and psychosocial issues, cohort and outcome studies, etc. Each group was subdivided by topic so that team members received approximately equal numbers of papers from each group, chosen randomly for distribution. Based on the CCGPP formation of an iterative process and the volume of work available, the team elected to limit consideration in this first iteration to guidelines, systematic reviews, meta-analyses, randomized controlled trials (RCTs), and cohort studies. This yielded high level literature that included 2 guidelines, 12 systematic reviews, and 12 RCTs. Selected Low level literature representative of each topic is also provided for the reader's consideration.

## *Evidence Rating*

***Methods to assess the quality and strength of the evidence***

The evidence was assessed by team reviewers using standardized SIGN instruments, templates, and procedures. The resulting assessments were recorded in evidence tables.

*Evidence rating:*

Rating and interpretation of the literature is a complex task that often leads to divergent opinions arising from a number of sources of bias. Experimental bias arises from uncontrolled variables within the conduct of research that is reported. Publication bias occurs when, by advertent or inadvertent effort, a journal's editorial board policy or practice favors articles that are positive or negative with respect to a specific topic. The last form is interpretation bias, which favors or disputes results based on weighting consideration of intrinsic or extrinsic factors of the work under review.

The CCGPP literature synthesis summarizes both past and recent literature, up through 2008, attempting to minimize bias through the use of standardized criteria by multiple assessors. Where disagreement on rating was identified between assessors, a formal Delphi process was used to reach consensus. Standardized ratings were accomplished by first matching the type of literature to the appropriate scoring system before random distribution to the team members.

**And, what if there is little to no evidence?**

In many cases there is limited research supporting some of the common procedures performed in the chiropractic office. Some chiropractors fear that lack of such research

support might summarily preclude procedures that they deem useful. The CCGPP recognizes that the lack of research on a topic or procedure is not the same as a negative assessment. It is at junctures such as these that reason be employed to assess each situation. As a result, the CCGPP has adopted the positions of Sackett (a) and of Sox (b) in producing recommendations for provider consideration in those instances where guidance from high quality research is absent.

Those considerations include:

1. Review and summarize available studies.
2. Biological thinking may help. Is it physiologically plausible?
3. Be sure that current thinking is based on valid evidence. Trust differences in subgroup results only when the intervention works unambiguously in one and fails utterly in another.
4. Costs do matter.
5. Primum No Nocere. "Many believe that this principle has particular force when applied to healthy persons . . . when we are in doubt we should take special care to avoid actions that might cause harm."
6. Talk to the patient.
7. Plan for the usual, adapt for the unusual. Algorithms are applied to usual patients and modified for unusual patients. Patient care decisions should be made on an individual basis.

a. Sackett DL. A science for the art of consensus. J Natl Cancer Inst 1997;89:1003-5.
b. Sox HC. Screening mammography in women younger than 50 years of age. J Ann Inern Med 1995;122:550-2.

There is a formal process (SIGN) for creating quality guidelines and best practice documents. By vigorously adhering to these protocols, the CCGPP's best practice document is constructed in such a manner that it should pass a process (AGREE) assessment.

**Key Point:** Risk stratification, benchmarking, and outcome assessment become most important when diagnostic or treatment selections are based on low level evidence.

## *Use of Evidence Tables*

Evidence tables for selected studies were constructed using SIGN methodology. (4) Templates were provided to each team member for recording and documenting each study's quality. The team leader consolidated and tabulated the results.

## *Forming Conclusions from the Evidence*

### *Methods to analyze the evidence*

Multidisciplinary panel review and rating of hierarchy and study quality scores were used to analyze and weight the evidence in accordance to SIGN protocol. A detailed description of the process is available in the literature. (18)

### *Hierarchy of Evidence*

- Systematic reviews and meta-analyses of randomized controlled trials
- Randomized controlled trials
- Nonrandomized intervention studies
- Observational studies
- Non-experimental studies
- Expert opinion

**Table 3. SIGN Evidence Rating System**

| Rating | Levels of Evidence |
|---|---|
| 1++ | High quality meta-analyses, systematic reviews of randomized controlled trials, or randomized controlled trials with a very low risk of bias |
| 1+ | Well conducted meta-analyses, systematic reviews of randomized controlled trials, or randomized controlled trials with a low risk of bias |
| 1- | Meta-analyses, systematic reviews of randomized controlled trials, or randomized controlled trials with a high risk of bias |
| 2++ | High quality systematic reviews of case control or cohort or studies<br>High quality case control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal |
| 2+ | Well conducted case control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal |
| 2- | Case control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal |
| 3 | Non-analytic studies, e.g., case reports, case series |
| 4 | Expert Opinion |

### *Methods to formulate conclusions*

Evidence tables and considered judgment forms were completed by the team and reviewed by the team leader. A Delphi consensus process was used to collapse differences in assessments by team reviewers. Failure to reach consensus would have initiated a majority/minority opinion report. A summary of the submitted material was drafted by the team lead and presented to the team for assessment and revisions. The resulting conclusions were submitted for stakeholder review. Stakeholder comments were be reviewed by the team and comments and responses from both entities were made public.

### *Considered Judgment*

Recommendations put forth by clinical practice guidelines and best practice documents are generally based on the best available evidence. In some cases the available evidence is scant, incomplete, controversial, or totally lacking; in such instances additional considerations beyond the evidence are needed in order to formulate specific and applicable recommendations for clinical practice. Verkerk et al. developed a series of questions that are organized into a set of 10 domains. The questions are intended to serve as a guide when considering relevant information as described above. The domains include: (i) clinical relevance, (ii) safety, (iii) patient's perspective, (iv) availability of resources, (v) health care costs, (vi) organization of care, (vii) professional's perspective, (viii) legal consequences, (ix) possible conflicts of interest by the industry, and (x) other "considered judgment". While still under development, this process is designed to parallel and complement the AGREE instrument. The team considered this approach when assessing procedures with little or no ratable literature. (19)

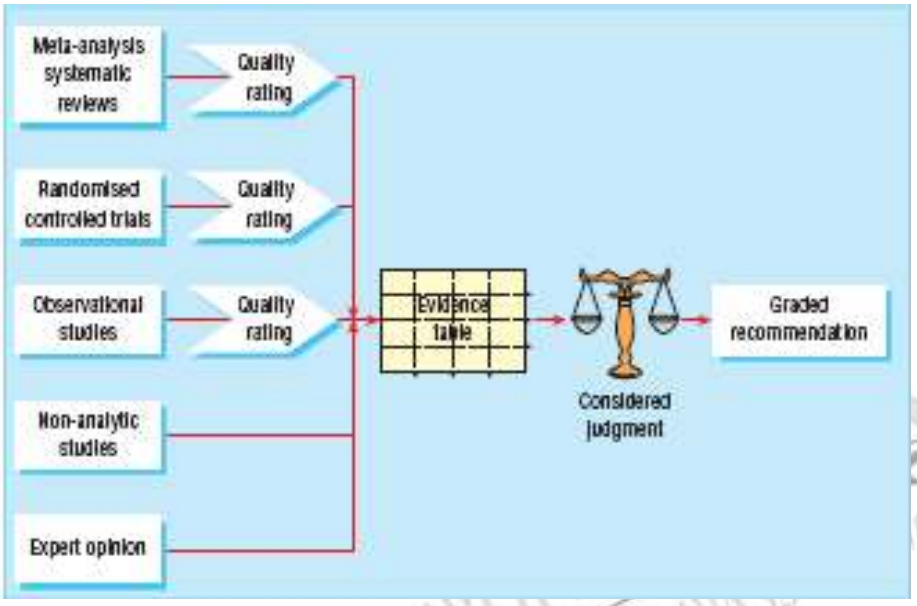



Figure 2. Graphic from: Robin Harbour, Juliet Miller for the Scottish Intercollegiate Guidelines Network Grading Review Group, A new system for grading recommendations in evidence based guidelines; BMJ VOLUME 323 11 AUGUST 2001 bmj.com

### *Grades of Practice Options*

**GRADE A** Evidence including at least 1 meta-analysis, systematic review, or RCT rated as 1 + + and directly applicable to the target population; or a systematic review of RCTs, or a body of evidence consisting principally of studies rated as 1 + directly applicable to the target population and demonstrating overall consistency of results

**GRADE B** Evidence including studies rated as 2 + + directly applicable to the target population and demonstrating overall consistency of results; *or* extrapolated evidence from studies rated as 1 + + or 1 +

**GRADE C** Evidence including studies rated as 2 + directly applicable to the target population and demonstrating overall consistency of results; *or* extrapolated evidence from studies rated as 2 + +

**GRADE I (D)*** Evidence level 3 or 4; *or* extrapolated evidence from studies rated as 2 +

* The CCGPP evidence grading system differs from the standard as described by Harbour et al. (18) due to shareholder concern that a "Level D" recommendation may be misinterpreted as a bad or failing grade. Due to this concern, the letter "I" has been substituted for "D" for rating purposes. A SIGN D rating is an exact equivalent to a CCGPP I rating. The rating system used is otherwise true to the SIGN methodology.

# *THORACIC SPINE DISORDERS*

Our work began with presentation and review of the Work Loss Data Institute's working data base material. This material is provided by WLDI to third parties for the purpose of assessing various health care interventions for consideration in their coverage policy. The raw material, available in the appendix, is presented to the reader for evaluation and consideration and for guideline construction transparency.

Subsequent to the review of the WLDI's material, a second round literature review was performed. The following is a report of the major findings. Detailed condition-related reports are listed below. Team member literature assessments are provided in the appendix.

As this work is a literature synthesis, we will report on literature beyond that reported in a guideline systematic review. This should provide the reader with a better grasp of the state of the literature.

***Epidemiology and Natural History***

It is probably due to the fact that neck and low back pain and disability are more common than thoracic pain and disability, that we see so much more literature dedicated to the former spinal regions. Conditions and management strategies for the thoracic spine and management strategies are not as well represented in the scientific literature as are the cervical and lumbar spine. Although there is limited literature available regarding the prevalence of thoracic spine pain in the general population, a low level epidemiologic study by Niemelainen et al. did report the prevalence, severity, and frequency of mid-back pain in a group of 600 Finnish men. The 1-year prevalence of thoracic pain in this group was 17%. This is much lower than the frequency of neck and low back pain, which were 64% and 66.8% respectively. The intensity of pain and frequency of disability were less than that associated with low back pain, while neck and mid-back pain severities were similar. The duration of disability associated with thoracic pain was similar to durations seen with neck and low back pain. The average number of days associated with difficult activity due to pain was reported to be 10 with an interquartile range of 4-30. The odds of having neck or low back pain increased when thoracic spine pain was present. (20)

***Benchmarking***

Benchmarking is defined as a point of reference from which measurements may be made. In health care terms, benchmarking is the act of documenting a starting point or point of reference as it applies to each individual patient. Documentation of a patient's exam findings, pain diagrams, visual analog scales, and other outcome assessment instruments can provide the physician with information regarding benchmark status of a patient. Considering case complexity issues, such as co-morbidities and known risk factors as they affect the natural history of a condition, can help physicians better evaluate a patient's initial status. Evaluation of the care process and comparison of ongoing

outcomes to initial benchmarks can help the physician, patient, and third-party payors assess if a patient is responding to care, the degree of response, and when the patient appears to have reached resolution or maximum therapeutic benefit. The evaluation must also consider complexities and complications inherent in the real world.

**KEY POINT: Benchmarking is an essential part of a first visit!**

Benchmarking is done in a number of ways. Its function is to provide a base-line and projected expectation of a patient's recovery from an injury or illness with the application of various treatment options. The doctor and patient can use benchmarking to evaluate the efficacy of various treatment options against the starting point and expected outcome. There are many benchmarking methods. One of the most common methods used is to consider average treatment convalescence time duration for the given condition. Using this method, a physician could inform a pregnant patient that a pregnancy usually involves a 266-day (38 weeks) gestation period. However, the use of averages alone can be problematic, in that other considerations such as the standard deviation should also be considered. In the pregnancy example, the standard deviation is estimated to be 12.4 days. Therefore, the patient could reasonable expect her baby to be born a number of days before or after the 266$^{th}$ day of gestation. Additionally, risk factors such as the age of the mother, and complexities such as twins or triplets, can markedly alter real-world expectations. In this instance, last menstrual period to pregnancy start presents with a 7-day standard deviation, and ultrasound assessment of fetal age presents with a standard deviation of 5.2 days. These complexities make selection of a parturition date uncertain. (21)

Private insurance brokers and other non-professional observers often inappropriately rely upon average durations of treatment history to limit costs and maximize profits. Of course, the problem with such a simplistic quantitative method of benchmarking is that it ignores individual case risk factors, variability, and complexity. In the pregnancy case referenced above, it would be unreasonable to expect a pregnant mother to be tossed out of the hospital on the 267$^{th}$ day, just because she had exceeded the average gestation period. For those wishing to assess the appropriateness of frequency and/or duration of care, it is recommended that a chiropractic physician who is experienced, trained, qualified, and certified in the area of quality assurance and utilization review, be consulted.

There are only 3 general treatment outcomes: the patient improves in a timely manner, there is no change, or the patient's condition deteriorates. The outcome is dependent upon the appropriateness of care administered, the complexity of the case, and the intervention of factors outside the control of the provider and sometimes the patient. These factors cannot be assessed with simple comparisons of statistical averages. Private insurance brokers and other non-professional observers would better serve their claimants if physician service payment determinations were based on case assessments that included consideration of known co-morbidities, risk factors, and complexities.

With these considerations, where the process of care is reasonable, it is not in the patient's best interest for third parties to stop, alter, or otherwise interfere with the care process. Of course, physician dependence and unnecessary care are not to be encouraged.

It is the intent of the CCGPP to assist stakeholders in reaching agreement and promoting best practices in the process of care, and to facilitate improved outcomes for patients by optimizing the chance of recovery and minimizing the administrative interference. The intention is that these efforts might result in the reduction of the disruption of continuity of appropriate care, while encouraging provider due-diligence in pursuing appropriate care.

***Complexity and Risk Stratification***

Documenting a patient's case complexity and risk stratification allows the physician, patient, and third parties to review and consider issues such as the patient's age, fitness, prior history, concurrent co-morbidities, traumatic causation, psychosocial factors, ergonomic factors, and environmental conditions, that might influence patient recovery. Documentation of these factors can provide better insight to assist in estimating the anticipated duration of care.

**KEY POINT: Complexity and risk stratification can support the necessity of extended patient care but should not be used as an excuse to foster inappropriate physician dependence.**

**Table 4. Risk factors for injury, absenteeism and subsequent episodes of spine pain as reported in the CCGPP Best Practice Introduction.**

| Category | Factor |
|---|---|
| **Personal** | Age (older)<br>Gender (female)<br>Severity of symptoms<br>Leg pain > back pain<br>Increased spine flexibility<br>Reduced muscle endurance<br>Prior recent injury (< 6 months) including surgery<br>Prior surgery<br>Asymmetric atrophy of multifidus up to 5 years later<br>Abnormal joint motion with or without abnormal EMG function of medial spine extensors<br>Poor body mechanics.<br>Falling as mechanism of prior injury |
| **Biomechanical** | Prolonged static posture > 20° (odds ratio 5.9)<br>Poor spinal motor control<br>Vehicle operation > 2 hours per day<br>Sustained (frequent / continuous) trunk load > 20 lbs<br>Materials handling (Static work postures, frequent bending and twisting, lifting demands, pushing, pulling and repetitive exertion). |
| **Psychosocial** | Condition chronicity<br>Employment history (<5 years same employer)<br>Employment satisfaction<br>Lower wage employment<br>Family / relationship stress<br>Attorney retention<br>Expectations of recovery |

### *Clinical Judgment*

The old adage that "not everything is written in a book" is true. It is in this instance that the physician need rely on his or her training, clinical experience, and reasoning skills to assess and interpret issues such as patient wishes, clinical relevance, safety, reasonableness, and availability of resources. While the treating physician is in a unique position to provide considered judgment in context to the given situation, non-conventional approaches to patient care, or those with little supporting evidence, require detailed reporting as to the rationale, procedures employed, and intended outcome and goals. In these cases it is most important that the outcomes be measured and reported during the clinical trial of care so treatment efficacy of care can be assessed.

## THORACIC SPINE DISORDERS IN GENERAL

There is a surprising lack of high quality studies reviewing biomechanical issues of the thoracic spine. The lack of data makes the job of reporting them short, but the task of

interpreting the data challenging. Atchison did a large literature survey in 2000 on manipulation efficacy on the upper body. The studies mostly pertained to the cervical spine and upper limb, due to the limited amount of high quality data pertaining to the thoracic spine. Since the number of studies published for the thoracic spine is so small and in some cases with conflicting, the available information often leaves the individual practitioner to decide if and when manipulation fits into his or her treatment plan. (22)

**High & Moderate Level/Quality Literature Summary**

A mid-level high quality prospective cross-sectional cohort study by Musgrave investigated the association between estrogen replacement therapy use, back pain, and back function in a very large cohort of elderly women. (23) Baseline data on estrogen replacement therapy use, functional status, back pain and function, and general lifestyle variables were obtained from 7209 elderly Caucasian women. The study results indicated that postmenopausal estrogen use was associated with an increased likelihood of back pain and impaired back function, with the relative risk (95% confidence interval) for impaired back function in former and current users at follow-up being 1.1 (0.9, 1.3) and 1.6 (1.3, 2.0), respectively.

A mid-level moderate quality study by Wood et al. reviewed MRI findings of asymptomatic patients to determine the natural history of asymptomatic thoracic disc herniations. (24) The incidence of asymptomatic herniations was reported to be 37%. Follow-up MRI studies done over an average of 26 months showed that the herniated discs stayed asymptomatic and remained the same size or in a state of mild flux with some slight increasing and decreasing in size. The authors also noted a slight trend for small disc herniations either to remain unchanged or to increase in size, and for large disc herniations often to decrease in size.

A mid-level moderate quality cohort study by Wood et al. similarly noted that 73% of 90 asymptomatic subjects had at least 1 abnormality on MRI evaluation of the thoracic spine; 37% had disc herniations, 53% disc bulges, 58% annular tears, 29% showed evidence of cord deformity, and Scheuermann's or kyphosis was noted in 38%. (25) The study indicated that a high frequency of anatomical irregularities, including cord and disc deformity, is to be expected in the asymptomatic population.

**Low level/Quality Literature Summary**

A low level study done by Santavirta et al. reviewed 27,000 Finnish women and 30,000 men for the presence of a thoracic vertebral fracture. (26) The authors found that there was an increase in fractures in the men over 40 years old and women over 55. In the men there was an increased risk of osteoporotic thoracic spine fracture when there was a history of tuberculosis and/or peptic ulcer, and in current smokers. The authors opined that the increase in early fractures seen in men might be due to increased exposure to trauma.

In a low level basic science study, Harreby et al. evaluated radiologic changes in the thoracic and lumbar spine of adolescents in order to assess risk factors for low back pain

in adulthood. In a 25-year prospective cohort study involving 640 school children, 11% of the cohort reported low back pain in adolescence, and results showed an 84% lifetime prevalence of low back pain in these subjects as adults. (27)

### *Literature on Manipulation/ Mobilization as a Treatment*

**High & Moderate Level/Quality Literature Summary**

A high quality randomized controlled trial by Cleland et al. done in 2005 found that thoracic spine manipulation resulted in immediate and marked pain relief in patients with mechanical neck pain. (28) Although the mechanism of improvement remained elusive, the effect size was relatively large and clinically meaningful. The authors postulated that the improvement might be related to stimulation of descending inhibitory pathways or increased range of motion and associated reduction in biomechanical stress to the spine. The authors suggested that thoracic spine manipulation might be used in lieu of, or in conjunction with, cervical spine treatment to avoid or reduce the small risks that might be associated with cervical manipulation.

There are some data supporting the use of manual manipulative treatment on the thoracic spine. Schiller performed a high quality randomized controlled trial pilot study that compared the application of spinal manipulative therapy (SMT) to a non-functional ultrasound placebo for the treatment of mechanical thoracic spine pain. (29) The small size and the design of the study limit the weight of the findings. While the findings were not conclusive, they suggested that spinal manipulation is superior to placebo ultrasound for treatment of mechanical thoracic spine pain as defined by Triano et al. (30) SMT was specifically more effective in increasing ranges of motion and pain thresholds during the treatment trial. The Schiller study noted that most patients required 6 treatment sessions to show improvement, which contrasted with the findings of Triano et al., who reported an average of 3 treatments for clinical resolution. The objective benefits persisted at a 1-month follow-up. Additional studies with larger sample sizes would be necessary to confirm these preliminary findings.

A moderate quality prospective randomized controlled trial by Savolainen et al. (31) reviewed the effects of thoracic manipulation versus exercise therapy for neck-shoulder pain. The study, which was carried out in Finland in an occupational setting, found that 4 manipulative sessions given at 1-week intervals were more effective than application of a personalized exercise program in reducing non-specific neck-shoulder pain. The relief provided by manipulation was most notable during the intense phase of pain, but was also effective at a 12-month follow-up. It should be noted that a decrease in average and worst pain was also noted in the drop-out group (although the "pain right now" was reportedly higher than baseline), leading the authors to surmise that there might be a degree of long-term spontaneous reduction in some symptoms over time.

Allison et al. conducted a moderate quality single-blind controlled trial with subjects randomly allocated to 1 of 2 manual therapy intervention groups or a 3rd control group. (32) The treatment effect on cervicobrachial pain was evaluated by using a pain Visual Analogue Scale (VAS), as well as the short-form McGill pain and Northwick Park neck

pain questionnaires, which were completed before, midway, and after the treatment period. One manual therapy intervention group involved mobilizing neural tissue structures and the cervical spine, and the other the glenohumeral joint and thoracic spine (T2-T5). Both intervention groups demonstrated improvements in pain and disability, suggesting that both manual therapy interventions might be effective in improving pain intensity, pain quality scores, and functional disability levels. Conclusions that can be drawn from this study are limited due to design, size, and uncontrolled variables in interventions and between groups.

A 2001 moderate quality randomized controlled trial by Liebler et al. tested the effect of thoracic spinal mobilization on lower trapezius strength. (17) The authors postulated that the thoracic joint arthokinetic reflex (AKR) would inhibit full muscle contraction of the lower thoracic spine by inhibiting the recruitment of the maximum number of motor units to the muscles. The authors measured lower trapezius muscle strength before and after grade IV mobilization in one group and grade I mobilization in a control group. The group receiving the grade IV mobilization had a 6% increase in strength as compared to the control group, which showed a 0.2% increase. The authors believed the increase in strength was related to the reversal of muscle inhibition by type I and II mechanoreceptors, resulting in "pseudoparesis". They continued to postulate that the associated weakness might result in slouching thoracic posture problems such as upper cross syndrome.

A moderate quality randomized controlled trial by O'Leary et al. evaluated the application of deloading tape in asymptomatic subjects. The general rationale for using deloading tape is to provide support for tendons and/or muscles of a joint, thereby decreasing the load on the tissues. The authors found that pressure pain threshold did not change significantly. Little else can be concluded from this study. (33)

**Low Level/Quality Literature Summary**

Chiropractors routinely assess range of motion (ROM) as a baseline and treatment outcome measure. A low level study by Gavin assessed the effect of the manipulation of restricted thoracic spine segments on thoracic active ROM in asymptomatic subjects. (15) The study revealed that spinal manipulation can increase thoracic spine active ROM after only 1 session. Study subjects were divided into 3 categories: a control group, a group that received mobility testing only, and a 3rd group that received both mobility testing and thoracic manipulation. The subjects' T3-T8 ROM was assessed, after which the subjects rested, received mobility tests, or were manipulated. Post-test measurements were then performed. A comparison of pre-treatment versus post-treatment ROM, revealed no change in forward bending ROM; however, a significant ($P = .012$) difference was seen in side bending to the left (2.0°). The results of the study indicated that 1 session of manipulation can influence mid-thoracic spine active ROM. Clinical application of this study is limited due to quality issues.

An observational study by Triano et al. revealed interesting results regarding how patients responded to manipulation depending on their type and duration of pain. (30) Duration classifications included acute (< 7 days), subacute (7-50 days), chronic (> 50

days), and recurrent pain. Pain types were categorized into 1 of 3 forced descriptions: nerve entrapment, mechanical spine pain, or muscular spine pain. Findings indicated that chronic disorders required more care than acute, subacute, or recurrent conditions. The cervical and lumbar lordotic areas of the spine required twice the care than did the thoracic and transitional areas, with the majority (89.6%) of cases resolving within 6 weeks. The number of treatments to resolution ranged from 1-22 with the mean number of sessions for thoracic problems being 3. An average of an additional 3.8 treatments were needed in those cases where treatment was required beyond 6 weeks, with the maximum being 11 additional visits. Interestingly, there were no differences in treatment duration based on the descriptive classifications of entrapment, mechanical, or muscular pain.

One of the problems with interpreting back pain research is that back pain is often ill-defined regarding type or origin. This is likely due to the fact that we do not currently have the ability to assess the etiology of back pain. Nonetheless, clinical practitioners frequently categorize patients by educated intuitive measures and provide various treatments based on those criteria. Our team found the forced descriptive classification method to be intriguing and suspects that such a classification system can be a valuable instrument for future research construction and interpretation until better classification methods are developed. (See table 5)

**Table 5. Forced descriptive classifications by Triano et al.**

***Entrapment***

- Predominately distal leg pain
- Dermatomal distribution of pain
- Possible backache
- Usually with 1 or more neurological deficits such as
  - -diminution of sensation
  - -reflex loss
  - -muscle weakness and wasting

***Mechanical spine pain***

- Midline back pain.
- Non-dermatomal referred pain difficult to localize
- No signs of nerve root tension
- No major neurological deficit
- Pain with compression into spine extension
- Reduced range of motion

***Muscular spine pain***

- Diffuse spine pain
- Soft tissue tenderness and pain
- No signs of nerve root tension
- No pain with compression into spine extension

An interesting low level basic science study by Ross et al. (34) evaluated 64 asymptomatic participants, initially to locate the source of joint cavitation in the thoracic and lumbar spine in response to manipulation. The data were used to assess the accuracy and specificity of manipulation. Accelerometers were employed to identify the source of the vibration. In the lumbar spine, SMT was accurate about half the time, and slightly more accurate in the thoracic spine. Of 124 lumbar cavitations, the average error distance from target was 5.29 cm (at least 1 vertebral segment away from target). SMT was deemed to be accurate in 57 cavitations (46%), and inaccurate in 67. Of 54 thoracic manipulations, 29 were accurate (54%) and 25 were not; the average error being 3.5 cm away from target. Most SMT resulted in multiple cavitations (2-6) and in most cases these did include the target joint. Thoracic spine SMT appeared to be more accurate than lumbar. The chiropractic clinician and researcher might note that focused manipulative forces might not be cavitating the intended joint.

**Clinical Questions / Graded Practice Options**

***1. Is spinal manipulative therapy an effective treatment option for mechanical thoracic pain?***

> **GRADE A** Yes - There are high quality data (1++) supporting the use of manipulative therapies for mechanical thoracic pain.

***2. Is spinal manipulative therapy an effective treatment option for mechanical neck and/or shoulder and/or arm pain?***

> **GRADE A** Yes - There are high quality data (1++/1-) supporting the use of manipulative therapies to the thoracic spine for neck and/or shoulder-and/or arm pain.

***3. Is spinal manipulative therapy an effective treatment for trapezius weakness?***

> **GRADE C** Yes - There are moderate quality data (1+) that can be extrapolated to support the use of manipulative therapies to the thoracic spine for trapezius weakness and associated postural alterations.

**Key Point Summary:** The literature supports that spinal manipulative therapy is a reasonable treatment option for primary mechanical thoracic pain, as well as neck, shoulder, and/or arm pain that might be referred in nature or secondary to kinetic chain alterations. Additional research is warranted.

## *Literature on Diagnostic Issues*

### Palpation

**High & Moderate Level/Quality Literature Summary**

Stochkendahl et al. performed a high quality systematic review and meta-analysis of the literature (1965-2005) pertaining to various types of spinal palpation examination reproducibility. (35) The types of palpation included motion palpation (MP), static palpation (SP), for osseous pain (OP), for soft tissue pain (STP), for soft tissue changes (STC), and global alignment (GA). The authors found strong evidence that inter-observer reproducibility of identifying OP and STC with palpation was clinically acceptable (Kappa 0.4), and that intra-observer reproducibility of STP and GA was clinically acceptable. The remaining palpation procedures either lacked reproducibility or the evidence was found to be conflicting or preliminary. It was found that MP might be reproducible within the same observer, but intra-observer reproducibility was poor. The poor reproducibility of MP might be due to study design flaws rather than the quality of the pupation procedure itself. Given these findings, the authors opined that palpation for pain is reproducible between observers at a clinically acceptable level. However, clinicians should not base their diagnosis on a single clinical examination such as palpation, but rather on a range of tests and findings. They also concluded that it might be premature to develop solid clinical guidelines regarding the utilization of palpation due to the lack of assessment of its validity and its reproducibility in a clinical setting.

Huijbregts performed a high quality systematic review of reliability studies on spinal motion palpation that was published in 2002. (16) Spinal motion palpation has been used by many professions, including chiropractic. Huijbregts found that research studies on the reliability of motion palpation were statistically and methodologically flawed, bringing into question the validity of the procedure. Similar findings were reported in a review by Najm et al. (36) Huijbregts noted that it might not be realistic to research motion palpation for reliability and validity as a stand-alone diagnostic tool, but rather as a part of an array of diagnostic tools. In either case, he noted that further research would be necessary to determine the reliability of motion palpation techniques.

Joint end-play is a commonly employed method of assessing joint restrictions that might respond to mobilization or manipulation. Haas et al. did a high quality randomized controlled trial comparing rotary thoracic end-play in a group receiving spinal manipulation and a control group that did not. (37) They found that segmental end-play restrictions and changes could be identified with manual palpation methods. These findings tend to support construct validity of end-range assessment methods and their utilization as an evaluative test; however, additional research would be needed to further assess the generalizability of the study and the procedure's clinical usefulness.

Christensen et al. performed a high quality mid-level reliability study that assessed hour-to-hour and day-to-day reliability, intra-observer reliability, and inter-observer reliability of 3 types of spinal palpation. (38) The study assessed sitting motion palpation for end-play, prone motion palpation for biomechanical dysfunction, and paraspinal palpation for tenderness; each focusing on the upper 8 segments of the thoracic spine. The study used an "expanded" definition of agreement that accepted small inaccuracies (+/-1 segment) in the identification of spinal segments. Using this expanded definition of agreement, the authors found kappa values of 0.59 to 0.77 for hour-to-hour and day-to-day intra-observer reliability with all 3 palpation procedures; kappa coefficients were 0.24 and 0.22 for

inter-observer reliability with prone and sitting motion palpation, and 0.67 and 0.70 for paraspinal palpation for tenderness. The authors concluded that with expanded agreement, there was good hour-to-hour and day-to-day intra-observer reliability for all 3 palpation procedures, and good inter-observer reliability for paraspinal tenderness, but inter-observer reliability was unacceptably poor for prone and sitting motion palpation.

A moderate quality mid-level diagnostic study by Potter et al. evaluated the intra-rater reliability of identifying a manipulable lesion in the lumbar and thoracic spine. (39) Manipulable lesions were identified by an experienced osteopath and physiotherapist utilizing visual postural analysis, which included symmetry assessment and spinal ranges of motion. Passive motion, in which an anterior cephalic force was applied to the spinous process, was used for the thoracic examinations to assess areas for hypo/hyper-mobility. The study found that the lumbar spine joint perceived to be most likely to benefit from a high-velocity low-amplitude thrust could be identified with good within-day reliability in an asymptomatic sample using a defined examination protocol. However, the reliability for identifying a joint exhibiting signs of segmental dysfunction in the thoracic spine was poor. The intra-class-correlation (ICC) (1,1) for the thoracic spine was 0.70 (95% confidence interval (CI, 0.27-0.90)

Palpation for pain and tenderness is an integral part of the manual therapy assessment for musculoskeletal dysfunction. A moderate quality mid-level study by Keating et al. evaluated pressure pain threshold (PPT) of the cervical, lumbar, and mid-thoracic regions in 50 asymptomatic subjects. (40) A within-subject study design was used to examine PPT at 4 spinal levels (C6, T4, T6, and L4). Results showed significant ($P<0.001$) regional differences, with PPT increasing in a caudal direction. The cervical region was the most tender of all the regions and had the lowest PPT scores. PPT values increased in the thoracic region and were found to be the highest in the lumbar region. The study contributes to the normative data on spinal PPT values and demonstrates that mid-thoracic tenderness relative to the cervical spine is not a normal finding in asymptomatic subjects.

Johnston et al. did a moderate quality inter-examiner reliability evaluation of the percussion style of palpation including assessment on agreement of a dysfunction's location. This type of palpation is purported to be a method of detecting deep muscular tension thought to indicate spinal segment dysfunction in the thoracic spine. Tissue tension was rated from 0 to 3 by each examiner. Agreement levels among the 5 examiners exceeded 79% in differentiating between normal tissue tension (<1) and increased tension (>2). (41)

Love and Broduer performed a mid-level moderate quality inter-examiner and intra-examiner reliability study regarding a method of motion palpation as described by Gillet and Liekens. (42) Eight college students with at least 1 year of experience palpated the thoracolumbar spines of 32 student volunteers and the most hypomobile motion unit of the spine was recorded. Each of the volunteers was palpated twice by each examiner in order to assess inter- and intra-examiner reliability. The authors found statistically significant agreement for intra-examiner reliability, but inter-examiner reliability was not

statistically significant. The palpators assessed the T9-T10 motion unit as the most hypomobile motion unit with the greatest frequency.

**Clinical Questions / Graded Practice Options**

***1. Is motion palpation a valid/reliable diagnostic procedure?***

> **GRADE B** No – There is high quality literature (1++) indicating that motion palpation has poor reliablity and thus questionable validity as a diagnostic procedure.

**Key Point Summary:** The available literature indicates that motion palpation lacks inter-observer reliability. The value of motion palpation as a stand-alone diagnostic method is called into question. Additional research is warranted.

***2. Is static palpation for pain and/or joint end play a valid/reliable diagnostic procedure?***

> **GRADE B** Yes for reliability - There is high quality literature (1++) indicating static palpation has established reliability as a diagnostic procedure. Equivocal for validity.

**Key Point Summary:** Simple static palpation has long been utilized for diagnostic purposes. The literature supports the continued utilization of static palpation for pain, tenderness, and joint end-play assessment. Additional research regarding its validity is warranted.

## Other Diagnostic Issues

### High & Moderate Level/Quality Literature Summary

A moderate quality systematic literature review was performed by Meyer regarding the validity of thoracolumbar paraspinal scanning EMG as a diagnostic test. (43) The author found that thoracolumbar paraspinal scanning EMG failed to meet any of the 12 key issues required to validate a diagnostic test prior to general clinical acceptance. The available data fail to support the use of thoracolumbar paraspinal scanning EMG for clinical purposes, and indicate that it should be considered an investigational procedure.

Mannion et al. performed a mid level high quality reliability study on a skin surface instrument referred to as the Spinal Mouse. The Spinal Mouse was designed to measure spinal curves without the use of ionizing radiation. (44) The spinal curvature of 20 healthy volunteers was measured using the Spinal Mouse on 2 separate days, in standing, full flexion, and full extension positions. Intra-class correlation coefficients (ICC), and standard errors of measurement (SEM) with 95% confidence intervals were calculated. Measurements of global regions (thoracic, lumbar, or hips) showed good between-day reliability, with ICCs ranging from 0.67 to 0.92 for examiner 1 (average 0.82) and 0.57 to

0.95 for examiner 2 (average 0.83). The ICCs were greater than 0.8 for 70% of measured parameters, with lumbar spine and whole trunk measures scoring highest. For lumbar spine range of flexion, the SEM was approximately 3°. Inter-examiner ICCs ranged from 0.62 to 0.93 on day 1 (average 0.81) and 0.70 to 0.94 on day 2 (average 0.86). For segmental ranges of flexion, ICCs were lower than for the global measures (average for all levels in all analyses, ICC 0.6). The average between-day SEM over all vertebral levels was approximately 2° for each examiner. Generally, lower reliability was noted as the angles being measured became smaller. On the whole, the study indicated that the Spinal Mouse could produce reliable values for standing curvatures and ranges of motion for global regions of the spine. The authors opined that the device might reliably be used for studies of the sagittal profile and range of motion of the spine, but noted that its usefulness for interpretation of individual results and the detection of changes on an individual basis was questionable.

Wood et al. produced a mid-level moderate quality prospective case control investigation to determine the responses of asymptomatic individuals to thoracic discography. (45) They evaluated 10 adult lifelong asymptomatic volunteers, aged 23 to 45 years, with magnetic resonance imaging of the thoracic spine, followed by 4-level discography. Pain responses were graded on a scale of 0 to 10, and imaged discs were graded using a modified Dallas scheme. Ten adults with chronic thoracic pain served as a control group. The mean pain response in the asymptomatic volunteers was 2.4/10. Ten discs that were read as normal on magnetic resonance imaging showed annular pathology on discography. In the group with chronic thoracic pain, the average pain response was 6.3/10 ($P < 0.05$). Of the 48 discs studied, 24 were concordantly painful, with a pain response of 8.5/10 ($P < 0.05$). On magnetic resonance imaging, 21 of the 48 discs appeared normal. However, on discography, only 10 were judged as normal. The authors concluded that on discography, thoracic discs with prominent Schmorl's nodes might be intensely painful, even in lifelong asymptomatic individuals and that thoracic discography might demonstrate disc pathology not seen on magnetic resonance imaging. The study called into question the reliability of MRI in identifying painful derangements of thoracic discs.

***Clinical Question: What components might be included in a clinical history and exam?***

Prior chiropractic guidelines of moderate quality have provided history and examination recommendations that have been assessed as suitable for use in clinical practice. (1, 46-48)

The Guidelines for Chiropractic Quality Assurance and Practice Parameters note that, depending on the presentation of the patient and the judgment of the practitioner, any or all of the following components might be considered in a history: (1)

1. Data-age, sex, etc.

2. Chief complaint

3. Hist/present complaint
   a. Hist. / trauma.
   b. Description of CC.
   c. Quality/character
   d. Intensity
   e. Frequency
   f. Location/radiation
   g. Onset
   h. Duration
   i. Palliative/provocation

4. Family history

5. Past Health History
   a. General health
   b. Prior illness
   c. Surgical hist.
   d. Previous injury
   e. Past Hospitalization
   f. Prior Dx. tests & Tx
   g. Medication
   h. Allergies

6. Psycho-social history
   a. Occupation
   b. Activities
   c. Recreation
   d. Exercise

7. Social history
   a. Marital status
   b. Education
   c. Social habits

8. Review of systems
   a. Musculoskeletal
   b. Cardiovascular
   c. Respiratory
   d. Gastrointestinal
   e. Genitourinary
   f. CNS
   g. EENT
   h. Endocrine
   i. Peripheral vascular
   j. Psychiatric

The Guidelines for Chiropractic Quality Assurance and Practice Parameters note that all or some of the following components may be included in a thoracic examination: (1)

- Vitals: BP, pulse, height, weight & temperature
- Cranial nerves
- Inspection-observation & posture
- Vascular exam
- Palpation
- ROM active & passive
- Neurologic exam
- Muscle strength
- Provocation tests
- Auscultation/Percussion:
  - Chest
  - Heart
  - Abdomen

**Clinical Questions / Graded Practice Options**

***1. Is paraspinal scanning EMG a valid tool for diagnosing thoracic disorders in a clinical setting?***

**Grade A** No – There is high level literature of sufficient quality (1+) indicating that scanning EMG use is not valid for routine clinical diagnosis and should be considered an investigational procedure.

**Key Point Summary:** The current literature indicates that scanning EMG use is not valid for routine clinical diagnosis and should be considered an investigational procedure.

***2. Is skin surface instrumentation a valid clinical diagnostic tool for the measurement of spinal curves?***

**Grade B** No – There is mid-level literature (2++) indicating that surface instrumentation, specifically the Spinal Mouse, is not a valid clinical diagnostic tool for the measurement of spinal curves.

**Key Point Summary:** Surface instrumentation, such as the Spinal Mouse is not a valid clinical diagnostic tool for the measurement of spinal curves. Additional refinement and assessment are warranted.

***3. Is thoracic discography a valid clinical diagnostic tool?***

**Grade C** Yes **-** There is mid-level literature of moderate quality (2+) indicating discography may demonstrate disc pathology not seen on magnetic resonance imaging.

**Key Point Summary:** The literature supports that clinical situations arise where it could be appropriate to follow up on a suspected occult disc lesion with discography.

## *LITERATURE ON NATURAL HISTORY*

### High & Moderate Level/Quality Literature Summary

None identified

### Low level/Quality Literature Summary

There is very little high quality literature pertaining to the natural history of acute thoracic spine pain when compared to the cervical and lumbar spine. However, a low level study by Wagner et al. reviewed MRI findings of 14 patients diagnosed with acute, symptomatic Schmorl's nodes or vertebral body endplate fractures. (49) Their findings indicated that asymptomatic Schmorl's nodes, which are quite often identified on radiography, might have their origin in a preceding acute and painful event, such as an acute end-plate fracture. Eight (57%) patients had a sudden-onset of localized non-radiating back pain that could be traced to a significant initiating episode. While chronic Schmorl's nodes are routinely identified on imaging studies and are thought to be asymptomatic and insignificant, acute, traumatic Schmorl's nodes are less frequently identified and are potentially symptomatic. The authors noted that the clinical significance of their findings might be limited, in that Schmorl's nodes are biomechanically stable and require no major interventions. Nonetheless, chiropractic clinicians and researchers might like to closely assess patients with Schmorl's nodes for subtle findings.

***Acute compression fractures***

### High & Moderate Level/Quality Literature Summary

None identified

### Low level/Quality Literature Summary

A low level study by Patel et al. reviewed the clinical profiles of 30 osteoporotic patients with acute vertebral compression fractures. (50) The majority of these (46%) occurred spontaneously or after trivial strain (36%). The authors found that 66% of the patients reported pain radiating to the flank, but leg pain was uncommon and seen in only 6% of patients. Associated symptoms including abdominal pain (20%), chest pain (13%), and nausea (26%) were seen in several patients. The presence of associated symptoms was thought to complicate the diagnostic picture, as a correct diagnosis was made in only 43% of these cases on the first visit. While this is a low level study, the practitioner might like to consider expanded examinations in patients with osteoporosis and associated symptoms as listed.

**Clinical Questions / Graded Practice Options**

None identified

**Key Point Summary:** The lack of high quality literature does not allow for recommendations.

***Acute care management***

**High & Moderate Level/Quality Literature Summary**

The highest quality acute care management literature identified was an acute thoracic pain guideline chapter published by the Australian Acute Musculoskeletal Pain Guidelines Group. (2) The guidelines were evaluated with the AGREE instrument and found to have high quality scores in all domains.

**Table 6. Standardized Mean Domain Scores for the Australian Acute Musculoskeletal Pain Guidelines**

| *Domain 1* | *Domain 2* | *Domain 3* | *Domain 4* | *Domain 5* | *Domain 6* |
|---|---|---|---|---|---|
| Scope | Stakeholder | Rigour | Clarity | Applicable | Editorial |
| 94.44 | 83.33 | 90.48 | 91.67 | 88.89 | 83.33 |

**Acute Musculoskeletal Pain Guideline Recommendations**

The following is a summary of the Acute Musculoskeletal Pain Guidelines Group key messages on acute thoracic spine pain management. (2) An expanded summary is included in the Appendix. The Guideline evidence rating system is reported below.

**Management Plan**

The Acute Musculoskeletal Pain Guidelines Group recommends that the clinician and patient develop a management plan for acute musculoskeletal pain comprising the elements of assessment, management, and reassessment/review: * CONSENSUS SIGN equivalent Grade: D (I)

**DIAGNOSIS**

**Etiology and Prevalence**

The Acute Musculoskeletal Pain Guidelines Group notes that pain may be referred to the upper thoracic spine from visceral structures and cervical spinal structures or arise in the thoracic interspinous ligaments, paravertebral muscles, and zygapophyseal joints.
* LEVEL IV - SIGN equivalent grade: C

Patients over 60 years of age are at risk for spontaneous osteoporotic fractures of the thoracic spine; extent of vertebral deformity and multiple fractures appear linked with pain intensity. * LEVEL IV - SIGN equivalent grade: C

Most cases of thoracic spinal pain are of mechanical origin; however, clinicians should be alert to the potential for rare, serious conditions presenting as acute thoracic spinal pain. * LEVEL IV - SIGN equivalent grade: C

**History**

The Acute Musculoskeletal Pain Guidelines Group notes that while the patient history serves to differentiate sources of acute thoracic spinal pain to identify features of potentially serious conditions, it carries little diagnostic weight. * CONSENSUS - SIGN equivalent Grade: D (I)

**Physical Examination**

The reliability of palpation for tenderness of the thoracic spine is good, but its validity is unknown. * LEVEL IV - SIGN equivalent grade: C

The reliability of motion palpation of the thoracic spine is marginal. * LEVEL IV - SIGN equivalent grade: C

Following blunt trauma, a negative clinical examination in the presence of a clear sensorium makes a thoracic spinal fracture unlikely. * LEVEL IV - SIGN equivalent grade: C

Despite the absence of supportive, scientific data on the utility of physical examination of the thoracic spine, such examination provides an important opportunity to identify features of serious conditions. * LEVEL IV - SIGN equivalent grade: C

**Ancillary Investigations**

In the absence of trauma, plain radiography is of limited use in defining the cause of pain. * LEVEL IV - SIGN equivalent grade: C

Fractures are more likely to occur in people over age 60 with a history of blunt trauma; a lower threshold for radiographic investigation is warranted in this group. * LEVEL IV - SIGN equivalent grade: C

In the presence of trauma, x-ray of the thoracolumbar spine is not indicated in those who are awake, alert, and have no clinical evidence of injury; however, those with equivocal or positive clinical findings or with an altered level of consciousness should undergo thoracolumbar spine evaluation. * LEVEL IV - SIGN equivalent grade: C

CT scanning is only indicated for the evaluation of the neural canal and posterior elements of the thoracic spine when fractures have been detected with plain films. * LEVEL IV - SIGN equivalent grade: C

There is no research to inform ancillary investigations for acute thoracic spinal pain; investigations should be selected on the basis of clinical features suggesting the presence of serious conditions. * CONSENSUS - SIGN equivalent Grade: D (I)

## INTERVENTION

### Non-Pharmacological Interventions

Simple interventions (providing information, assurance, and encouraging reasonable maintenance of activity) may be used alone or in combination with other interventions for the successful management of acute musculoskeletal pain. * CONSENSUS - SIGN equivalent Grade: D (I)

There is evidence that spinal manipulation is effective in the management of thoracic spinal pain, compared to placebo. * LEVEL II - SIGN equivalent grade: A

### Pharmacological Interventions

While many chiropractic physicians do not prescribe medication, the following is reported for those who do and/or those who co-manage care.

Simple analgesics are recommended for relief of mild to moderate acute musculoskeletal pain and can be used in conjunction with non-pharmacological interventions.
* CONSENSUS - SIGN equivalent Grade: D (I)

Non-steroidal anti-inflammatory (NSAID) medication may be used, unless contraindicated. * CONSENSUS - SIGN equivalent Grade: D (I)

Oral opioids may be necessary to relieve severe musculoskeletal pain, but ongoing need for opioid analgesia is an indication for reassessment. * CONSENSUS - SIGN equivalent Grade: D (I)

Benefits from muscle relaxants may be outweighed by their adverse effects, therefore they cannot be routinely recommended. * CONSENSUS - SIGN equivalent Grade: D (I)

The Acute Musculoskeletal Pain Guidelines Group does not recommend anticonvulsants and antidepressants. * CONSENSUS - SIGN equivalent Grade: D (I)

### Terminology Issues

The appropriate labels for non-specific “mechanical” thoracic spinal pain are “thoracic spinal pain of unknown origin” or “somatic thoracic spinal pain”. * CONSENSUS - SIGN equivalent Grade: D (I)

There is a lack of published data on the natural history and influence of prognostic risk factors for acute thoracic spinal pain. * NO EVIDENCE - SIGN equivalent Grade: D (I)

### *LITERATURE ON RISK FACTORS*

There is little high quality data regarding risk factors as noted in the summary above. However, the Acute Musculoskeletal Pain Guidelines Group notes that age is a factor, with those over 60 having a higher risk for spontaneous osteoporotic fractures of the thoracic spine. Increased pain appears to be linked to greater deformity and fracture frequency. * LEVEL IV - SIGN equivalent grade: C

**Rating System**

* The following is the rating system utilized by the Acute Musculoskeletal Pain Guidelines Group:

- I Evidence obtained from a systematic review of all relevant randomized controlled trials.
- II Evidence obtained from at least 1 properly designed randomized controlled trial.
- III-1 Evidence obtained from well-designed pseudo-randomized controlled trials (alternate allocation or some other method).
- III-2 Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomized (cohort studies), case control studies, or interrupted time series with a control group.
- III-3 Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without parallel control group.
- IV Evidence obtained from case series, either post-test, or pre-test and post-test.
- CONSENSUS In the absence of scientific evidence and where the executive committee, steering committee, and review groups are in agreement, the term "consensus" has been applied.

SIGN equivalent evidence grades have been provided so that the reader might interpret the above guideline recommendations in comparison and context with the scoring mechanism utilized in this document. Equivalent grades were created by using comparative evidence level assessments between SIGN and the Acute Musculoskeletal Pain Guidelines Group's rating systems. Slight scoring differences do not allow for exact translations of rating systems, which results in slight rating and grading differences between the SIGN and the Acute Musculoskeletal Pain Guidelines Group's rating systems.

**Key Point Summary:** The guidelines produced by the Acute Musculoskeletal Pain Guidelines Group are of high quality and suitable for use in clinical practice.

### *LITERATURE ON ADJUSTING, MANIPULATION, AND MOBILIZATION FOR ACUTE SPINE CONDITIONS*

### High & Moderate Level/Quality Literature Summary

Cleland et al. published a high quality randomized controlled trial finding that thoracic spine manipulation can provide immediate analgesic effects in patients with mechanical neck pain. (28) Additional research would be needed to evaluate long-term effects.

### Low level/Quality Literature Summary

A low level non-systematic review by Dietze and Fesseler reported that localized back or torso pain and sensorimotor deficits were often associated with acute thoracic disc herniations. (51)

Several low level studies have noted that acute thoracic burst fractures (without neurological deficits) may be managed with conservative bracing and rehabilitation, including mobilization. (52-54) It would be reasonable for a chiropractor to assist in the diagnosis and possibly late management of these types of injuries. More research on the effects of mobilization and team integration would be helpful in establishing what role, if any, chiropractors might have in this type of post-traumatic rehabilitation.

A 1991 low level study by Karjalainen et al, involving a series of 126 patients with conservatively treated stable fractures of the thoracic and lumbar spine. (55) The fractures were found to occur most often (56%) in the thoracolumbar junction. The mean follow-up time was 7.2 years (range 5.5-10.7) and the mean patient age was 45.9 years (range 14-83). The radiological measurement of vertebral deformity and evaluation of clinical outcome showed that patients with poor outcome had significantly greater anterior wall compression and kyphosis on admission than did patients with good outcome, but deformity worsened similarly in both groups. The use of an extension brace seemed to decrease subjective symptoms during the mobilization phase, but it did not prevent the development of kyphosis deformity during the follow-up period. The authors opined that patients with a primary angle of gibbus of 13 degrees or greater, or anterior wall compression of 30% or greater, have a poor prognosis and that surgical stabilization should be considered. Additional higher quality studies are needed to confirm their findings and assessments.

**Clinical Questions / Graded Practice Options**

***1. Is there evidence supporting the utilization of manual therapies to the thoracic spine for acute neck pain?***

> **Grade A** Yes - A high quality guideline and literature (1 ++) support the utilization of manipulation to the thoracic spine for the treatment of acute mechanical neck pain.

**Key Point Summary:** High quality literature supports the use of thoracic manipulation for acute neck pain. This pain may be referred or related to mechanical kinetic chain dysfunction. Additional research might assist in the identification of mechanisms that

result in these findings. Low level literature suggests that chiropractors might be able to assist in the diagnosis and possibly late treatment of more serious osseous injuries. Additional research would be needed to define further what role, if any, chiropractors might have in managing serious trauma.

## CHRONIC PAIN

### High & Moderate Level/Quality Literature Summary

A high level moderate quality randomized controlled clinical trial conducted by Giles and Muller compared medication, needle acupuncture, and chiropractic spinal manipulation for managing chronic pain (>13 weeks). (56) This study evaluated general spinal manipulation and non-specific manipulation to the thoracic spine. The details did not provide specific data regarding the regions manipulated. Manipulation provided the largest number of early recoveries (27%), followed by acupuncture (9.4%), and medication (5%). Manipulation also provided the best overall results, with 50% ($P = 0.01$) improvement on the Oswestry scale, 38% ($P = 0.08$) on the Neck Disability Index, 47% ($P < 0.001$) on the SF-36, and 50% ($P < 0.01$) on the VAS for back pain. There was a 38% ($P < 0.001$) improvement in lumbar standing flexion range of motion (ROM), 20% ($P < 0.001$) improvement in lumbar sitting flexion ROM, 25% ($P = 0.1$) for cervical sitting flexion ROM, and 18% ($P = 0.02$) in cervical sitting extension ROM. Despite the shortcomings of this study, it did provide evidence suggesting that manipulation can result in greater overall short-term improvement than acupuncture or medication in patients suffering from chronic spinal pain.

The results of a high quality mid level cohort study by Cleland et al. suggested that lower thoracic manipulation techniques might be beneficial in reducing the lower trapezius muscle inhibition commonly associated with many postural syndromes. (13) The authors speculated that zygapophyseal extension restrictions in the middle to lower thoracic spine are associated with muscle strength deficits secondary to reflexogenic muscle inhibition related to the dysfunctional joints. While plausible and intriguing, additional higher level studies would be needed to confirm these theories.

A mid-level high quality large prospective cohort study by Magni et al. investigated the hypothesis that depression causes pain and that pain causes depression. (57) The study included 2324 subject with a history of both pain and depression. Findings indicated that those suffering depression for 1 year were more likely to suffer musculoskeletal pain at year 8 (odds ratio 2.14), compared to non-depressed subjects. Those who suffered chronic pain were found to be more likely to suffer depression (odds ratio 2.82) compared to those who did not. Other factors associated with depression included low education, rural living, unemployment, and female sex. The findings showed depression to promote pain and pain to promote depression, with the latter effect being slightly greater. The clinician might consider appropriate referrals in those instances where depression is suspect.

Ettinger et al. produced a mid-level moderate quality cross-sectional study of 610 older women, testing the hypothesis that an increase in thoracic kyphosis would be associated

with increased pain, disability, and loss of height. (58) Findings suggested that while an increase in thoracic kyphosis was associated with a loss of bone mineral density and a related to loss of height, it was not strongly related to a marked increase in chronic back pain, disability, or poor health in general. These results are consistent with a high quality systematic review by Christiansen and Hartvigsen that found no relationship between pain and spinal curves. (59)

A mid-level moderate quality 60-subject cohort study by Bryner et al. assessed thoracic paraspinal tenderness in chronic pain sufferers by applying a device to measure pain thresholds. (60) Findings indicated that chronic mid-back pain sufferers had more tenderness than those without chronic back pain. Pain findings were most pronounced at the T2-T7 region; findings at the T1 level were less reliable. Since chronic pain sufferers appeared to exhibit more tenderness than those without chronic pain, pain threshold assessment might be supported in a clinical setting.

**Low level/Quality Literature Summary**

Poor posture might be associated with pain. A low level study by Griegel-Morris et al. assessed 88 healthy subjects for degree of posture anomalies (head-forward posture, increased kyphosis, and/or rounded shoulders), and correlated these data with reported incidence and severity of pain. (61) No direct linear correlation between the degree of postural abnormality and severity and frequency of pain was found. There was, however; a correlation between severe postural abnormalities and incidence of pain. Subjects with severely increased kyphosis and rounded shoulders had an increase in inter-scapular pain, while those with a head-forward posture were noted to have an increased frequency of cervical, inter-scapular, and headache pain.

An interesting study by Triano et al. assessing differences in treatment history in subjects suffering acute, subacute, chronic, and recurrent spine pain, revealed that chronic conditions (> 50 days duration) took longer to resolve than acute, sub-acute, or recurring conditions. (30) The chronic pain sufferer required an average of 8.2 sessions of manipulation over 6 weeks to achieve resolution. Those patients needing care beyond 6 weeks resolved with an average of 3.8 additional sessions, although some required as many as 11 additional treatments. These data could assist in assessment of the impact of patient care and prognosis.

A low level study by Jamieson and Merskey documented cases of chronic pain associated with thoracic outlet syndrome. (62) The clinical practitioner might consider this diagnosis in chronic cases. More detailed information regarding thoracic outlet syndrome will be covered later.

A low level observational study by Nathan evaluated the effects of spinal osteophytes on the sympathetic trunk and splanchnic nerves in the thorax. (63) The author found evidence of neural compression in 655 of 1000 (65.5%) cadavers examined. The right side was generally affected more than the left side, especially below the T5 level. This appeared to be due to the effect of pulsations from the descending aorta, as the pattern was reversed in cases of situs inversus and cases of right-sided descending aorta. The

compressed ganglia, cords, splanchnic nerve, and roots were enlarged, angulated, and deflected from their normal course. Those with marked compression were discolored and found to be infiltrated with connective tissue. Clinical management conclusions cannot be made, given that the findings were from cadavers. However, the study can alert clinicians and researchers as to the common frequency of spinal osteophytes and the potential for neural compromise.

Chronic pain and symptoms have been attributed by several authors in lower level observational studies to arthritis, and to associated sympathetic nerve compression and deformity of the thoracic spine, costovertebral, and costotransverse joints. (63-66)

**Clinical Questions / Graded Practice Options**

***1. Can manipulation provide relief for chronic pain/ conditions?***

> **Grade B** Yes - There is literature (2++) supporting the use of spinal manipulation for chronic pain and, to a lesser degree, postural weakness (2+).

**Key Point Summary:** The literature supports that manipulation can provide better short-term improvement than acupuncture or medication in patients suffering from chronic spinal pain. There is some weaker evidence that manipulation can affect trapezius muscle strength; however, the mechanism of how this occurs is unclear.

***2. Can pain threshold assessment identify chronic back pain?***

> **Grade C** Yes - There is mid-level literature (2+) supporting the use of pain threshold assessment as an option for identifying chronic back pain.

**Key Point Summary:** While pain threshold assessment might be an option for identifying chronic back pain, its routine clinical utilization is uncommon and of questionable utility.

***3: Does chronic pain relate to depression?***

> **Grade B** Yes - There is mid-level literature (2++) of high quality indicating that chronic pain is related to clinical depression, and that depression may magnify chronic pain.

**Key Point Summary:** Considering the interrelationship between pain and depression, a clinician might wish to consider referring chronic pain sufferers for mental health assessment and/or treatment when appropriate.

***4. Is there a relationship between an increase in the thoracic kyphosis and chronic pain and/or disability?***

**Grade B** No - There are high quality data (2++) indicating that an increased kyphotic curve has not been shown to be related to chronic pain or disability.

**Key Point Summary:** With the exception of advanced spinal deformity, an accentuated kyphosis has no known correlation with chronic pain. Additional research is warranted.

## SCOLIOSIS/KYPHOSIS

**General information/Topic Summary:**

There are two main forms of scoliosis, non-structural and structural. (67)

Non-structural forms include:

- Postural scolioses, which are usually habitual and small.
- Pain-provoked scolioses, which are antalgic in nature, and often secondary to sciatica, inflammatory abdominal lesions, or spinal neoplasms. These are generally transient in nature.
- Compensatory scolioses, which are generally secondary to leg length discrepancies, pelvic distortion, or muscle contractures.

Structural forms include:

- Idiopathic Scoliosis categorized by age.
  - Infantile (0-3 yr)
  - Juvenile
  - Adolescent (most commonly encountered)
  - Adult
- Neuromuscular Scoliosis
  - Neuropathic scolioses are secondary to upper motor lesions.
  - Myopathic scolioses are seen in cases of muscular dystrophy and other muscle diseases.
- Congenital scolioses are associated with bony anomalies such as wedge or hemi-vertebrae, incomplete segmentation with unilateral fusion, or bilateral block fusion, and spina bifida.
- Lumbosacral base unleveling, secondary spondylolysis, or spondylolisthesis can result in scoliosis.
- Traumatic scolioses are seen in cases of fracture, irradiation, or as surgical complications
- Other miscellaneous causes include Marfan's syndrome, neurofibromatosis, osteogenesis imperfecta, and others

The most prominent curve is referred to as the "major" curve, whereas a lesser curve is referred to as "compensatory", "secondary", or "minor". The terms "compensated" and

"decompensated" refer to whether or not the spine has compensated to center the torso over the pelvis.

Examination for evidence of a rib hump with Adam's forward bending test is commonly employed to assess patients for scoliosis. This test is simple and easy to do. In a high quality 2006 systematic review of the accuracy of spinal orthopedic tests, Simpson et al. found only 2 studies meeting their inclusion criteria for the screening of scoliosis. (68) One study by Cote et al. found the Adams forward bending test to be of moderate quality and more sensitive than the scoliometer, and concluded Adams forward bending to be the best non-invasive clinical test to evaluate scoliosis. They reported it to have 92% sensitivity and 60% specificity. (69) Conversely, Karachalios et al. concluded that the Adams test could not be used as an effective tool due to the high number of false positives. This study reported sensitivity to be 87% and specificity 93%. (70) Ogilvie et al. suspect that adolescent idiopathic scoliosis (AIS) is the result of 1 or more genes, and are analyzing the genome in a scoliosis population in an effort to identify the related gene or genes. This work might lead to diagnostic tests to assist in identifying people at risk for AIS. (71)

**Adolescent Idiopathic Scoliosis (AIS)**

Though chiropractors encounter any of the above-noted scoliosis forms, the most commonly seen form is adolescent idiopathic scoliosis (AIS). AIS represents approximately 70-90% of all scoliosis cases. (67, 72, 73) While there is no evidence to support the notion that chiropractic care can correct idiopathic scolioses, there are some data suggesting that the inclusion of conservative therapies can be beneficial to enhance the effect of bracing, and/or address issues of flexibility, pain, and weakness. (73-78) Chiropractors also often have the opportunity to diagnose previously undetected scoliosis, participate in observation, and with appropriate training, potentially co-manage existing scolioses. (67, 72)

Reports of the prevalence of scoliosis in the general population have varied and have been dependent on the form and degree of scoliosis selected for inclusion. The Scoliosis Research Society has defined a scoliosis as a frontal plane curvature with a Cobb angle greater than 10°. The prevalence of scoliosis is reported as being inversely related to the size of the curve. (67) Prevalence of AIS when defined as a curve greater than 10° is reported to be between 2 and 3%. Prevalence of curves greater than 20° is reported to be between 0.3 and 0.5%, and curves greater than 40° are thought to be found in less than 0.1%. (7) The Scoliosis Research Society also notes that females are more likely than males to present with AIS, with the overall ratio reported to be 1.25:1.0. The female to male ratio is noted to increase with the severity of the curve; in curves over 20° a ratio of 5.4:1.0 is reported. (67) Risk of curve progression is reported to drop significantly after menarche. (73) Risk of progression of the curve is described as increasing with the magnitude of the curve at the time of detection. (79) Double-curve patterns are also reported to have a poorer prognosis. (80)

Curve size is most commonly expressed as a Cobb angle on a posteroanterior radiograph. The Cobb method of assessing scoliosis involves identification of the apical vertebra that is the most displaced and rotated vertebra with the least tilted end plate, and the ends of the scoliosis, which are the most superior and inferior vertebrae in the scoliotic curve that have the maximally tilted end plates. A line is drawn parallel across the superior and inferior end plates of the ends of the scoliosis, after which a perpendicular line is drawn to each end plate. The angle of the resulting intersecting lines is then measured and reported in degrees as the Cobb angle. In S-shaped scoliosis, the lower end vertebra of the upper curve will represent the upper end vertebra of the lower curve.

There are other methods for measuring the thoracic curve. The Cobb method has largely replaced the Risser-Ferguson method. Since the Cobb angle defines a curvature only in a single plane with 2 dimensions, it fails to address important issues associated with the 3 - dimensional nature of the disorder. Reporting kyphotic depth and vertebral rotation can assist in further understanding the 3-dimensional nature of a spinal deformity. Vertebral rotation is often reported with the Nash-Moe technique, which measures pedicle rotation by dividing the vertebral body into 6 segments. The pedicle is located in relationship to the segments and quantifies the extent of rotation. The rotation is graded according to the extent of migration of the pedicle toward the convex side of the curve. The Cobb method of assessing vertebral rotation uses the position of spinous process for assessing the degree of vertebral rotation. The vertebra is divided into 6 equal segments by drawing 5 vertical lines. The spinous process is normally positioned in the midline of the vertebra overlying the third line. With increasing rotation, the spinous process is rotated toward the convex side of the curve. The Cobb measurement of kyphosis is used to quantify the degree of thoracic kyphosis. (81) Other classification systems include Rigo, Perdriolle, Raimondi, SRS-Ponseti, King, Lenke, and 3-DEMO classifications. These systems are used to further define the elements of a scoliosis in 3 dimensions and are generally used to assess and classify scoliosis curve types for bracing or surgical purposes. (7, 9, 67, 72, 81, 82)

The Risser index is commonly used to assess skeletal maturity via the degree of ossification of the iliac apophysis. Grade I reflects ossification of the lateral 25% of the iliac apophysis, grade II is 50%, grade III is 75%, and grade IV represents ossification of the entire apophysis. Grade V indicates that there has been ossification and fusion of the epiphysis to the iliac wing. The value of the Risser index is somewhat limited in that it is not a highly accurate measure of spinal maturity, and it is therefore of limited value in defining a prognosis for the deformity. Since the risk of progression of a scoliosis is linked to skeletal maturity, more advanced methods of assessment are indicated, such as the Tanner-Whitehouse-III RUS method (TW3). This method of scoring skeletal maturity was originally developed in 1962 and has been revised to its current form. The TW3 method involves radiographic assessment of the radius, ulna, short bones (RUS), and carpals, and is the most commonly employed method of assessing skeletal maturity at present. Other methods, including Greulich-Pyle, prior Tanner-Whitehouse TW2, and TW2-Mark II methods, are sometimes used to assess skeletal maturity. Most recently, computer-assisted skeletal age scores (CASAS) have been developed. (83)
(7, 9, 67, 72, 82, 84-87)

Lonstein and Carlson developed a progression estimation formula for curves between 20° and 29° that is easily implemented in a clinical setting using readily available information. (7, 88) A numerical value termed a progression factor is calculated by taking the Cobb angle, subtracting 3 times the value of the Risser sign, and then dividing this result by the age of the patient. The progression factor can be converted to a percentage incidence of progression as seen on the graph in Figure 4 or on the Nomogram seen in Figure 5. The projected risk of progression can be used to assist the clinician and patient in selecting management strategies that might range from observation to surgical intervention.

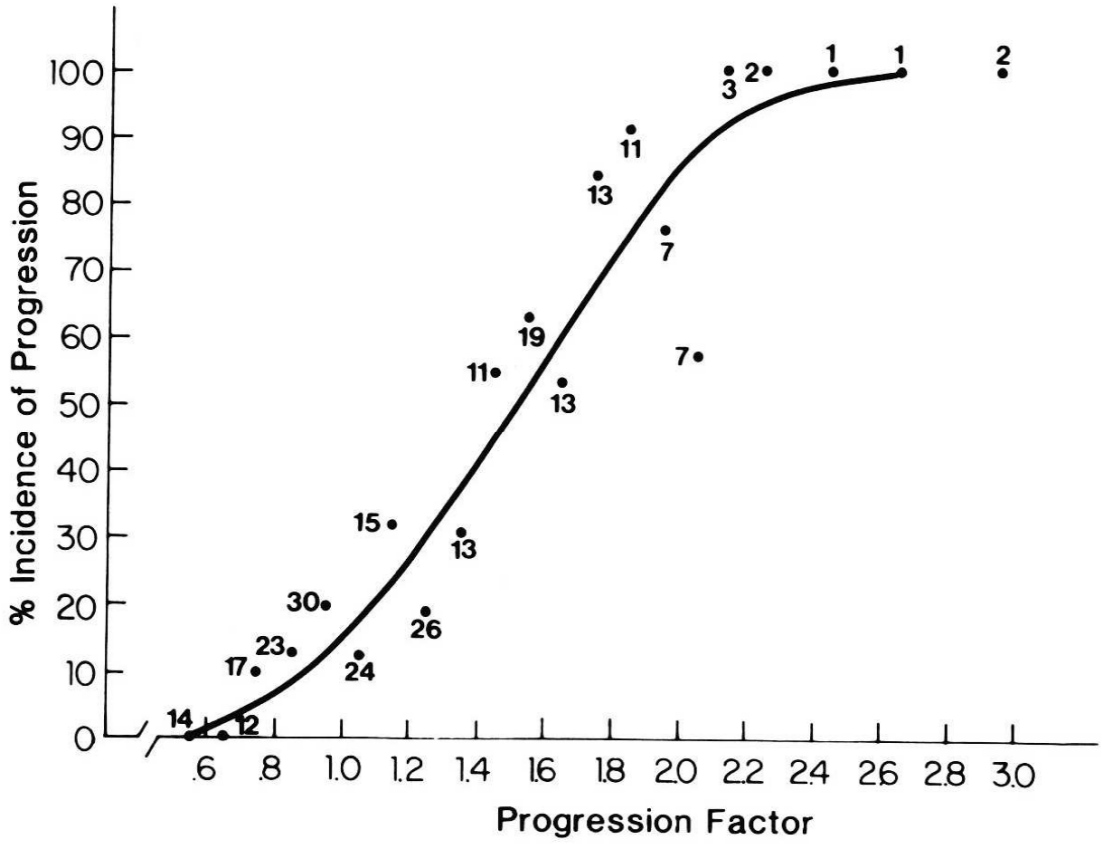



**Figure 4. Graph showing incident of progression according to progression factor, which is calculated by the formula: Cobb angle – 3 x Risser sign / chronological age.**

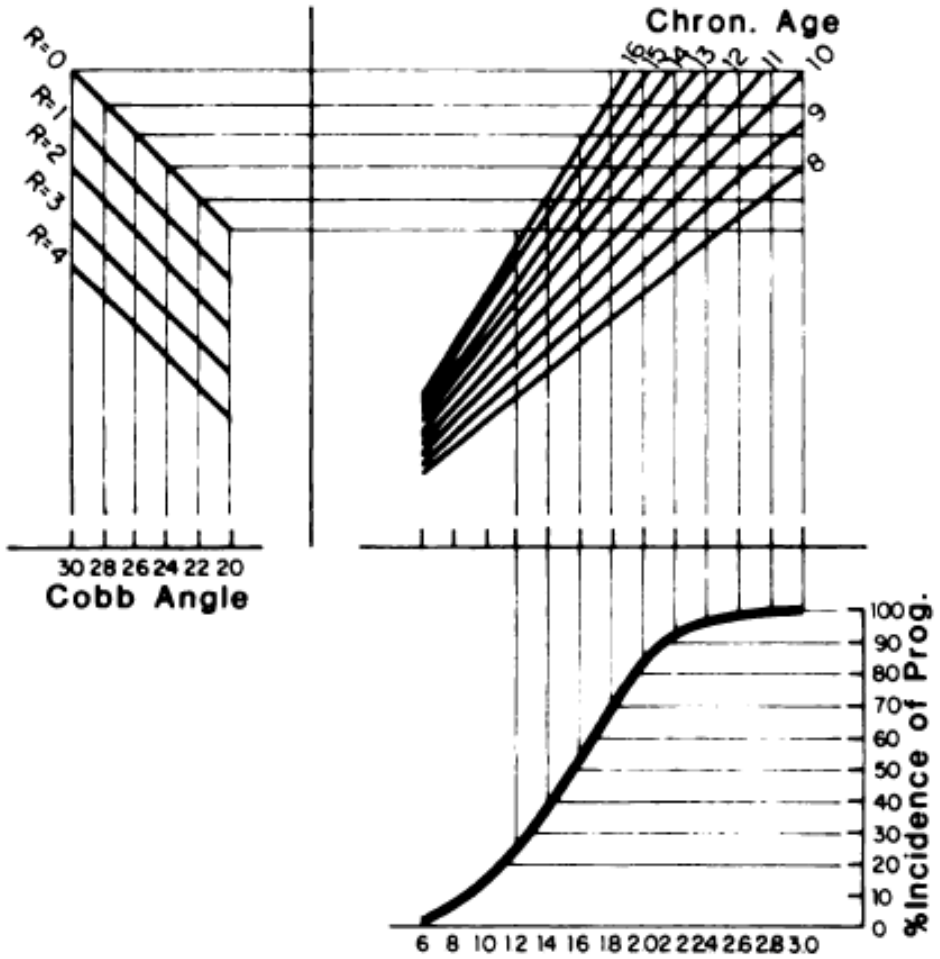



**Figure 5. Lonstein and Carlson Nomogram (88)**

Curve progression is related to the age of onset, the patient's sex, onset of puberty, curve type and magnitude, as well as combinations of these factors. Plagiocephaly (head deformity) has been correlated with infantile scoliosis, leading some to suspect asymmetric posture loading as a cause. (72, 89)

Scoliosis Intensive Rehabilitation (SIR) is currently recommended by some authorities as an early method of conservative treatment for scoliosis management. This specific therapy is available in Europe and has recently been introduced to the United States in limited locations.

Reamy and Slakey, in a non-systematic review of AIS literature, claimed that severe pain, a left thoracic curve, or an abnormal neurologic examination, are considered to be red flags indicating possible underlying pathology related to the scoliosis. (86) Such red flags warrant referral for specialty consultation and magnetic resonance imaging.

In 2007, Colliard et al. published an interesting stratified multi-case series study that evaluated the effect of the SpineCor brace on 493 patients with idiopathic scoliosis. (90)

This study was completed using the Scoliosis Research Society's (SRS) parameters for AIS bracing studies. (91) The SRS established these study parameters to allow for easier comparison of various bracing studies. The authors concluded that the SpineCor brace was an effective treatment for AIS, with 59.4% of subjects attaining correction (>5°) or stabilization (+/- 5°), and 95% of corrected or stabilized subjects maintained correction after a 2-year period. Higher level studies would be needed to confirm these intriguing results. By using the standardized study criteria for AIS developed by the SRS, future studies may be directly compared to these and others that employ the SRS standards.

**High & Moderate Level/Quality Literature Summary**

Our literature search returned remarkably little high quality data regarding the diagnosis and management of scoliosis. The Italian Guidelines on rehabilitation treatment of adolescents with scoliosis or other spinal deformities stood out as the only comprehensive guideline identified by our literature review. (9) Authors of these Guidelines also note that they were unaware of any comparable initiative. While the Guideline methodology was found to be of high quality (see AGREE scores), many of the recommendations are based on consensus and/or low quality studies. Differences in study construction involving variables such as blinding, patient variability, standardization, etc., have made it difficult to compare and integrate findings. The practicing clinician should be aware that future high quality studies might provide new insights and developments for consideration. Researchers might consider using standardized criteria and methodology, like that proposed by the Scoliosis Research Society, so that future study results can be easily compared.

ITALIAN AIS GUIDELINES

- Summary

The Italian Guidelines note that there is insufficient scientific evidence to recommend or not recommend school screening for idiopathic scoliosis in children. (9) However, the authors conclude that early detection may lead to early conservative bracing with associated positive outcomes. This contrasts with the recommendation statement by U.S. Preventive Services Task Force (USPSTF) position on Screening for Idiopathic Scoliosis in Adolescents, which found that screening leads to moderate harms, including unnecessary brace wear and unnecessary referral for specialty care. As a result, the USPSTF concluded that the harms of screening adolescents for idiopathic scoliosis exceed the potential benefits.

The Italian Guidelines also recommend utilization of the Scoliometer, which measures the angle of trunk inclination (ATI), as an evaluation tool. Sensitivity is reportedly nearly 100%, and specificity is 47% at an ATI of 5°. As the ATI increases to 7°, the sensitivity drops to 83% and specificity rises to 86%. (92) A hump-meter is also commonly employed in the measurement of scoliosis. A hump-meter is a level protractor that measures the height of the difference

between curve concavity and convexity. The guideline reports 5 mm as a significant reading. A significant finding from a scoliometer or hump-meter would prompt radiographic assessment of the scoliosis via a Cobb angle. The Cobb angle intra- and inter-observer variability is reportedly 3-5° and 6-7° respectively. Radiographic assessment of vertebral rotation, Risser sign, and apophyseal ring maturity should all be considered.

Guideline Assessment Recommendation Summary:

School-age children should be screened both at school and during general physical examinations. Physicians should use Adam's forward bending test for assessment. Radiography should not be ordered when Adam's test is negative. Children with AIS should be assessed by physicians with specialized training in scoliosis management. Bunnel's scoliometer should be used, with 5° being considered significant and an indication for radiographic studies. The back hump should be measured with a hump-meter or level protractor. Clinical follow-up is recommended twice yearly in those found to be at low risk of progression.

The first radiographic study should include a lateral view. The patient should place their extremities at 45° to the shoulder with elbows extended and hands resting on a support. Gonadal shielding is recommended. Curve magnitude should be measured with the Cobb method. Vertebral rotation should be measured using Raimondi tables or ruler, or Perdriolle torsionmeter.

ITALIAN GUIDELINES - TREATMENT AND EXERCISES

Systematic reviews of the available literature show limited data of poor quality on the topic of exercise for scoliosis. (93) There are no conclusive data to support that exercise is, or is not, effective in treating scoliosis, although there are some data indicating that exercise might be effective in slowing the progression of scoliosis in AIS patients with mild curves. There are no high quality data supporting the utilization of manipulation, homeopathy, acupuncture, diets, or shoe inserts for AIS. (9)

Treatment and Exercise Recommendation Summary:

Non-structural scoliosis and scoliosis with a Cobb angle less than 10° need not be assessed/treated by a physician with specialized training in scoliosis management, but regular examinations would be warranted until puberty and associated growth. Minor curves can be treated with specific exercises as a first step with the goal of improving neuromotor and postural control along with strength and thoracic tone. A treatment team approach is recommended, with exercises provided by personnel with specific training in scoliosis rehabilitation therapy. Exercises should be custom-designed for the needs of the specific patient and performed regularly. Exercises utilized should not increase joint freedom or spinal mobility,

except during the preparatory phase in those cases requiring bracing. Mobilization and manipulation are to be avoided, except in the preparatory phase for bracing.

Specific Exercises and Respiratory Exercises: Exercises are recommended to improve respiratory function in patients with scoliosis. Exercise can be performed in brace or with assistance to produce chest expansion on the concave side of the scoliosis to promote expansion and ventilation of the lung compartment.

Exercise during bracing: Specific mobilizing exercises may be performed during bracing periods to increase joint freedom, except during the release phase. Postural training may also be employed.

Sports: Intense physical activities that increase spinal mobilization and stretching, including swimming, artistic gymnastics, and dancing, may be associated with scoliosis progression in at-risk patients. Swimming and sports are not recommended as a treatment for AIS; however, school and general sports may be recommended for psychological well-being and neuromotor benefits, and can be continued during bracing treatment periods.

ITALIAN GUIDELINES – BRACE TREATMENT

Bracing strategies have advanced from the 1980's and 90's to consider the 3-dimensional nature of spinal scoliosis. A prospective case control study by Nachemson et al. revealed a 4-year success rate of 74% for a braced group as compared to a 34% success rate for an observed group. (80) Other studies have reported similar findings. According to the literature, the most effective bracing system is the Milwaukee brace. Bracing is not recommended by the Guidelines in cases where the Cobb angle is less than 15°, and is recommended when the Cobb angle exceeds 20°. Braces should be custom-designed for the curve being treated by a trained orthotist, and should consider the 3-dimensional nature of the curve. Braces should generally be worn full-time or no less than 18 hours per day, with wearing time gradually reduced over a weaning period at skeletal maturity. The least invasive brace should be considered to reduce physiological impact, and respiratory function should not be restricted. A patient-centered approach that keeps the patient informed as to strategies, duration of care, and options is also recommended. The Guidelines recommend that a patient be seen regularly by the prescribing treatment team physician. (9)

## KYPHOSIS

The Italian Guidelines include recommendations (listed below) regarding sagittal plane deformities. Additional information regarding kyphosis will be included in a separate section later in this chapter.

ITALIAN GUIDELINES – KYPHOSIS

The most common type of kyphosis, or round back, is Scheuermann's juvenile thoracic kyphosis. Classically, by definition, Scheuermann's involves the anterior wedge shape end-plate deformity of 3 or more vertebral bodies. The Guidelines classify the disorder as mild when the curve is less than 50°, moderate between 50° and 70°, and severe over 70-75°. The condition can produce physical and psychological discomfort. (9)

Kyphosis Assessment: There are no established assessment protocols. The Guidelines do recommend screening of children between 10 and 17 years of age. A history including age of onset, family history, and previous pathologies, along with a general examination, is also recommended. Surface measurements, spinal flexibility, sagittal deviation, tenderness, orthopedic, and neurological status should all be assessed. Radiographic examination of the spine is generally recommended when considered necessary by a specialist in spinal curve management, and then yearly if needed. The Cobb method should be used to measure the degree of deformity. (9)

Kyphosis Treatment: There is no evidence-based protocol based on high level data. The Guidelines' recommendations are based on lower level data. Specific therapy and bracing are not recommended for kyphosis less than 45°. Specific exercises designed by a trained specialist are recommended as a first step in treating kyphosis. The goals of the exercise program are to improve balance, proprioception, and postural control of the spine, and to strengthen and tone the back muscles. Posture and ergonomic training are also recommended by these Guidelines. Brace treatment is recommended for kyphosis with Cobb angles above 55° and with good curve reducibility. Plaster bracing is recommended for kyphosis with Cobb angles exceeding 65°, and surgery is considered when the curve exceeds 75° or in cases where conservative treatment has failed. Specific exercises are recommended as adjunctive treatment for both bracing and surgical treatment options. Sports should not be prescribed as a treatment, but general sporting activities are recommended and a sedentary lifestyle is discouraged.

## ITALIAN SCOLIOSIS GUIDELINES
## GRADED RECOMMENDATIONS

**Table 7. Italian Evidence Rating Systems with SIGN equivalent rating**

| Italian Rating | *Italian Evidence Rating Requirement* | SIGN Equivalent Rating |
|---|---|---|
| A) Very strong | More than 1 randomized controlled study with comparable results | A |
| B) Strong | At least 1 randomized controlled study with results comparable with other published studies | A |
| C) Fair | No randomized studies but various controlled studies with comparable results | B |
| D) Poor | 1 controlled nonrandomized study or various studies with divergent results | C |
| E1) | Strong scientific consensus General consensus on a procedure or treatment | D |
| E2) | Fair scientific consensus Prevalent but not general consensus on the procedure or treatment | D |
| E3) | Commission opinion where a general consensus was absent | D |

***Recommendations – Assessment***

- School screening programs for the early diagnosis of idiopathic scoliosis should be conducted (E2). - SIGN equivalent grade: D (I)
- During general physical examination, pediatricians, internal physicians and sports physicians should perform the Adam's test on children aged from 8 to 15 years (E2). - SIGN equivalent grade: D (I)
- The Adam's test should be conducted under a physician's guidance (E1). - SIGN equivalent grade: D (I)
- Assessment of scoliotic patients should be carried out by a physician specialized in spinal deformities (E1). - SIGN equivalent grade: D (I)
- Patients with idiopathic scoliosis should always be examined by the same physician. When this is not possible, validated assessment methods and standard clinical data collection forms should be used (E2). - SIGN equivalent grade: D (I)
- A clinical diagnosis of scoliosis should be established, and the assessment of patients with idiopathic scoliosis should be comprehensive, including clinical and radiographic information (E1). - SIGN equivalent grade: D (I)
- Assessment of patients with idiopathic scoliosis should comprise pathologic, cosmetic, psychological, functional, and family aspects (E2). - SIGN equivalent grade: D (I)

- History taking should be performed during physical examination (E2). - SIGN equivalent grade: D (I)
- During examination, sagittal alignment of the spine should be evaluated. (E2). - SIGN equivalent grade: D (I)
- Bunnel's Scoliometer should be used (E1). - SIGN equivalent grade: D (I)
- When the Scoliometer is used, the cut-off point should be 5° (E2). - SIGN equivalent grade: D (I)
- The back hump should be measured using a hump-meter, level protractor, or other instrument, in the clinical evaluation during specialist examination (E3). - SIGN equivalent grade: D (I)
- Clinical evaluation should be accurate; radiographic study of leg length discrepancy should be performed only when needed (E3). - SIGN equivalent grade: D (I)
- Sequential collection of clinical and diagnostic data should be recorded on specific forms (E2). - SIGN equivalent grade: D (I)
- Clinical follow-up examinations should be performed twice yearly in patients with idiopathic scoliosis or more often in patients at risk (E3). - SIGN equivalent grade: D (I)
- Radiographic studies should not be ordered when the Adam's test is negative (E3). - SIGN equivalent grade: D (I)
- An ATI angle 5° and/or 5 mm of back hump should be taken as the significant cut-off points for ordering a radiographic study at initial examination (E3). - SIGN equivalent grade: D (I)
- The decision whether to perform a radiographic study should be made by a specialist (E3). - SIGN equivalent grade: D (I)
- Radiographic studies should be made using centimetered films with a ratio of 1:1 in relation to real dimensions (even when digital), including visualization of the femoral heads and protection of the gonads, in any standing position without the use of support aids or indication of correct posture (E1). - SIGN equivalent grade: D (I)
- Curve magnitude should be measured using the Cobb method on the radiographic film (E1). - SIGN equivalent grade: D (I)
- Vertebral rotation should be measured using Raimondi tables or ruler or a Perdriolle torsionmeter on the radiographic film (E2). - SIGN equivalent grade: D (I)
- The first radiographic evaluation should include a lateral view (E2). - SIGN equivalent grade: D (I)
- On radiographic lateral projection, the patient's upper extremities should be placed at a 45° angle to the shoulder, with elbows extended and hands resting on a support to preserve the sagittal curvature of the spine (E1). - SIGN equivalent grade: D (I)
- To reduce the invasiveness of follow-up, no more than 1 radiographic study per year should be performed, or as decided by a clinician specialized in spinal diseases (E3). - SIGN equivalent grade: D (I)

- The least number of projections should be made on radiographic study (E1). - SIGN equivalent grade: D (I)
- In daily clinical routine, complex and costly studies should not be ordered, unless otherwise justified in the opinion of a clinician specialized in spinal pathology (E1). - SIGN equivalent grade: D (I)

***General Recommendations***

- The choice of therapeutic options should be made by a clinician specialized in spinal diseases on the basis of information from history taking, objective, and diagnostic procedures (E1). - SIGN equivalent grade: D (I)
- A nonstructural scoliotic curve and scoliosis with a Cobb angle <10 (±5°) should not be treated specifically, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). - SIGN equivalent grade: D (I)
- Scoliosis with a Cobb angle <10 (±5°) and a prominent nonstructural scoliotic curve should be regularly examined until the pubertal growth spurt, unless otherwise determined per the opinion of a clinician specialized in spinal diseases (E2). - SIGN equivalent grade: D (I)
- In treating minor curves, specific exercises should be initiated as a first step in the approach to treating idiopathic scoliosis to prevent progression of the deformity (C). - SIGN equivalent grade: B
- Specific treatment teams (not necessarily working directly together) should be constituted, with close cooperation between the physician and the rehabilitationist (E3). - SIGN equivalent grade: D (I)
- Exercise programs should be designed and carried out by a specifically trained rehabilitation therapist experienced in scoliosis treatment (E2). - SIGN equivalent grade: D (I)
- Exercises should be performed individually or, even better, in small groups according to a personalized exercise program (E3). - SIGN equivalent grade: D (I)
- Exercises should be performed regularly until the end of treatment (E2). - SIGN equivalent grade: D (I)
- Exercises should be customized to the patient's needs (E2). - SIGN equivalent grade: D (I)
- The goals of an exercise program should be to improve neuromotor and postural control of the spine, balance, and proprioception, and to strengthen thoracic muscle tone (E2). - SIGN equivalent grade: D (I)
- Exercises should not increase joint freedom or spinal mobility, except in the preparatory phase for brace treatment (E2). - SIGN equivalent grade: D (I)
- In specific exercises, the use of single methods, none of which are adapted to all therapeutic phases, should be avoided in children with idiopathic scoliosis (E2). - SIGN equivalent grade: D (I)
- In each treatment phase, the best methods, techniques, and exercises should be employed to achieve the treatment objectives established for the patient (E2). - SIGN equivalent grade: D (I)

- Manual mobilization and manipulation of the spine should be avoided, except in the preparatory phase for brace treatment (D). - SIGN equivalent grade: C
- Correction of leg length discrepancy, if needed, should never be total and should be decided by a clinician specialized in spinal diseases (E3). - SIGN equivalent grade: D (I)
- Plantar insets (not lifts), bytes, conventional and homeopathic medicines, acupuncture, or specific dietary regimens should not be used to correct a spinal deformity (E1). - SIGN equivalent grade: D (I)

***Recommendations – Specific Respiratory Exercises***

- Where needed, exercises to improve respiratory function are recommended in patients with idiopathic scoliosis (D). - SIGN equivalent grade: C
- Training in regional respiratory strategies is recommended to promote the expansion and ventilation of a specific lung compartment (E2). - SIGN equivalent grade: D (I)
- Exercises performed in brace or assisted pushing on the back hump are recommended to promote chest expansion of the concave side of the thorax (E2). - SIGN equivalent grade: D (I)

***Recommendations – Specific Exercises During Brace Treatment and Surgical Therapy***

- Specific exercises should be performed in combination with brace treatment (C). - SIGN equivalent grade: B
- Mobilization exercises should be performed to improve joint freedom of the spine braced full-time, but not during the release phase (B). - SIGN equivalent grade: A
- Mobilization exercises are recommended as preparation for brace treatment (E2)
- Exercises to strengthen muscle tone during brace treatment are recommended (E1). - SIGN equivalent grade: D (I)
- Exercises and posture training to recover sagittal pattern during brace treatment are recommended (E2). - SIGN equivalent grade: D (I)
- Exercises in posture and function training are recommended, particularly during weaning off the brace and the postsurgical period (E2). - SIGN equivalent grade: D (I)

***Recommendations – Sports Activities***

- Sports should not be prescribed as treatment for idiopathic scoliosis (E2). - SIGN equivalent grade: D (I)
- General sports activities that offer patients specific benefits in terms of psychological, neuromotor, and general organic well-being are recommended (E2). - SIGN equivalent grade: D (I)
- During all treatment phases, physical education at school should be continued. Based on the severity of the curve, progression of the deformity, and the opinion of a clinician specialized in spinal disease, restrictions may be placed on practicing certain types of sports activities (E2). - SIGN equivalent grade: D (I)

- Sports activities should also be continued during brace treatment because of the physical and psychological benefits these activities provide (E3). - SIGN equivalent grade: D (I)
- Swimming should not be used to treat pathologic curves (E2). - SIGN equivalent grade: D (I)
- Competitive activities that greatly mobilize or stretch the spine should be avoided in patients with scoliosis at high risk of progression (D). - SIGN equivalent grade: C

***Recommendations – Brace Treatment***

- Brace treatment is recommended in the conservative therapy of idiopathic scoliosis (C). - SIGN equivalent grade: B
- Brace treatment is not recommended in treating curves with a Cobb angle <15 (±5°), unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). - SIGN equivalent grade: D (I)
- Brace treatment is recommended in treating patients curves with a Cobb angle >20 (±5°), future growth potential, and demonstrated progression of deformity or elevated risk of worsening, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (C). - SIGN equivalent grade: B
- A fixed brace (plaster or fiberglass) is recommended in treating curves with a Cobb angle >40 (±5°), unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). - SIGN equivalent grade: D (I)
- Braces should be worn full-time or no less than 18 hours per day at the beginning of treatment, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E3). - SIGN equivalent grade: D (I)
- Braces should be worn and the wearing time gradually reduced until the end of vertebral bone growth (E2). - SIGN equivalent grade: D (I)
- The brace system should be specifically designed for the curve to be treated (E1). - SIGN equivalent grade: D (I)
- Brace systems proposed for treating scoliotic deformity on the frontal and horizontal planes should take into account the sagittal plane as far as possible (E3). - SIGN equivalent grade: D (I)
- The least invasive brace in relation to the clinical situation should be used to reduce its psychological impact and to ensure better patient compliance (E1). - SIGN equivalent grade: D (I)
- Braces should not so restrict thorax excursion that they reduce respiratory function (E1). - SIGN equivalent grade: D (I)
- The specialist should accurately inform the patient about the length of time the prescribed brace is to be worn (E1). - SIGN equivalent grade: D (I)
- Removable braces should be prescribed, constructed, and fitted on an ambulatory basis (E1). - SIGN equivalent grade: D (I)
- A specific treatment team should be constituted (not necessarily directly working together), with close cooperation between the prescribing physician and the brace

examiner, the orthotist constructing the brace, and the rehabilitationist (E3). - SIGN equivalent grade: D (I)

- Braces should be constructed by an orthotist specialized in the construction of the prescribed brace system (E1). - SIGN equivalent grade: D (I)
- The brace system should be examined by the prescribing physician, who shall personally verify the validity of the brace constructed by the orthotist, and propose (and verify) all necessary corrections to ensure major brace efficacy and tolerability (E1). - SIGN equivalent grade: D (I)
- The construction and testing of a fixed plaster or fiberglass brace should be performed in a specialized setting (E1). - SIGN equivalent grade: D (I)
- A fixed plaster or fiberglass brace should be constructed *manu medica* (E1). - SIGN equivalent grade: D (I)

***Recommendations - Sagittal Plane Deformities***

- On screening and general physical examination of children aged 10 to 17 years, pediatricians, internists, and sports physicians should also evaluate the spine sagitally (E3). - SIGN equivalent grade: D (I)
- Evaluation of patients with spinal deformities on the sagittal plane should be performed by a physician specialized in spinal diseases (E1). - SIGN equivalent grade: D (I)
- Patients with spinal deformities on the sagittal plane should be examined by the same physician. When this is not possible, the use of validated methods and standardized data collection forms is recommended (E2). - SIGN equivalent grade: D (I)
- Evaluation of patients with spinal deformities on the sagittal plane should be comprehensive, including clinical and radiographic assessment (E1). - SIGN equivalent grade: D (I)
- A comprehensive evaluation of the patient should comprise pathologic, cosmetic, psychological, functional, and familial aspects (E2). - SIGN equivalent grade: D (I)
- History taking should be conducted during visits (E3). - SIGN equivalent grade: D (I)
- A non-invasive method of surface measurement should be used to document patient follow-up (E3). - SIGN equivalent grade: D (I)
- Sequential collection of clinical and diagnostic data should be recorded on specific forms (E2). - SIGN equivalent grade: D (I)
- Follow-up visits should be conducted every 6 months, or more often in at-risk patients (E3). - SIGN equivalent grade: D (I)
- The decision to order radiographic studies should be left to the specialist (E3). - SIGN equivalent grade: D (I)
- Deformities should be measured using the Cobb method on the radiograph (E1). - SIGN equivalent grade: D (I)
- To reduce the invasiveness of follow-up procedures, no more than 1 radiographic study per year should be performed (E3). - SIGN equivalent grade: D (I)

***Recommendations – Treatment***

- The choice of therapeutic options should be made by a clinician specialized in spinal diseases on the basis of information from history taking, physical examination, and diagnostic studies (E1). - SIGN equivalent grade: D (I)
- Kyphosis with a Cobb angle <45 (±5°) should not be treated with specific therapy, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E1). - SIGN equivalent grade: D (I)
- Thoracolumbar and lumbar kyphosis should always be treated with specific therapy (E1). - SIGN equivalent grade: D (I)
- Specific exercises are recommended as a first step in the therapeutic approach to hyperkyphosis, and also in functional forms (postural), since they may progress to stiffness and structuring (E2). - SIGN equivalent grade: D (I)
- Exercise programs should be proposed and conducted by a specialized rehabilitationist (E2). - SIGN equivalent grade: D (I)
- Exercises should be performed individually or, even better, in small groups with personalized programs (E3). - SIGN equivalent grade: D (I)
- Exercises should be practiced regularly (E2). - SIGN equivalent grade: D (I)
- Exercise programs should be personalized according to patient needs (E2). - SIGN equivalent grade: D (I)
- The goals of the exercise program are to improve postural control of the spine, balance, and proprioception, and to strengthen muscle tone of the back muscles (E2). - SIGN equivalent grade: D (I)
- Patients should be trained to maintain a correct posture in activities of daily living and should be involved in a comprehensive ergonomic training program (E1). - SIGN equivalent grade: D (I)
- Brace treatment is recommended in the conservative treatment for hyperkyphosis (E1). - SIGN equivalent grade: D (I)
- Brace treatment is recommended for hyperkyphosis with Cobb angle >55 (±5°), good but incomplete curve corrigibility and future growth potential, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). - SIGN equivalent grade: D (I)
- The use of a preliminary fixed brace (plaster or fiberglass) is recommended in treating hyperkyphosis with a Cobb angle >65 (±5°), reduced curve corrigibility and future growth potential, unless otherwise justified in the opinion of a clinician specialized in spinal diseases (E2). - SIGN equivalent grade: D (I)
- Braces should be specifically designed for the curve to be treated (E1). - SIGN equivalent grade: D (I)
- The least invasive brace in relation to the clinical situation should be used, to reduce the psychological impact of the device on the patient and to improve patient compliance (E1). - SIGN equivalent grade: D (I)
- The specialist should accurately inform the patient about the number of hours the brace should be worn, in relation to the type of system prescribed and extent of the deformity (E1). - SIGN equivalent grade: D (I)

- Removable braces should be prescribed, constructed, and tested on an ambulatory basis (E1). - SIGN equivalent grade: D (I)
- A specific treatment team should be constituted (not necessarily directly working together), with close cooperation between the prescribing physician and the brace tester, the orthotist constructing the brace, and the rehabilitationist (E2). - SIGN equivalent grade: D (I)
- Braces should be constructed by an orthotist specialized in the construction of the prescribed brace system (E1). - SIGN equivalent grade: D (I)
- The brace system should be examined by the prescribing physician, who shall personally verify the validity of the brace constructed by the orthotist and propose (and verify) all necessary corrections to ensure major brace efficacy and tolerability (E2). - SIGN equivalent grade: D (I)
- Construction and testing of a fixed plaster or fiberglass brace should be performed in a specialized setting (E1). - SIGN equivalent grade: D (I)
- A fixed plaster or fiberglass brace should be constructed *manu medica* (E1). - SIGN equivalent grade: D (I)
- Brace treatment should always be combined with a specific exercise program (C). - SIGN equivalent grade: B
- Mobilization exercises should be practiced in preparation for brace treatment (E1). - SIGN equivalent grade: D (I)
- In brace exercises should be performed to strengthen muscle tone (E1). - SIGN equivalent grade: D (I)
- Exercises in posture and function training are recommended, particularly during weaning off the brace and the postsurgical period (E1). - SIGN equivalent grade: D (I)
- Sports activities should not be prescribed as treatment for sagittal plane deformities (E2). - SIGN equivalent grade: D (I)
- General sports activities that offer patients specific benefits in terms of psychological, neuromotor, and general organic well-being are recommended (E2). - SIGN equivalent grade: D (I)
- During all treatment phases, physical education at school should be continued (E2). - SIGN equivalent grade: D (I)
- Sports activities should also be continued during brace treatment because of the physical and psychological benefits these activities provide (E3). - SIGN equivalent grade: D (I)
- A sedentary lifestyle should be discouraged, as it constitutes a negative factor for the pathomechanics of hyperkyphosis (E2). - SIGN equivalent grade: D (I)
- In atypical Scheuermann's lumbar disease, particularly in the presence of severe lumbar pain, excessive mechanical stress on the spine should be avoided, as with several competitive types of sports (E2). - SIGN equivalent grade: D (I)

In 2003, Negrini et al. performed a high quality high level systematic review of the literature to assess the efficacy of physical exercises as a treatment for adolescent idiopathic scoliosis. Their methodology was unique in that they made a concerted effort to evaluate non-English/indexed literature on the topic. Although AIS treatment protocols

have emerged in Central and Southern Europe, much of the information and data have gone unnoticed in the English-speaking world. The authors noted that little high quality data were identified; however, several exercise methods were noted that warranted further scientific evaluation. Some of the methods identified included:

- The Milwaukee method, which utilizes instruction from a physiotherapist and home exercise to mobilize and strengthen posture.
- Side-shift therapy, which involves physiotherapy instructions on how to incorporate side-shifting in a daily living environment.
- The Lyon method, which uses a twice-weekly physiotherapy program and a home program to enhance postural control, strength, and balance.
- The Schroth method, which is an intensive in-patient exercise program designed to enhance active straightening and auto-correction of the patient's scoliosis.

The authors noted that prior summaries of the English literature might have resulted in prematurely dismissing the value of physical exercises for AIS. They cited poor compliance issues present in these studies; many were based on mechanical strategies vs. the more recent neurological perspective that takes into consideration the complexity of the neuromotor system. The authors also indicated that there could be secondary benefits to physical exercise beyond reduction of the Cobb angle, such as increased neuro-control and stability of the spine, reduction of posture collapse, increase in breathing function, as well as enhancement of strength and postural balance. The authors conceded the lack of definite proof either way, and noted that more study would be needed to assess the value of physical exercise as a treatment for AIS. (93)

A 2008 high quality systematic review by Romano and Negrini examined the literature on manual therapy as a treatment for AIS. (78) The authors specifically defined manual therapy as osteopathic, chiropractic, and massage techniques. The authors failed to find conclusive high quality evidence regarding the efficacy of manual treatment for AIS, and cited the urgent need for scientific study in this field. Their findings were consistent with those of our team.

Focarile et al. performed a high quality systematic review of the literature, published in 1991. (94) Studies in the English literature regarding the effectiveness of non-surgical treatment of idiopathic scoliosis were examined. This review found that there was a significantly higher frequency of failure/progression in curves with Cobb angles over 30°. The authors opined that screenings might be useful to allow early treatment of scoliosis, before curves approach 30°. The authors also commented on the lack of data on leg length deficiencies or their correction. Since the literature is scant and of poor quality, interpretation of the limited data available was noted to be difficult, and additional research was recommended.

A 1997 high level moderate quality meta-analysis of the literature by Rowe et al. evaluated non-operative treatment for idiopathic scoliosis. The authors noted that the use of the Milwaukee brace or another thoracolumbosacral orthosis for 23 hours per day effectively halted progression of the curve. Bracing for eight or 16 hours per day was

found to be significantly less effective ($p < 0.0001$). Treatment with lateral electric surface stimulation (LESS) was found to be no better than simple observation. (79)

A moderate quality 2003 systematic review by Hawes evaluated literature regarding the use of exercises in the treatment of scoliosis. The author evaluated what she referred to as a long-standing bias regarding the use of exercise in the treatment of scoliosis leading to uncritical acceptance of opinions that are poorly supported. The author went on to critique the limited and poor quality of literature published against exercise. The most-cited paper regarding the failure of exercise as a treatment was a 1979 pilot study, which the authors acknowledged was flawed due to poor patient compliance. (89) The lack of literature negating the value of exercise was then contrasted with the limited low level animal and case studies supporting its application for the treatment of scoliosis. Hawes noted that the Schroth program and scoliosis in-patient rehabilitation, suggested as potentially effective treatments, would require additional investigation. The author also opined that the prone sleeping position might be preferable for babies to avoid plagiocephaly and scoliosis. (95)

A mid-level cohort study of moderate quality by el-Sayyad et al. evaluated the effect of exercise, bracing, and electrical stimulation on AIS. (96) The study found the benefits of bracing or electrical stimulation to be no better than exercise.

A mid-level high quality study published in 2005 by Kuklo et al. compared the utility of alternate radiographic measures to assess vertebral rotation by proxy via thoracic torsion assessment to conventional methods. (97) Cobb, Nash-Moe, and Mehta are some of the methods commonly employed to assess vertebral rotation arising from the 3-dimensional distortion associated with scoliosis. These 3 measures of vertebral rotation are based upon the position of the vertebral body in relationship to the posterior elements. The most common method used in clinical practice is the Perdriolle torsionmeter, which provides a measurement of the axial rotation angle of a vertebra. Techniques of Aaro and Dahlborn, and Ho et al. are used for the assessment of vertebral rotation in CT scans, and are generally considered to be more accurate than the previously mentioned methods. The authors opined that for clinical purposes, it would be beneficial to employ a less costly, less invasive, and more convenient method of assessment with conventional radiology to monitor the progression of scoliosis. Therefore, they compared various roentgenometric methods of assessing thoracic torsion to the very accurate CT measurements of actual vertebral rotation, to determine how well these proxy measurements of torsion correlated with actual vertebral rotation. Three methods of thoracic torsion assessment (apical rib hump prominence, apical vertebral body-rib ratio, and apical rib spread difference) demonstrated moderate to good overall correlation with the main thoracic curve Cobb angles, apical Perdriolle rotation, and apical CT rotation. The authors concluded that these thoracic torsion assessment methods should be useful as alternative clinical measures for assessing 3-dimensional deformity progression or correction on radiography. The authors also found the Nash-Moe ($r = 0.32$, $P < 0.0001$) and more so the Perdriolle ($r = .85$, $P < 0.0001$) methods to correlate significantly with CT measurements.

In 2005, Kuklo et al. evaluated the reliability of digital methods of measuring AIS. This mid-level high quality study assessed the intra- and inter-observer reliability of common

radiographic parameters with a digital software measurement program (PhDx). (98) Most of the methods assessed had good or excellent intra- and inter-observer reliability. Lower reliability was seen with parameters including the relationship of the LIV to the CSVL (intra-observer kappa = 0.48-0.78, fair to excellent; inter-observer kappa = 0.34-0.41, fair to poor), inter-observer measurement of AVT (rho = 0.49-0.73, low to good), Risser grade (intra-observer rho = 0.41-0.97, low to excellent; inter-observer rho = 0.60-0.70, fair to good), intra-observer measurement of the angulation of the disk inferior to the LIV (rho = 0.53-0.88, fair to good), apical Nash-Moe vertebral rotation (intra-observer rho = 0.50-0.85, fair to good; inter-observer rho = 0.53-0.59, fair), and especially regional thoracic kyphosis from T2 to T5 (intra-observer rho = 0.22-0.65, poor to fair; inter-observer rho = 0.33-0.47, low). The authors found that preoperative measurements were more reliable than postoperative, and that coronal angular measurements were more reliable than sagittal ones. The authors concluded that most digital methods of commonly employed AIS assessment techniques demonstrated good to excellent reliability and were appropriate for routine clinical and academic use.

A 1995 high quality prospective cohort study by Nachemson et al., sponsored by the Scoliosis Research Society, evaluated the outcomes of underarm plastic bracing, nocturnal surface electrical stimulation, and observation in 286 Swedish girls with (AIS). (80) The study was conducted in Sweden, where the national health care system allows for free, high quality, orderly care, as well as standardized record keeping. No differences were noted between observation and nocturnal surface electrical stimulation, whereas, bracing treatment was found to be successful in preventing more than 6° of progression (Cobb method) until subjects were 16 years of age ($P < 0.0001$). The crude rate of failure for bracing treatment was reported to be 19%, while the other treatment cohorts had a failure rate of 50%. This study suggested that patients with an untreated scoliosis might have an increased risk of progression than those treated, of 6° or more by the time skeletal maturity is reached. The authors cited the need for higher level research in this area.

A high quality mid-level paper by Peterson et al. was generated by the 1995 Swedish Brace Study of the Scoliosis Research Society. (99) This paper reviewed the prediction of progression of scoliotic curve in 159 girls with AIS of moderate severity. As reported in the Nachemson paper, there was no apparent difference in outcomes between patients who were managed with observation only and those who were given electrical stimulation. Statistical analysis was performed to determine which of 11 factors might be predictive of scoliotic curve progression. Of those 11 factors, a low Risser sign, an apical level cephalad to the 12$^{th}$ thoracic vertebra, and an imbalance of 10 millimeters or less were found to be valuable for prognostic purposes, and indicated that the curve might continue to progress more than 6°. These 3 factors, in conjunction with consideration of the patient's age, allowed for an accurate model of classification of scoliotic curves as either progressive or non-progressive in 81% of the study subjects with thoracic or thoracolumbar AIS. The model is a 4-factor regression equation that provides a positive predictive value of 82%, and a negative predictive value of 80%. Sensitivity and specificity for each was 81%. While dichotomous inputs relating to each of the factors are easy to identify, the equation is neither intuitively simple nor easy to apply in a

clinical setting. The SRS progression probability model does correspond well to the Lonstein and Carlson progression nomogram and risk progression chart, which are simple to employ in a clinical setting. (88)

Swedish patients participating in the 1995 Scoliosis Research Society study (80, 99) were invited to take part in a long-term follow-up. This high quality study evaluated brace treatment versus observation alone in patients with AIS. Results of this prospective cohort study by Danielsson et al. were published in 2007. (100) The study was designed to assess and compare curve progression and frequency of surgery from baseline as well as after maturity in the 2 cohorts. The mean follow-up time was 16 years. A search of the mandatory national database for surgeries performed identified patients who had undergone surgery after maturity. Of 106 patients, 87% attended the follow-up, including radiography and chart review. All radiographs were (re)measured for curve size (Cobb method). Patients who were initially treated with a brace had a reduction of 6° during treatment, but the curve size returned to the original level during the follow-up period. None of the patients who were braced went on to undergo surgery, 20% of patients who had observation alone (intention to treat analysis) required bracing during adolescence due to progression, and another 10% underwent surgery. The authors found that curves of a moderate or smaller size at maturity did not deteriorate beyond their original curve size at the 16-year follow-up. None of the patients who were treated primarily with a brace went on to surgery, whereas 6 patients (10%) in the observation group required surgery during adolescence. No patient required surgery after maturity. The authors concluded that brace treatment was superior to observation alone, as was noted in the original 1995 SRS brace study by Nachemson et al.

A mid-level moderate quality study by Burwell et al. evaluated the use of the scoliometer in 3 different positions. The standing forward bending position is generally used to measure AIS. Since leg length can also produce rib humping, some authorities have advocated the use of the scoliometer in the sitting forward bending position as well. Evaluation in the prone position has also been recommended. The authors of this study employed ultrasound to measure rib and spinal rotation in 30 subjects. The gleaned measurements were compared to scoliometer measurements (Angle of Trunk Inclinations or ATIs) in standing, seated, and prone positions. Reproducibility was found to be most accurate in the sitting and prone positions. Though the prone position appeared to have advantages, the authors did not advocate its use in clinical practice. They recommend the sitting forward bending position for the early detection of AIS. (101)

Adult Scoliosis:

A high quality 2007 systematic review by Everett and Patel examined the literature regarding the efficacy and effectiveness of conservative treatment options for adult scoliosis. (75) The review covered literature on bracing and casting, physical therapy and exercise, chiropractic and manipulation, as well as injections or epidurals. The evidence available for adult scoliosis is even more limited than for AIS, with a lack of quality data. Everett and Patel found very weak evidence, (case studies and expert opinions) for bracing or casting, as well as for physical therapies and exercise. Some of the therapies

addressed in the studies reviewed included heat, lumbar traction, and side shift exercises. Chiropractic and manipulative care were also found to have very weak evidence supporting their application. There was slightly more data supporting the use of trans-foraminal epidural steroid injections for treatment of radiculopathy associated the adult deformity, but the evidence was still weak. The risks and benefits of each of these treatments were noted to be unclear. In light of the lack of evidence, the authors suggested that the practitioner utilize best clinical practices for the degenerative aging spine, including activity modification and NSAIDs, until further research is available for consideration.

Schwab et al. performed a high quality mid-level prospective study of 95 adult patients that had AIS as children or de novo degenerative scoliosis to test the hypothesis that radiographic findings correlated with clinical symptoms. The authors noted that there are 2 main categories of adult scoliosis: adolescent idiopathic scoliosis of the adult (also referred to as adult idiopathic scoliosis) and de novo degenerative scoliosis. Results of the study indicated that pain correlated to lateral vertebral olisthy, L3 and L4 endplate obliquity angles, lumbar lordosis, and thoracolumbar kyphosis. (102) Although limited clinical conclusions can be drawn from correlational data, these data supported the notion that problems associated with scoliosis are not limited to the skeletally immature.

**Low level/Quality Literature Summary**

*Indications for Conservative Management of Scoliosis*, produced by the Society on Spinal Orthopaedic and Rehabilitation Treatment (SOSORT), includes consensus recommendations. Although created by consensus, the SOSORT document recommendations strongly relied upon the literature and findings reported in the Italian Guidelines. (7, 8) The SOSORT guideline's quality scores were very low, since the authors did not independently report details of their construction methodology. However, private communications with the authors did confirm that the SOSORT guidelines were based on the Italian Guidelines, which had high quality scores. The SOSORT guidelines also employed Lonstein and Carlson's prognostic risk calculations to estimate the risk of progression. While the quality of the SOSORT guideline is debatable, the work might have value, and is summarized for the physician's consideration in the appendix.

A low level non-systematic review on non-surgical rehabilitation in adolescent scoliosis by Weiss is significant, in that it examined treatment options outside of the Anglophonic literature. (73) While this paper lacked a high quality rating due to poor reporting of methodology, it was written by one of the leading scoliosis experts in Europe, and provides valuable insight on a topic with very little quality data available to guide the practitioner. Dr. Weiss maintained that there is an unsubstantiated bias against exercise-based therapies in the English-speaking countries, and that research and evidence from continental Europe have not been objectively considered. The paper went on to review the rationale, procedures, and goals of Scoliosis Intensive Rehabilitation (SIR). SIR is 4 to 6 weeks in duration, and involves a 3-dimensional approach based on sensorimotor and kinesthetic principles. The goal of SIR is to facilitate correction of the asymmetric posture and to teach the patient to maintain the corrected posture during daily activities. Physician and therapist work as a coordinated team to intensely assess and address the

specific biomechanical issues of each patient. The author concluded that evaluation of modern rehabilitation (such as SIR), as well as updated bracing techniques, might produce results superior to those noted over the last century in the English-speaking world. Additional research of higher quality would be needed to assess this theory.

Another low level non-systematic review by Wong and Liu concerned non-operative management of AIS. The authors noted that while AIS etiology is unknown, it has been linked to allosomal and autosomal dominant inheritance. Other potential links were noted to include central nervous system and brainstem anomalies, melatonin, and muscle and connective tissue defects as well. The article also reviewed common brace types and other non-surgical treatment options. While the paper provides valuable insight and background information, its lack of a systematic review of the literature limits any conclusions that might be drawn. (103)

A low level study done in the late 1990's by Dobosiewicz investigated the unloading reflex in paraspinal muscles using surface EMG, and suggested that the method could be used to detect progressive idiopathic scoliosis in the early stages of the disease. (104) Dobosiewicz found prolonged latency periods and decreased silent/rebound cycles, which the author opined could be used to differentiate between progressive and non-progressive idiopathic scoliosis. While intriguing, scientific rigor was lacking in the study. A 2004 study by Perret and Robert further evaluated the unloading reflex with surface bipolar EMG electrodes. The authors' findings differed from Dobosiewicz's. Perret and Robert concluded that the EMG technique needed more precise analysis before it could be used in a clinical setting as a diagnostic and prognostic tool to assess scoliosis. (105)

In a low level study done in 1983, Healey and Lane radiographed 50 osteoporotic women for evidence of scoliosis, kyphosis, and compression fracture. (106) Study findings confirmed the authors' hypotheses; that scoliosis is more common in osteoporotic patients than in the general population and represents a correlative risk factor. The authors opined that pending further studies, young women might consider taking prophylactic calcium supplements to avoid osteoporosis, and adult women with scoliosis should be evaluated for evidence of osteoporosis.

A 1980 low level case series study by Miyasaki assessed 14 female subjects with idiopathic scoliosis enrolled in Milwaukee brace programs. (107) The study evaluated the performance of Blount - Moe thoracic flexion exercises on thoracic vertebral rotation and lateral deviation. It is interesting to note that Blount and Moe developed the Milwaukee brace in the early 1950's; it was to be worn 23 hours a day until skeletal maturity, followed by a weaning period Along with the brace protocol, Blount and Moe recommended a general and corrective exercise program. This study evaluated one of the corrective exercises that involves taking a deep breath while flexing the thoracic part of the spine in the Milwaukee brace. According to Blount and Moe, this exercise was designed to enhance derotation of the spine. Miyasaki found the exercise effective in reducing vertebral rotation and lateral deviation for the duration of the exercise. The long-term effect was not evaluated. While this is a low level study and the clinical

implications are limited, it does support the idea of considering the value of exercise as a potential treatment for scoliosis management.

A 1984 low level study by Lonstein and Carlson sought to investigate factors related to progression of AIS. (88) These authors were intrigued by the possibility of using such factors to obtain an accurate prognosis for the risk of progression. The rate of curve progression was correlated with various factors in 727 cases of AIS. The strongest correlations included curve magnitude, Risser sign, and patient age. These correlative factors were used to produce a formula, graph, and nomogram to be used for prognostic purposes. Only variables with high correlative values were used in developing the progression factor. This progression formula can be used with the graph to deduce the risk of progression. The nomogram allows one to input raw data to find the percentage incidence of progression.

A 1989 low level study by Carr et al. evaluated the thoracic kyphosis angles of 16 normal individuals, 10 patients with Scheuermann's disease, and 11 with AIS with standard radiographic techniques and Integrated Shape Imaging System (ISIS) scans. The ISIS system uses stereo photographic surface measurements to compute and analyze the shape of the back in 3 dimensions. A high correlation was found between the standard radiographic method and the automated ISIS method (0.88 – 0.96). The authors considered the ISIS system to be useful for measuring pre- to post-treatment changes in patients. (108) There is little other literature indicating that this procedure has been widely adopted in a clinical setting

A low level case report by Morningstar et al. focused on the reduction of scoliosis by manipulative treatment and postural reflex rehabilitation. (109) The authors noted that while spinal manipulation alone does not seem to alter scoliotic curves (74), adding motor coordinative posture skills might do so. Indeed, the 19 subjects in this case study reportedly had an average 17° reduction in their Cobb angle measurement after 4 to 6 weeks of treatment. While only tentative conclusions may be drawn from this study due to limitations in design and quality, the findings do support additional scientific scrutiny and study in this area. Pending additional corroborative research, the findings of this study are not particularly useful for clinical management at present.

Dobosiewicz et al. produced several low level papers, including 2 case series tracking the effect of asymmetric trunk mobilization on idiopathic scoliosis progression and hypokyphosis, using the Dobosiewicz method. (76, 110) It should be noted that hypokyphosis commonly associated with scoliosis in some cases results in a post-surgical iatrogenic complication known as flat-back syndrome. (3) The Dobosiewicz method employs exercises and positions that accentuate the thoracic kyphosis, causing derotation of the scoliosis. The procedure involves activation of mainly superficial chest and back muscles. Derotation and attention to treating the kyphosis were noted to provide positive findings in both case series. In order to ascertain their efficacy in a clinical setting, these techniques would require additional study of more rigorous construct and methodology.

An intriguing low level prospective case series by d'Amato et al. evaluated the effect of a night-time thoraco-lumbar-sacral orthosis (TLSO) brace on 102 adolescent girls with idiopathic scoliosis. (111) The authors opined that hyper-corrective night-time bracing might be an option for some patients, for a lesser impact on psychosocial function than a brace worn 23 hours per day. An interesting aspect of the study is that attempts were made to monitor brace pressure by use of pressure-sensitive film and CAD/CAM techniques to fabricate the orthosis. The newer bracing techniques also pay closer attention to correcting the 3-D deformity of the spine. The authors reported a 74% success rate (< 5° progression) utilizing the hyper-corrective night-time bracing and recommended it for curves > 35° having a major curve apex below T8. Additional higher level studies are warranted and would be required to confirm the routine clinical utility of this procedure.

In 2003, Rigo et al. did a low quality retrospective case analysis comparing clinical outcomes from a clinic that employed active management in the form of physical therapy and bracing, with the results of a non-intervention group from a prior study by Goldberg et al. (112) The Goldberg et al. authors noted that despite literature support for the success of conservative measures in decreasing progression of AIS, surgical frequency was not reduced. Rigo et al. maintained that the former study was flawed, in that comparison groups were not matched. (77) In the Rigo et al. study, only 5.6% of patients went on to surgery, as compared to 28.1% of the non-intervention group reported by Goldberg et al. Rigo et al. maintained that conservative care should be a considered option for patients with AIS. The clinician should note that interpretation of these limited data leaves much room for debate. Both of these studies provide thoughtful perspective, yet are insufficient to clearly answer clinical questions regarding the efficacy of conservative care.

A 1977 low level retrospective case series study by Edmonson and Morris evaluated Milwaukee brace treatment in 125 patients with idiopathic scoliosis. (113) There was a great deal of variation in adherence to the treatment programs among patients. The authors did note that progression of small and medium-sized curves (60° or less) could be routinely halted and that the best outcomes were seen in those patients who were compliant with the prescribed bracing duration and exercise programs. The authors recommended corrective surgery for larger progressive curves. Again, this low level study is of limited value in establishing clear clinical protocol, however, it does add to the minimal, but building evidence that bracing may well halt small and moderate sized curves.

A 1989 Low level case study by Chase et al. assessed the efficacy of the Boston brace on a group of 14 patients with adolescent scoliosis. (114) The Boston bracing system is a TLSO type brace that allows for placement of pads on the inner surface to create pressure at selected contact areas on the patient's torso. This small study is of interest as it used transducers to measure pad pressure with a microprocessor pressure monitor. Cobb angle measurements and interface pressure measurements were taken when the brace was first applied and on 2 addition occasions within a 6-month period. Mean values of total force exerted through the brace of 58 +/- 18 N were associated with an initial curve correction

of 37 +/- 21%. The mean force level was maintained throughout the study, although the mean curve correction at 6 months had reduced to 15 +/- 14%. The authors noted that curve correction was related to the amount of force applied and the overall flexibility of the patient. The authors further suggested that little correction was achieved unless the brace was adjusted so that the scoliosis exhibited at least 20% correction on lateral radiographs. While this information may not greatly impact clinical management of AIS, researchers might wish to give further attention to the pressure and flexibility issues highlighted in this study.

In 1997, Ferrari et al. did a low level observational study on the immediate respiratory effects on exercise of bracing in 6 females with mild idiopathic scoliosis of the thoracic spine. (115) In normal patients, there is equilibrium between muscular effort and ventilatory output of the lungs. Disruption of neuroventilatory equilibrium is termed neuroventilatory dissociation or NVD. In patient terms, NVD is experienced as inspiratory difficulty or breathlessness. The authors found bracing affected respiratory effort, NVD, and dyspnea scores during progressive exercise. However, it was concluded that the diminished exercise tolerance in these patients reflected impaired physical fitness, rather than the effect of bracing.

A low level case series by Durham et al. evaluated the effect of surface electrical stimulation on 40 adolescent patients with idiopathic scoliosis. (116) The overall failure rate reported was 15 of 30 (50%), with 10 patients dropping out of the study. The authors concluded that electrical stimulation was ineffective in preventing curve progression in patients with idiopathic scoliosis. The findings of this small flawed study are consistent with those reported in systematic reviews and guidelines.

In 1988, Hanks et al. performed a retrospective case series including 100 female patients treated for idiopathic scoliosis. (117) The study evaluated the efficacy of the Wilmington jacket (underarm TLSO), as well as clinical variables that could statistically predict success. Variables assessed included age, sex, curve location, number of vertebrae in curve, Cobb angle, maturity (Risser sign, menarche), curve flexibility, and hours in the jacket. The authors also assessed the results of part-time bracing in 25 of the patients. Overall bracing success rate was reported to be 81%, and the onset of menarche and Risser sign were found to be statistically significant prognostic variables. Post-menarchal patients did not respond well and part-time brace wearing produced positive results. With the exception of the duration brace utilization, the findings of this low level study are largely in keeping with the main body of literature as reported in systematic reviews and guidelines we have encountered. It is interesting to note that “success” or “failure” has been assessed differently across studies. In this study, success was reported as progression less than 10°. Future researchers might like to agree on such terms.

In 2001, Karol did a low level retrospective case series review to assess the effectiveness of orthotic treatment with 112 males with idiopathic scoliosis, and then compared the findings with published data on female patients. (118) Most studies have focused on female patients. Progression in this study was defined as an increase in curve magnitude of 6°, and surgical progression was defined as progression to 50° and/or arthrodesis. Progression was noted in 74% of the boys, with 46% of this group proceeding to surgery.

Data analysis indicated that curve progression was related to immature Risser status, but not to age or curve magnitude. Progression to surgery was related to immature Risser status and initial curve magnitude greater than 29°. Compliance was an issue, as only 38% of boys displayed good cooperation. The author hypothesized that these compliance issues could be related to age, as a boy's peak growth velocity occurs at a later age than girls, and therefore boys finish treatment later. Karol suggested that behavioral patterns of the older teenager might account for the subjects' lack of cooperation and compliance. Boys were also found have less curve flexibility than girls. While causality remains to be established, the findings of this paper suggest that bracing is notably less successful in boys as compared to girls.

A 2003 low level retrospective case series by Landauer et al. evaluated the outcome of Chêneau TLSO brace treatment in 62 adolescent females according to 4 levels of compliance and initial curve correction. (119) The authors developed a 5-item compliance scoring system. One point each was given for: positive subject reporting by patient and family, keeping appointments, uninterrupted treatment, dermal evidence of brace wear, and signs of wear on brace. A score of 3 or better indicated good compliance, and a score of 2 or less poor compliance. The scoring system has not been subjected to validity testing. Four groups were statistically assessed: group A (good compliance/high initial correction), group B (good compliance/low initial correction), group C (bad compliance/high initial correction), and group D (bad compliance/low initial correction). The authors found that compliant patients with high initial corrections had a final correction of 7°, compliant patients with low initial corrections maintained the curve, while poor compliance was associated with curve progression.

A low level but very interesting 2003 case series report by Maruyama et al. evaluated the effect of conservative treatment for adolescent scoliosis on 328 females from 1986 through 1999. (120) The treatments examined consisted of side shift exercises and/or hitch exercises, and bracing. Side shift exercises involve the patient shifting the trunk towards the concavity of the curve while sitting, and maintaining that position. The hitch exercise has the patient lift the heel on the convex side of the curve while extending the knee joint to contract the paravertebral muscles. The heel is then lowered while the patient maintains the contraction of the paravertebral muscles. The Milwaukee brace was worn part-time (8 hours/day) by those with a thoracic or double major curve, while the Boston brace was used for those with a thoracolumbar or lumbar curve. Of the 328 patients in the program, 20 (6.1%) went on to have surgery. The results appear to support the notion that bracing and exercises can be an effective treatment. While the study is most intriguing and had a large number of participants, the study's design does not provide conclusive evidence that can be broadly generalized to a clinical setting.

In 1983 a low level study, Rudicel and Renshaw evaluated 22 female patients with idiopathic thoracolumbar or lumbar scoliosis who were treated with a Milwaukee brace, in order to evaluate its effect on decompensation of curves. (121) Decompensation was defined as the distance between a vertical line passing through the midline of the sacrum and one passing through the mid-occiput or highest vertebra observed. The authors found

no improvement in decompensation, despite compliant brace treatment. These findings cannot be generalized to a clinical setting, given the design and size of this study.

A 2002 low level study by Nicholson et al. (122) evaluated patient compliance with spinal bracing in adolescents with AIS. Two types of data loggers were embedded in the braces of 10 female patients for a 15-month period. The data loggers took measurements of temperature at the skin/brace interface at 16-minute intervals over the period between routine follow-up assessments. Compliance was assessed by reviewing temperature variances and was found to range from 8-90%; with the average being 65%. Patients over-estimated their compliance by 150% (SD 50%). There was no significant difference between weekday and weekend compliance, but nightwear was significantly greater than daywear. While this was a small study, it does emphasize the problems with compliance and particularly the assessment of compliance. Advances in technology now provide inexpensive methods for objective assessment of compliance that should prove valuable in both researchers and clinicians settings.

A small 2003 low level study by van Rhijn et al. evaluated the outcome of 18 AIS patients to see if thoracic and double thoracic lumbar scolioses could be successfully treated with the application of a lumbar brace. (123) The authors theorized that correction of the lumbar distortion by specific better fitting bracing would result in better correction of the lumbar curve and compensatory correction of the thoracic spine. The theory was tested on a small number of patients who had insufficient initial lumbar curve correction with the application of a thoracic brace. These patients were subsequently treated with a lumbar brace. Radiographs taken of those who wore a thoracic brace showed a mean decrease of the thoracic curve of 9° (27%) and a mean decrease of the lumbar curve of 5° (16%). In the group that had subsequent lumbar bracing, the mean decrease of the thoracic curve was 7° (21%) and the mean decrease of the lumbar curve was 12° (38%). Brace treatment was successful (i.e., less than 6° of progression of the major curve) in 13 patients (70%). The lumbar brace provided better initial correction than the thoracic brace (TLSO); longer term follow-up results (1991-1996) resulted in a 70% rate, which is generally comparable to expected bracing success rates reported in other studies. While this study was small, limited by design, and not generally applicable to clinical practice, it does challenge the research world to reconsider some basic bracing principles.

In a low level study, Raso et al. evaluated 16 subjects with AIS to assess compliance and mechanical support of the Boston brace. (124) While 3-point loading is thought to be an essential component of effective bracing, there is no consensus regarding the importance of such loading to the clinical effectiveness of braces. The authors opined that that braces might be effective for reasons unrelated to the mechanical forces as we currently envision them. Sixteen subjects, 3 males and 13 females, participated in this study assessing the correlation between quantity and quality of brace wear, and treatment outcomes. Force sensors and battery-powered data loggers were attached to the patients' braces. These devices collected and recorded data and provided immediate feedback via a visual LED signal, giving the patient the opportunity to optimally adjust the brace. The results of the study indicated that target force levels set for the active pad in the braces varied by a large amount, and that the braces applied the targeted load only 25% of the prescribed

time. While this study was too small and limited in design to affect clinical recommendations notably, the findings do call attention to the need for basic research to assess these issues.

A 1995 low level study by Olafsson et al. evaluated patients with AIS to assess the long-term effect of a high axillary Boston braces with 0° lumbar profile (64 subjects) and the short-term effect when the brace design was modified to a 15° profile (60 subjects). (125) The authors found that the Boston brace was as effective with a change in brace design from 0 to 15° lordosis, and suggested that the modified brace might be more acceptable to patients, thereby increasing compliance. Although its design and findings do not allow for clinically useful generalizations, the study does give researchers another issue to investigate.

A low level study by Beausejour et al. reviewed the effect of strap tension on AIS subjects' in-brace spine curve correction. (126) The authors noted that the effect of the strap tension on curve correction had not been previously assessed and should be further investigated.

Post-surgical iatrogenic loss of the lumbar lordosis after insertion of thoracolumbar distraction instruments has been recognized in the literature. Wiggins et al. did a low level non-systematic review on the management of iatrogenic flat-back syndrome. (3) The authors reported that while distraction instrumentation provides marked improvement of the scoliosis in the frontal plane, it can also cause flattening of the lumbar lordosis and can lead to a condition termed flat-back syndrome. The condition is characterized by forward inclination of the trunk, the inability to stand erect without flexing the knees, and pain. The pain is thought to be related to fatigue arising from postural strains associated with altered spinal biomechanics. In addition to spine pain, anterior thigh pain and/or knee pain may present due to prolonged flexion of knees, as the patient attempts to achieve an elusive postural balance. Conservative treatment recommendations include exercises to increase back and hip extension. Hip flexion contracture should also be resolved if possible. The authors maintained that once a patient has become symptomatic, conservative therapies generally fail and surgical osteotomies are often necessary to re-establish the sagittal balance of the spine. There are little to no high level data regarding this condition and the procedures to address it. Additional research is warranted.

A 2002 low level study by Mamyama et al. evaluated 69 adults with idiopathic scoliosis to assess the effects of side shift exercise in skeletally mature individuals. (127) The authors reported that side shift exercise appeared to be a useful treatment option for the management of idiopathic scoliosis, even after skeletal maturity. The small number of patients involved and limitations of the study's design do not permit generalization to clinical practice.

## KYPHOSIS

Thoracic kyphosis appears to increase with age and is affected by disc and vertebral morphology. (84, 128) Thoracic body fractures and disease processes such as Scheuermann's disease can also produce an increase in the thoracic kyphosis. Halal believes that Scheuermann's juvenile kyphosis might be an autosomal dominant disorder. (129) Christensen and Hartvigsen's review of the literature revealed no strong association between sagittal spinal curves and general health or spinal pain. (59)

**High & Moderate Level/Quality Literature Summary**

A high level high quality systematic review by Christensen and Hartvigsen examined the literature regarding the relationship between sagittal spinal curves and health. (59) The authors identified and evaluated 54 relevant studies, mostly of low methodological quality. There was no strong evidence for any association between sagittal spinal curves and any health outcomes, including spinal pain. Though some low level literature of questionable quality was cited reporting evidence for associations between sagittal spinal curves and temporomandibular disorders, pelvic organ prolapse, and daily function, Christensen and Hartvigsen questioned the causality of these associations. The authors noted that additional research utilizing better methodological quality was warranted, but concluded that manipulation and therapies based on sagittal spinal curve configuration were not currently supported by the available evidence.

A mid-level moderate quality cohort study by Ettinger et al. assessed 610 women between 65 and 91 years of age and found increased kyphosis to be associated with a decreased bone mineral density and loss of height, but not with substantial chronic back pain, disability, or poor health. (58)

A 1995 moderate level, moderate quality cohort study by Wood et al. reviewed 90 subjects, 60 with no symptoms and 30 with thoracic pain. (25) The authors found Scheuermann's end-plate irregularities with kyphosis in 38% of the asymptomatic subjects. The authors concluded that identification of these types of asymptomatic radiographic anomalies does not necessarily warrant treatment in a clinical setting.

**Low level/Quality Literature Summary**

A 1988 low level prospective case evaluation study by Reid et al. evaluated 404 consecutive patients from 1983 through 1987 who suffered burst fractures of the thoracic spine. (130) The authors concluded that operative care was not necessary when all the following conditions applied: the patient was neurologically intact, kyphosis angle was less than 35°, other injuries did not preclude the use of an appropriate orthosis, and the patient was capable of understanding and cooperating with the treatment plan. While these recommendations were not based on high level research, they do represent a management trend based on emerging literature.

An interesting low level cohort study Murray et al. evaluated 67 patients diagnosed with Scheuermann's kyphosis. (131) The diagnosis was based on the 1964 Sørenson criteria of 3 adjacent wedged vertebrae with at least 5° of wedging. Subjects were re-evaluated after an average 32 years following initial diagnosis. The intent of the study was to assess and

describe the natural history of the disorder. Of 67 patients, 54 had a physical examination and radiography, 52 received pulmonary function assessment, and 45 had assessment of trunk muscle strength. Findings were then compared with the results from 34 subjects in the control group. Those with Scheuermann's kyphosis had were found to have more intense back pain, jobs that were less physically demanding, decreased strength and range of trunk, and different localization of pain. No significant differences between the groups were found for variables including level of education, work loss due to low back pain, reduction in activities of daily living due to pain, presence of lower extremity numbness, self-consciousness, self-esteem, social limitations, related use of medication, or level of recreational activities. Physical appearance was not a major concern for most subjects. Pulmonary function was normal or better in subjects with less than 100° kyphosis. Those having kyphosis greater than 100° with involvement of the upper 8 thoracic vertebra displayed evidence of restrictive lung function. Mild scolioses were also common. Although this was a low level study, the findings might have clinical significance in light of the suggestion of potential significance of deformities and dysfunction caused by Scheuermann's disease. The authors noted that although patients with Scheuermann's disease might have some associated functional limitations, they generally did not experience major problems that interfered with their lives. Additional research is warranted.

In a low level study, Singer et al. evaluated the Cobb technique assessment with a computer-aided digitizer. Thoracic kyphosis and curve apex were measured from the T3 to T11 segments. The computer method was found to be more reliable; producing a coefficient of variation of 1.4% on repeated measurement, versus 3.4% for the (unassisted) Cobb method. (132) The ability to quantitatively describe thoracolumbar curve characteristics, calculate angles between selected segments, and determine points of inflexion and maximum curvature, appears to be improved with the use of computer-aided measurement in radiographic evaluation of sagittal spinal curvature. High level studies would be needed to confirm clinical utility.

Sinaki et al. did a low level observational study in 1996 assessing the correlations among back extensor strength, thoracic kyphosis, and lumbar lordosis in 65 estrogen-deficient women. (133) Back extensor strength, bone mineral density, and physical activity scores were assessed and correlated with radiographic measurement of vertebral body ratios and the kyphosis index. Back extensor strength correlated inversely with thoracic kyphosis ($r = -0.30$, $P = 0.019$), and positively with the lumbar lordosis ($r = 0.26$, $P = 0.048$) and sacral inclination ($r = 0.34$, $P = 0.009$). Bone mineral density and physical activity scores did not show any significant correlations with radiographic findings. The authors concluded that stronger back extensors correlated with a smaller thoracic kyphosis, as well as with a larger lumbar lordosis and sacral inclination. While these findings are interesting and warrant additional scientific attention, clinical implications are limited.

A low level observational study by Kuklo et al. found that with manual radiographic measurement analysis for T2-T5 regional kyphosis in patients with AIS, intra-observer (0.22-0.83) and inter-observer (0.33-0.47) reliability were generally poor. (134) Further study by Kuklo et al. (98) found that digital measurements of regional thoracic kyphosis

(T2 to T5) demonstrated slightly better reliability (intra-observer rho = 0.22-0.65, poor to fair; inter-observer rho = 0.33-0.47, low). The authors opined that the reliability of digital measurements would be increasingly important as digital radiography becomes commonplace. Higher level studies would be needed to support clinical application.

A low level observational study by Harrison et al. evaluated the effect of anterior and posterior translation of the thoracic cage and the resulting effect on the skeletal system. (135) Full-spine radiography of 20 subjects was assessed with the thoracic cage in a neutral posture, anterior translated posture, and posterior translated posture. Notable changes in spinal curve configuration were observed, with an increase in the thoracic kyphosis occurring during posterior translation, and hypo-kyphosis of the thoracic curve during anterior translation. The authors surmised that an anterior translated position of the thoracic spine might lead to an increased risk for scoliosis development, and that posterior translation might produce loading that increases the risk of kyphosis. While the study's inherent design limitations do not allow for direct clinical application, additional consideration and research do appear warranted.

Posture:

A 1995 low quality cohort study by Refshauge et al. investigated the relationship between posture and pain in the cervicothoracic spine. (11) The cervicothoracic kyphosis angles of 18 female volunteers with cervicothoracic pain were compared with that of 18 age-matched females. The angle was created by the intersection of a line drawn through marked C4 and C7 spinouses, and one drawn though C7 and T4, on a lateral photograph. An independent sample t-test was used to compare this angle in pain and non-pain subjects. The authors found no difference between the 2 groups ($t = -0.221$; $p = 0.827$), suggesting that the size of the cervicothoracic curve in the sagittal plane during relaxed standing is not associated with the onset of pain. Clinical inferences cannot be made from the study due to design and quality limitations. (11)

A low level observational study by Greigel-Morris et al. evaluated the incidence of postural abnormalities of the thoracic, cervical, and shoulder regions in 2 age-groups of healthy subjects to assess whether these abnormalities were associated with pain. (61) Eighty-eight healthy subjects, aged 20 to 50 years, completed a pain questionnaire and were subsequently assessed with a plumb line for postural anomalies, including forward head, rounded shoulders, and kyphosis. Subjects were divided into 2 age-groups: 20-35 and 36-50. No statistically significant relationship was found between the severity of postural abnormality and the severity and frequency of pain; however, an increased incidence of pain was noted in a cluster of patients with the most severe postural abnormalities. Again, clinical application is limited by the study design, but the findings do reflect data trends and might help direct future research.

Lou et al. did a low level small case study evaluating a biofeedback mechanism to help skeletally immature patients with an increased kyphosis maintain a corrected posture. (136) Subjects were alerted by a pager-type vibrator when their posture was sub-optimal. The short trial indicated that subjects did improve their posture when the feedback signals

were provided. The clinical implications of this study are limited due to study type and quality, however further research would seem warranted.

In a low level study, Goh et al. compared the Cobb technique for measuring kyphosis with an alternative Cobb method and a computer-assisted curve assessment technique. (81) The results indicated that the traditional Cobb method tended to overestimate kyphosis in the presence of vertebral body end-plate deformation. The degree of kyphosis was strongly related to the extent of vertebral body deformity and, to a lesser extent, the shape of the discs. The authors concluded that the study findings supported computer-assisted techniques for assessing thoracic kyphosis.

A low level study by Sach et al., conducted from 1960 through 1978, evaluated 120 patients diagnosed with Scheuermann's kyphosis who had used the Milwaukee brace to assess the long-term results. (137) Patients were followed for a minimum of 5 years after the completion of bracing therapy. The study findings led the authors to conclude that bracing is an effective method of treatment for patients who have Scheuermann's. However, study design and quality might limit the clinical utility of the findings.

In an interesting low level observational study, Heithhoff et al. reviewed 1522 CT scans and 1419 MRI scans of patients suffering low back pain, with the intention of documenting an association of degenerative lumbar disc disease with thoracolumbar Scheuermann's disease. (138) Classic Scheuermann's disease is defined as fixed kyphosis with greater than 5° wedging of 3 or more adjacent vertebra. A second type of lower Scheuermann's disease has been described in the thoracolumbar region; distinguished from the classical form by its location, with lack of kyphotic deformity and associated vertebral body wedging. In their review of MRI scans, the authors found 9% to have evidence of thoracolumbar Scheuermann's disease and lumbar degenerative disc disease; 74% of these were male and 26% female. In terms of age, 48% were younger than 30 and 10 % were under 21 years of age. In the review of CT examinations, 2% were found to have thoracolumbar Scheuermann's disease and degenerative lumbar disc disease. The authors hypothesized that both the thoracolumbar Scheuermann's disease and associated lumbar degenerative disc disease are the result of an intrinsic defect of the disc and/or vertebral end-plate. They assessed disc changes as the primary manifestation of the disease, and proposed the term "juvenile discogenic disease" as a more appropriate description of the condition.

Kyphosis and Burst Fractures:

A 2001 mid-level moderate quality study by Shen et al. compared the results of non-operative and operative treatment of burst fractures in 80 neurologically intact patients. (139) The operative group received short segment pedicle screws, while the non-operative group received an anterior hyperextension brace. The operative group had better initial kyphotic correction than the non-operative group, but the advantage was gradually lost. Similar outcomes were seen in both groups after a 2-year period. The degree of kyphosis did not correlate with clinical results in either cohort. A 1999 lower level study by Shen et al. reviewed the outcome of 3-column thoracic burst fractures in

patients without neurological deficits. The authors found that non-operative treatment of burst fractures without facet dislocation or pedicle fracture led to good functional recovery.(140) There appears to be a clinical trend towards non-surgical management of burst fractures in neurologically intact patients. The clinical contribution of chiropractic care has yet to be identified or defined in these types of injuries; however, it would be reasonable to consider the restoration of spinal range of motion in a multi-disciplinary setting to be a positive goal and worthy of future research.

A low level, but well done, retrospective case series by Mumford et al. evaluated the outcome of non-surgical management of 41 patients with thoracolumbar burst fractures. (141) The authors also examined the post-traumatic remodeling of the bony canal by serial CT. Although spinal canal compromise averaged 37%, there were no neurologic deficits, and none of the patients experienced progressive canal occlusion. Canal occlusion actually improved by 22% and the mid-sagittal diameter of the canal increased by 11%. On average, bony remodeling was complete within 1 year. At 2 years, 49% of the patients had excellent outcomes regarding pain and function; 17%, good; 22%, fair; and 12%, poor. Satisfaction with work status was reported by 90% of the patients. The authors concluded: 1) non-operative management yielded acceptable results; 2) following nonoperative management, bony deformity (i.e., kyphosis and body collapse) progressed marginally relative to the rate of canal area remodeling; 3) incidence of neurologic deficits was quite low; and 4) initial radiographic severity of injury or residual deformity following closed management did not correlate with symptoms at follow-up. This pattern of results suggests non-operative management as the preferred treatment in these circumstances, but higher quality research is needed.

A low level observational study by Karjalainen et al. evaluated the effect of extension bracing on 126 patients with stable fractures of the thoracic and lumbar spine. (55) The mean follow-up time was 7.2 years. A poorer outcome was seen in those patients with greater initial anterior wall compression and kyphosis. The kyphotic deformity did worsen with time. Use of an extension brace decreased subjective symptoms during the mobilization phase, but did not prevent the development of kyphotic deformity. The authors noted that fractures occurred most often at the thoracolumbar junction. While the study design limits the conclusions that can be drawn, there appears to be some support that kyphotic deformity is a likely consequence of thoracolumbar fractures.

A 1993 low level case series study by Cantor et al. followed 18 neurologically intact patients with burst fractures at the thoracolumbar junction who were treated conservatively with early ambulation and a total contact orthosis. (52) Patients with posterior column disruption were excluded. No deterioration of neurologic function developed in any patient. Follow-up computed tomography (CT) scans obtained in 8 patients showed significant resorbtion of retro-pulsed bone. At follow-up, 15 patients rated their pain as “little” or “none”, and 17 patients reported little or no restriction of activity. The authors concluded that early mobilization in a total contact orthosis (TLSO) could lead to satisfactory functional results, and that prolonged bed rest would not be required. This limited but interesting study falls in line with low level literature

supporting conservative care methods for burst fractures in patients without evidence of neurologic compromise or posterior column damage.

In 1996 Chow et al. did a small low level retrospective case series study reviewing the effect of bracing/casting and early ambulation on neurologically intact patients with unstable thoracolumbar burst fractures. (54) Follow-up examinations and questionnaires were given to 24 patients after a mean of 34.3 months of recovery. The authors found that initial kyphotic deformity could be corrected with hyperextension casting, but the kyphosis tended to recur during the course of mobilization and healing. There was no correlation found between degree of kyphosis and clinical outcome. The authors did not believe that ligamentous injury of the posterior column was a contraindication to nonoperative management of thoracolumbar burst fractures. The study is limited by design; however, it does appear to be consistent with a larger body of literature suggesting that burst fractures, including unstable ones, are manageable with conservative methods. The chiropractic physician's role in any such management is yet undefined.

An interesting low level case series by Bradford et al. evaluated surgical outcomes in 22 patients treated for advanced deformity associated with Scheuermann's kyphosis. (142) In 21 patients, the surgical procedures included placement of Harrington rods to reduce the kyphosis. The authors found that pre-surgical pulmonary function was not compromised in the vast majority of the patients. The incidence of post-surgical complications was high. Because of the high rate of complications associated with the surgical procedure, the authors recommended that it be reserved for patients with severe, incapacitating back pain that is not relieved by conservative care. Chiropractic manipulation and postural management could seem reasonable as conservative care options; however, there is no quality literature assessing the effect of these treatments with Scheuermann's kyphosis. Additionally, the interpretation of the outcomes in this study is limited due to the study design.

**Clinical Questions / Graded Practice Options**

***1. Are the Italian scoliosis Guidelines suitable for use in clinical practice?***

> **Grade B** Yes - The Italian scoliosis Guidelines are of high quality and evaluate literature of sufficient quality (2++) to warrant their utilization in clinical practice.

**Key Point Summary:** The CCGPP Thoracic team found the Italian scoliosis Guidelines to be well-constructed and suitable for clinical application.

***2. Are sagittal spinal curve configurations a notable health concern?***

> **GRADE B** No - There is high quality literature reviewing mid-level data (2++) indicating that sagittal spinal curve configurations are not currently a notable health concern.

**Key Point Summary:** The best evidence currently available indicates that clinicians should downplay the significance of sagittal spinal curves configurations and, pending additional higher quality evidence, assure patients that sagittal spinal curves do not appear to be associated with health or pain.

***3. Is manipulation/manual mobilization an effective treatment option for AIS scoliosis?***

> **Grade B** No - There is no strong evidence that manipulation/manual mobilization is an effective primary treatment for AIS.

**Key Point Summary:** The literature does not support the use of manipulation as an effective primary treatment for AIS. Chiropractic physicians might still monitor, manage, or co-manage AIS using other more effective strategies. Manipulation/manual mobilization might be warranted to increase flexibility prior to brace treatment. Additional research is warranted.

***4. Is bracing an effective treatment option for AIS?***

> **Grade B** Yes - There is literature of sufficient quality (2++) indicating that bracing may reduce, halt, or reverse the progression of scoliotic curves associated with AIS.

**Key Point Summary:** Newer bracing strategies are being developed that may provide an effective treatment for AIS.

***5. Are electrical muscle stimulation (EMS) strategies an effective treatment for AIS?***

> **Grade B** No - There is literature (2++) indicating that EMS is ineffective as a treatment for AIS.

**Key Point Summary:** There is a body of evidence indicating that EMS is not a suitable treatment option for AIS.

***6. Is digital assessment of radiographs an effective diagnostic tool for scoliosis assessment?***

> **Grade C** Yes - There is evidence (2+) to support the utilization of digitized assessment methods for standard radiographic evaluation and proxy torsion assessment of scoliosis.

**Key Point Summary:** Literature trends indicate that digitization may be a valuable tool for scoliosis curve assessment.

***7. Is there an optimum patient position for scoliometer assessment?***

**Grade D (I)** Yes - There is limited evidence (2+) to support the use of a scoliometer for AIS in the seated forward bending position.

**Key Point Summary:** Examination of patients with a scoliometer in the seated forward bending position may increase the test's accuracy.

***8. Should adults be monitored for curves progression and/or biomechanical dysfunction?***

**Grade D (I)** Yes - There is limited evidence (2+) that clinical symptoms may be associated with radiographic findings in adult patients with scoliosis.

**Key Point Summary:** Problems associated with scoliosis are not limited to the immature spine.

## THORACIC OUTLET SYNDROME

### General Information:

Thoracic outlet syndrome (TOS) is often used to describe diffuse arm and hand symptoms that are attributed to what is thought to be brachial plexus and vascular compression. Static work postures and trauma, especially whiplash injury, are thought to be predisposing factors. Although the mixed nerve involvement of TOS is thought to cause mixed nerve distribution of symptoms, an ulnar nerve distribution is commonly reported in the literature. Methods of diagnosing and treating TOS have been debated for decades. Some clinicians believe the diagnosis requires objective confirmation with electromyography (EMG), nerve conduction velocity testing (NCV), and/or Doppler studies that correlate with the orthopedic findings. Other clinicians rely on the history, clinical findings, and associated tests to make the diagnosis. Although not widely used and lacking validity assessment, Ribbe et al. developed an outlet syndrome index. (143) A diagnosis of TOS is entertained when 3 of 4 criteria are met; those being aggravation of symptoms with elevation of arm(s), C8/T1 dermatome paresthesias, tenderness over the brachial plexus, and a positive Roo's test. Many, if not most, TOS patients experience only subjective symptoms without definitive objective findings. There is general consensus that TOS is caused by compression of the neurovascular bundle in the upper thoracic region. Entrapment of the neurovascular bundle is thought to occur at different locations along the neurovascular tunnel, and the condition is commonly typed by the location of this entrapment. Scalenus anticus syndrome, costoclavicular syndrome, and pectoralis minor syndrome describe the 3 primary anatomical regions commonly used to type thoracic outlet syndromes. Cervical ribs, enlarged transverse processes, fibrous bands, Sibson fascia, subluxated ribs, and other occlusions to the thoracic outlet have also been described. Case studies also have reported osteoarthritis of the first rib as a cause of TOS. Subtypes of TOS include arterial, venous, neurological, and myofascial/unspecific. Associated orthopedic tests that are commonly employed include Adson's, Wright's, Roo's, Cyriax Release, and costoclavicular compression. There is no gold standard diagnostic test for TOS, although Roo's test is commonly used to establish a diagnosis.

Conservative management is recommended initially; especially isometric scalene exercises. The success rate of surgical rib resection is debated. Clinical recommendations are limited by the lack of high quality literature on the topic, although lower level literature can provide insight as to potential diagnostic and management options. (12, 62, 144-165)

### High & Moderate Level/Quality Literature Summary

In a moderate quality mid-level 2001 study, Gillard et al. prospectively evaluated provocative tests, including Doppler ultrasonography, electrophysiology, and helical computed tomography in 48 patients, to assess their clinical usefulness in the diagnosis of TOS. (166) The authors found provocative tests to have mean sensitivity and specificity values of 72% and 53% respectively. (See details in Table 8.) Interestingly, only the Adson and hyperabduction pulse tests were significantly correlated with the final TOS diagnosis ($P < 0.05$). The authors noted that there was no gold standard available to evaluate true/false negative/positives, thus making the sensitivity/specificity values reported in the study of dubious value. All paired provocative tests that included the Adson test significantly correlated with the final TOS diagnosis ($P < 0.001$). The Wright test combined with the Roo's or Hyperabduction with symptoms tests also correlated significantly ($P < 0.05$). Combining 3, 4, or 5 tests increased specificity, but not sensitivity. The sensitivity of Doppler ultrasonography was 87%, and specificity was 88%. For helical CT angiography, arterial findings, but not venous findings, correlated significantly with the final TOS diagnosis ($P< 0.001$), with 68% sensitivity and 90% specificity. The Adson test presented as the most effective test, especially when combined with Roo's, Hyperabduction test with symptoms, or Wright test with pulse abolition. These findings are inconsistent with some previous expert opinions. The Doppler ultrasound was thought by the authors to be ineffective as a screening tool, and electrophysiological testing was considered limited to the elimination of alternative diagnoses. The helical 3-D CT angiography was useful in detecting arterial and venous lesions, but its role in TOS diagnosis was noted as undefined. This is a relatively well done study; its limitations are mainly due to the subjective nature of TOS and difficulty with objective quantification. The final diagnosis was established by balancing the evidence and excluding all other causes based on all available data. Diagnoses are often generated in this manner in clinical practice and the findings may well have clinical significance. Additional research is warranted.

**TABLE 8. From Gillard et al. study (166)**

| Provocative tests | Sensitivity | Specificity |
|---|---|---|
| Adson ($P < 0.05$) | 79% | 76% |
| Hyperabduction (pulse abolition) ($P < 0.05$) | 52% | 90% |
| Hyperabduction (symptom reproduction) | 84% | 40% |
| Wright (pulse abolition) | 70% | 53% |
| Wright (symptom reproduction) | 90% | 29% |
| Roo's | 84% | 30% |
| Tinel | 46% | 56% |

In 2004 Brismee et al. did a mid-level moderate quality observational study to evaluate the rate of false positive findings associated with the Cyriax Release test for TOS. (12)

The Cyriax Release test is thought to release the tension or compressive forces on the brachial plexus by lifting the shoulder girdle. Cyriax thought that paresthesia and numbness appeared when the brachial plexus was first compressed, and that normal sensation soon returned, subsequently releasing the pressure caused latent symptoms to recur. The procedure is performed by elevating the patient's shoulders for up to 3 minutes. A return of arm/hand symptoms represents a positive test. The Brismee et al. study involved 119 subjects who were subjected to a modified Cyriax Release test with various durations. Chi-square analysis of frequency of a positive test condition reported on a questionnaire showed neck pain as the only statistically significant variable ($P< 0.001$). The authors found the Cyriax Release test to have a high specificity at 1 minute (97.4%) and 3 minutes (87.8%), and assessed the test as suitable for clinical use in diagnosing TOS. Additional studies of higher quality would be helpful to confirm these findings.

In 1992, Lindgren et al. did a mid-level moderate quality study to test the reproducibility of the cervical rotation lateral flexion test (CRLF test) that has been developed to detect restricted movement of the first rib in patients with brachialgia and thoracic outlet syndrome (TOS) symptoms. (154) Twenty-three patients were independently assessed both before and after treatment by 2 clinicians, in order to analyze inter-observer reliability. The test results were compared to cineradiographic examinations that were also performed to detect any first rib mobility restriction during expiration and inspiration. Inter-observer repeatability of the test was excellent, with a reliability Kappa (K) coefficient of 1.0. The cineradiographic findings also correlated well with exam findings, with a Kappa coefficient of .84. The authors concluded that the reliability of the CRLF test makes cineradiographic examination unnecessary, and recommended that CRLF test be included in the clinical examination of patients with brachialgia, with or without radicular pain. While this work is most intriguing, the study size was small and the methodology was not well defined. Additionally, despite a small study by Lindgren et al. showing a correlation between loss of rib mobility and TOS symptoms, there is currently no gold standard for measuring first rib movement. (151, 152) Additional study would be needed to confirm the CRLF test's validity and clinical utility.

**Low level/Quality Literature Summary**

In 1993, Lindgren did an interesting but low level non-systematic review of the literature on TOS, with special attention to first rib involvement. (146) Despite the non-systematic nature of this review, it does provide a good overview of the topic, especially from a skeletal perspective. Lindgren reported that the first thoracic rib has been implicated in TOS and possibly results in irritation to the stellate ganglia. Lindgren noted that the literature suggests that surgical removal of the first rib has provided many patients with initial relief, but long-term complications, including brachial plexus lesions, infection, hemorrhage, and others, have been documented. He reported finding no randomized studies comparing conservative versus surgical care. This is consistent with our findings to date. The author opined that the upper thoracic aperture should be thoroughly examined, and that scalene activation exercises and conservative care should be the first line of treatment for TOS. Chiropractic care would seem to fit into a conservative care

program. Again, this was a non-systematic review; further studies of higher quality are needed to better define the lesion, its etiology, and best treatment.

In 1997, Lindgren did a low level 2-year follow-up case series study on 119 patients who had undergone a conservative therapy program consisting primarily of home exercises. (149) The exercises employed were designed to mobilize the first rib and restore the upper thoracic aperture. Examples included rolling the shoulders while flexing and extending the upper thoracic spine, stretching the neck into a military posture while holding the shoulders and head against a wall, isometric activation of the anterior, middle, and posterior scalene muscles, and stretching of anterior cervical muscles. Lindgren reported that 88% of the patients were satisfied with their treatment outcome. Findings from a low level 2-year follow up retrospective analysis study by Lindgren et al. in which 175 TOS patient received surgical treatment, showed 59% of outcomes to be considered successful, and 41% failures. (157) The results of both studies prompted the authors to recommend conservative exercise therapy for treatment of TOS, with surgical consideration only as a last resort. Additional higher level studies are warranted to further explore and evaluate the clinical application of the findings of these lower level studies.

In a small low level observational study done in 1997, BenEliyahu et al. evaluated the use of duplex ultrasonography and evoked potentials with 18 females in diagnosing and managing TOS. (145) The patients, all of whom had signs and symptoms consistent with TOS, were tested with stress color-coded duplex ultrasonography (CCDS) and somatosensory evoked potential testing (SSEP). The authors found stress CCDS and SSEP to be highly sensitive (94%) and reasonably specific (80%) for TOS. These findings were similar to those reported Longley et al., who found Doppler sonography to be 92% sensitive and 95% specific for the diagnosis of TOS, (167) but conflicted with reports by others. (146) BenEliyahu et al. opined that TOS is generally a non-specific variant; a combination of functional and myofascial disturbances due to first rib dysfunction and myofascitis of the scalenes and/or pectoralis. These data support the necessity for more robust studies on the topic.

An interesting low level case series by Weinberg et al. evaluated 362 patients with TOS-like symptoms and identified 40 who appeared on radiographic examination to have arthritis of the first costovertebral joint. (144) Injections of 10 ml of 0.5% lignocaine hydrochloride were administered, and if relief ensued, a second injection of 10 ml of 0.5% lignocaine hydrochloride with 2 ml of hydrocortisone was performed. Complete symptomatic relief occurred in 25 (62%) of the 40 patients; 10 patients reported marked improvement, 4 had partial relief, and 1 did not respond to the treatment. Based on these findings, the authors concluded that inflammatory arthritis of the first costovertebral joint might cause TOS-like symptoms. The conclusions that can be drawn are limited due to study size and design; however, this case series does raise questions for research and clinical consideration regarding the potential involvement of arthritis in TOS.

In a low level paper, Lindgren et al. reported a case series of 22 patients with both (TOS) and reflex sympathetic dystrophy (RSD - currently referred to as complex regional pain syndrome or CRPS). (151) A simple test was used to evaluate first rib mobility; in each case there was a hypomobile first rib on the painful side. After isometric exercises of the

scalene muscles, mobility of the first rib was restored, and the symptoms completely relieved in 13 patients. The authors concluded that subluxation of the first rib might irritate the neural network and the stellate ganglion in the region of the first costotransverse joint. This, in turn, could cause the radiating pain and RSD symptoms. The clinical conclusions that can be drawn are severely limited, as this was only a basic case series; however, the osseous relationship with neural dysfunction is of obvious interest to the chiropractor. There have been other low level case reports of CRPS being successfully treated with manipulation; (168) however, higher quality studies are needed, and the role of manipulative therapy as a management option has yet to be defined.

A low level case series by Novak et al. evaluated the effect of conservative therapy on 42 patients with TOS. (169) The conservative therapy generally consisted of patient education regarding posture, and stretching and strengthening exercises. Physiotherapy modalities were used as well. Twenty-five of the patients improved, 10 were unchanged, and 7 worsened. The authors found that poor outcome was related to obesity ($P < .04$), workers' compensation ($P < .04$), and associated carpal or cubital tunnel syndrome ($P < .04$). Improvement in hand and arm pain was significantly greater in those without concomitant distal nerve compression ($P < .006$). While this was only a case series, it does raise the issues of differential diagnosis and co-morbidities for clinical consideration.

**Clinical Questions / Graded Practice Options**

***1. Are orthopedic tests helpful in the diagnosis of thoracic outlet syndrome (TOS)?***

**Graded Options**:

> **i. Grade D (I)** Yes - There is limited literature (2+) indicating that Adson's and hyperabduction pulse tests correlate with a TOS diagnosis. Paired provocative tests that include the Adson test also correlate with the TOS diagnosis. Wright's test combined with the Roo's or Hyperabduction with symptoms tests also correlate significantly.
>
> **ii. Grade D (I)** Yes - There is limited literature (2+) indicating that the Cyriax Release test correlates with a diagnosis of TOS.
>
> **iii. Grade D (I)** Yes - There is limited literature (2+) indicating that the cervical rotation lateral flexion test (CRLF test) correlates with a diagnosis of TOS.

**Key Point Summary:** There is no gold standard-available to evaluate TOS true/false negative/positives. This makes the sensitivity/specificity values reported in these studies of dubious clinical value. Doing more than 1 test (stacking) may increase diagnostic accuracy.

## DISC DISEASE/NERVE ROOT LESIONS

The lack of high quality literature regarding the thoracic spine limits our evidence base about disc disease and nerve root lesions. Some available studies indicate that herniated thoracic discs are thought to be both fairly common and often asymptomatic. Cadaver and MRI studies have reported incidental frequencies with wide variation (7-37%). Symptomatic thoracic herniations are thought to be rare (< 1%). (24, 25, 45, 51, 170)

**High & Moderate Level/Quality Literature Summary**

In a mid-level moderate quality study, Wood et al. evaluated the thoracic spines of 90 asymptomatic people with MRI. (25) The authors found that 73% had evidence of disc degeneration and/or annular disruption, 53% had at least 1 bulging disc, 58% had at least 1 annular tear, 37% had at least 1 herniated disc, and the spinal cord was deformed by disc protrusion in 29% of the subjects (81% of which were in men. P = 0.005). The authors reported that the prevalence of herniated thoracic discs with associated neurological deficits has been estimated to be 1 per million, and that MRI identification of thoracic herniated discs is so common as to be considered a normal variant. The similar distribution and prevalence of abnormal disc findings on MRI in both symptomatic and asymptomatic populations make clinical management difficult, as it is currently not possible to predict whether an asymptomatic herniated disc will be problematic in the future.

In a mid-level moderate quality study, Wood et al. also assessed the correlation between discography and MRI findings in 10 asymptomatic subjects. (45) The authors found discography to be pain-provoking in cases with occult annular damage, and remarkably so with Schmorl's nodes. Many of the anomalies did not show on initial MRI studies, as the high intensity signal commonly seen with lumbar disc derangement did not routinely serve as a reliable marker in the thoracic spine. The authors opined that discography might assist in the identification of thoracic disc derangement.

**Low level/Quality Literature Summary**

A low level non-systematic review by Dietze et al. reported that thoracic herniations commonly occur in the 4th through 6th decade and typically present as localized thoracic back pain with progressive sensory involvement. (51) Most herniations (70%-90%) are central or centrolateral. Radicular pain may or may not present. Varied symptoms and conditions can develop, depending on the level of herniation, and can include sclerotomal pain, nerve root pathology, and/or myelopathy. Clinical presentations can include Horner's, Brown-Sequard, or conus medularis-like syndromes, as well as various long tract signs, and bladder/bowel dysfunction. The varied presentations can create a diagnostic challenge and multiple diagnoses to differentiate. The ligamentum flavum and/or discal material often ossify, creating a hard disc. A hard disc or soft disc protrusion with associated myelopathy warrants surgical consideration. The authors recommended conservative management consisting of relative rest, analgesics, and therapy for neurologically intact patients. While this work is not a systematic review, it does highlight the diagnostic challenge presented by thoracic herniations.

A low level observational study by Awwad et al. retrospectively reviewed 433 cases and associated myelograms in an attempt to define the frequency of asymptomatic thoracic herniated discs. (170) The authors were unable to identify any imaging feature that differentiated a symptomatic from an asymptomatic disc. They found that even large herniations with cord deformity were often asymptomatic. The authors concluded that surgical management is not warranted for asymptomatic thoracic disc herniations.

A low level descriptive observational study by Videman et al. investigated MRI findings of the lower thoracic and lumbar spine in 232 adult men. (171) They found that disc height loss and bulging were most common in the lower thoracic and lumbar spine. Osteophytes were commonly associated with disc bulging, especially at the T6 through L3 levels. The lower part of the thoracic spine showed more disc height narrowing than did the upper region. The frequency of disc space narrowing and bulging increased with age. Age-related loss of signal intensity was noted in the 35-69 age range, while endplate irregularities and disc herniations were not.

A low level observational study by Goh et al. retrospectively reviewed 169 thoracic MR images to assess the influence of age and gender on vertebral body shape and disc degeneration. (84) The authors found that nuclear and annular degeneration were more common with advancing age, especially in the mid- and lower thoracic discs. Male spines were found to suffer more degenerative changes than female spines.

In a low level observational study, Heithhoff et al. reviewed imaging studies for evidence of an association of degenerative lumbar disc disease in patients with thoracolumbar Scheuermann's disease. (138) The authors theorized that early degeneration in patients with Scheuermann’s disease results from an intrinsic defect of the discs and/or cartilaginous end plates, with associated inadequate disc nutrition, structural weakness, or perhaps a combination of both.) Additional high quality research would be needed to support this hypothesis.

Numerous studies involving thoracic disc herniations have included descriptions of varied symptoms. (64, 172-182) This would be expected, given that herniated material may compress nerve root, cord, or pain sensitive structures, alone or in any combination. Canal stenosis with central and/or peripheral neurological damage can complicate the clinical picture. Horner’s syndrome, with associated miosis and ptosis of the eye, can result from disc compression of the anterior T1 nerve root. Other symptoms presented in case studies include pain, incontinence, spastic paraparesis, hypesthesia, leg weakness and numbness, and gait disturbances. Symptoms can vary widely and can mimic a cord tumor, Brown-Sequard syndrome, and conus medullaris syndrome. Disc compression with radicular pain has been reported to mimic cardiac, gallbladder, or other visceral pain or conditions; thereby presenting the clinician with a notable diagnostic challenge.

**Clinical Questions / Graded Practice Options**

***1. Is discography an effective diagnostic tool for routine clinical use?***

**Grade D (I)** Equivocal/No - There is insufficient evidence to support the routine use of discography as a diagnostic tool.

**Key Point Summary:** There are data indicating that asymptomatic disc and spinal deformities are common. Discography may be able to identify these types of occult disc lesions. The identification of an asymptomatic lesion is of questionable value.

## REFERRED PAIN AND SPECIAL CONDITIONS

GENERAL COMMENTS ON REFERRED PAIN

There are little high quality data specific to chiropractic issues regarding the topics discussed below. A summary of the lower level data is warranted, as these situations/conditions are commonly or potentially encountered in a clinical setting.

Referred pain to and from the thoracic spine and back can be generated by multiple sources. Pain patterns include radicular, visceral referred, and sclerotomal. Because referred patterns can vary and overlap, identification of a pain generator can be a difficult diagnostic task. Thoracic disc herniations have been reported to refer pain to the shoulder. (183) Upper thoracic disc degeneration (T2-3) has reportedly correlated with cervical referred pain. (184) Friction of a lower rib against the iliac crest may be the cause of pain radiating to the lower chest margin, as well as in the low back, hip, thigh, and groin. (185) Studies have documented that cervical facet pain can refer to the thoracic spine. (186, 187) Posterior thoracic pain of cervical origin (cervicogenic dorsalgia) relieved by cervical manipulation has also been reported. (188) Other named referred pain patterns or syndromes have been reported, some which will be addressed below.

### *Musculoskeletal Referred Pain*

**High & Moderate Level/Quality Literature Summary**

A high quality randomized controlled trial by Cleland et al. evaluated the immediate effect of thoracic manipulation on mechanical neck pain. (28) The findings of this study suggested that thoracic manipulation could result in dramatic and immediate relief for patients suffering neck pain.

Allison et al. did a moderate quality small randomized controlled trial that found direct and indirect forms of manual therapy, including cervical and thoracic mobilization, to produce significant improvement in upper quadrant pain and disability. (32)

**Low level/Quality Literature Summary:**

A 1967 low level observational study by Hockaday et al. expanded on earlier work by Kellgren and others in investigating the topic of referred pain. (189, 190) Kellgren's early work showed that injections of hypertonic saline solution into muscle, fascia, ligament,

and periosteal tissues resulted in deep referred pain following a spinal segmental pattern, allowing for the later development of generalized sclerotomal pain charts. Hockaday et al. injected the interspinous ligament of 28 healthy volunteers with 6% saline solution. Initially, injections generated sharp, stinging local pain, lasting just a few minutes. Within 30 seconds, an aching, diffuse referred pain developed; reaching maximum intensity within 2 minutes and usually persisting for 5 to 10 minutes. After 5 or more minutes, distal hyperalgesia was generally noted by the subjects. Muscle spasm, reddening of the skin, and subjective warmth were also reported. The authors observed that while referred pain generally followed a common pattern, there were some differences in patterns unique to each individual. The authors opined that sclerotomal maps might have some validity on an individual basis, but that the concept of a more generalized fixed sclerotomal map was unsupported by the research.

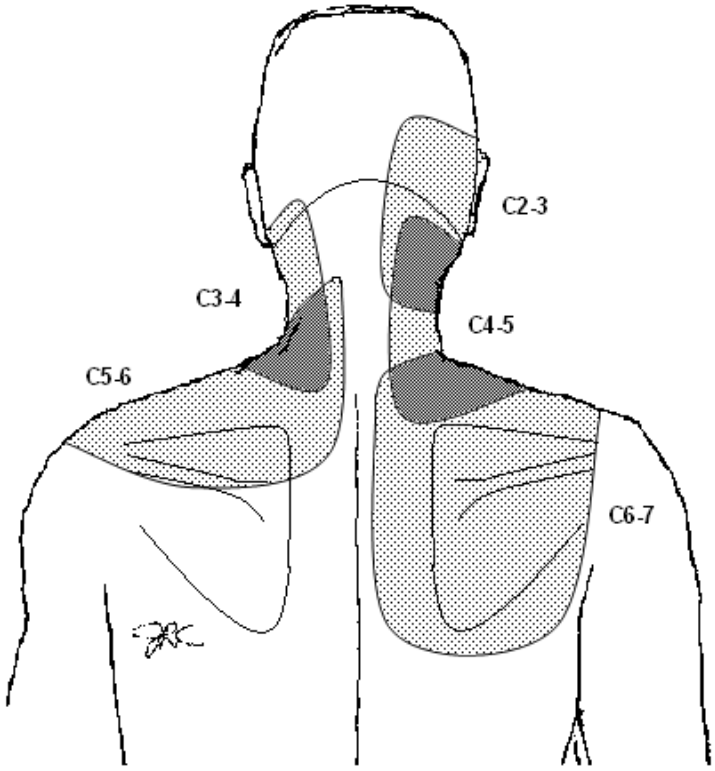
In a low level study done in1994, Dreyfuss et al. studied pain patterns generated in 9 asymptomatic subjects by injecting contrast media into, and thereby distending, the capsule of various thoracic zygapophyseal joints (T3 - T11). (191) Subjects described the pain as a deep, dull ache, and in some cases nauseating and boring in nature. Some reported a cramp-like feeling or sensation similar to delayed muscle soreness. None of the joints injected referred pain superiorly more than half the height of the vertebral segment. All the injected joints referred pain inferiorly and unilaterally, with none of the referred pain at or crossing the midline. The maximum distance of the inferiorly referred pain was reported to be 2.5 segments. The authors noted considerable overlap of referred pain distribution and concluded that a joint can generate both local and referred pain.

A 1996 low level study by Fukui et al. examined the distribution of referred pain from zygapophyseal joints of the cervical spine. (192) Subjects consisted of 61 patients with pain of suspected zygapophyseal origin that was reproducible by either injection of contrast medium into the joint or electrical stimulation of the dorsal rami. Provocation of the C3/4 through C7/T1 zygapophyseal joints and C4 though C7 rami produced upper thoracic pain. This evidence would suggest that neck, shoulder, and thoracic pain can be generated from cervical zygapophyseal injury or dysfunction, and that clinical examination of the cervical spine might be warranted in the presence of such symptoms. Higher level studies are needed to confirm these findings.

Fukui et al. produced a low level observational study in 1997 involving 15 patients, where thoracic zygapophyseal joint pain was further provoked by distending the joint capsule with an injection of contrast medium. (193) The exacerbated pain patterns were similar to those noted by Dreyfuss et al. (191) in 1994. The authors concluded that referral patterns were not consistent enough to be of notable diagnostic value in a clinical setting.

In 1990, Dwyer et al. did an interesting low level study evaluating the effect of cervical capsular distention of the zygapophyseal joints with contrast medium and subsequent anesthetic. (187) When stimulated, the C3-C4 through C6 – C7 joints where found to refer pain to the upper thoracic and scapular region. After the pain was relieved with a nerve block, hypesthesia was experienced in the same region. The authors surmised that

upper limb referral would be likely with additional provocation of the tissues. This information further supports the notion that thoracic pain can originate from the cervical spine. A follow-up study by Aprill et al. tested the predictive value of segmental pain charts for 10 patients with symptomatic cervical zygapophyseal joints. In 9 out of 10 patients, there was complete concordance between the predicted joint level and positive response to a nerve block. Findings were noted to support the use of pain charts for segmental location of symptomatic zygapophyseal joints.




Adapted from Dwyer A, Aprill C, Bogduk N. Cervical zygapophyseal joint pain patterns. I: A study in normal volunteers. Spine 1990;15(6):453-7.

**Figure 3.**

In 2002, Terrett and Terrett presented a case series and review of referred pain to the thoracic spine from the cervical posterior rami. (188) This low level but interesting paper further explored the issue of thoracic referred pain from the cervical spine. The authors noted that experts have found no simple explanation for the painful projection of pain into the interscapular area, but proposed that the pattern is produced by the cervical posterior rami referring pain to the related sclerotome and myotome, thus creating the thoracic referred pain, spasm, and tenderness. The authors also proposed a provocative test in which the head is rotated toward the side of the thoracic pain, initially without extension, and subsequently with extension if the first maneuver does not produce pain. The authors surmised that in cases of cervicogenic dorsalgia, pain is produced only with rotation plus extension. Manipulation to the mid- to lower cervical spine for this condition can reportedly restore full pain-free range of motion. Additional higher level

research would be needed to further investigate and assess the clinical utility of these intriguing findings.

A low level observational study by Norlander et al. evaluated the correlation of cervical thoracic spine mobility and musculoskeletal signs and symptoms. (194) The authors found that reduced or inverse segmental flexion mobility, as measured by the cervical-thoracic ratio technique, correlated with neck-shoulder pain and hand weakness. While quite intriguing, correlation does not equal causation, so additional higher quality studies would be needed before clinical recommendations can be made.

A low level paper by Lyu et al. documented unusual cases of thoracic disc herniation that appeared to mimic acute lumbar disc disease. (178) While this is only a low level paper, it does highlight the need for clinicians to consider the possibility of referred pain from other sites.

**Clinical Questions / Graded Practice Options**

***1. Is manipulative therapy an effective treatment for musculoskeletal referred pain to the neck and/or upper quadrant?***

> **Grade A** Yes - There are (1++/1+) data of sufficient quality to support the use of manipulative therapies for musculoskeletal referred pain to the neck and/or upper quadrant.

**Key Point Summary:** The clinician may find it useful to assess and address potential sources of referred pain from the thoracic spine.

***Costovertebral/Costotransverse Syndrome***

**High & Moderate Level/Quality Literature Summary**

None identified.

**Low level/Quality Literature Summary**

Triano et al. did a low level case series report that included a non-systematic review of the literature on costovertebral and costotransverse joint pain. (195) The authors pointed out that T2 through T10 ribs are bi-facetal synovial joints and are richly innervated. It was further noted that pain generated is generally localized; however, anterior chest pain is also commonly encountered. Disorder of the first or second costovertebral joints is thought to be a cause of arm pain via Kuntz' nerve, an inconstant intrathoracic ramus that can provide the costovertebral joints with neural communications to the brachial plexus. The pain associated with these disorders may be sharp, stabbing, and aggravated by posture and specific movements, or occasionally it will present as focal aching or burning pain. Some have reported both dorsal and ventral pain characterized as if "shot by an arrow". Reaching is thought to aggravate the upper ribs, and rotation and lateral bending

the lower. Marked sensitivity to pressure and provocation has been noted over the transverse process and outer angle of the involved rib, and deep inspiration may also cause pain at the rib's dorsal or ventral articulation. Loss of end range of the involved joints has been reported. Degenerative joint disease is common and has been reported as early as the third decade of life, with the most common site being T6-T9, T11, and T12. A short therapeutic trial of manual therapy, physiotherapy, and exercise will often resolve the pain, averting the need to pursue further diagnostic or therapy options. In recalcitrant cases or when the diagnosis is in doubt, an injection of analgesia with an anti-inflammatory can conclusively confirm the joint as the pain generator, as well as resolve the pain. Pain control and restoration of normal joint biomechanics are the goals of treatment. Manipulation of anesthetized joints has also been attempted with reported success. The authors opined that multi-disciplinary cooperation could promote more accurate diagnosis and effective treatment for these conditions. Hopefully, future higher level studies will provide clinicians clearer diagnostic and treatment direction.

According to a low level study by Arroyo, the costovertebral joint has long been suspected of producing atypical chest and back pain. In some cases, costovertebral joint pain has reportedly been misdiagnosed as cardiac or pleuro-pulmonary dysfunction. (196) Intercostal nerve blocks and manipulation have been suggested as effective treatments in clinical reports. Additional higher quality research would be needed to confirm the beneficial effects and mechanism of action.

In a low level observational study, Weinberg et al. surmised that arthritis of the first costovertebral joint could be a cause of thoracic outlet syndrome or shoulder girdle pain. (144) The authors identified 40 subjects with upper quadrant pain and radiographic evidence of degenerative arthritis in the upper costovertebral joints. The radiographic presentation included narrowing of the articular space, loose intra-articular bodies, sclerotic and irregular surfaces, and widening of the rib head. Pain on digital provocation of the first rib was noted in most subjects. All subjects were treated with a local infiltration of lignocaine hydrochloride into the first costovertebral joint. If pain was reduced, a mix of lignocaine hydrochloride and hydrocortisone was administered. Twenty-five (62.5%) of the patients reported complete relief of symptoms, 10 reported marked improvement, 4 reported partial relief, and 1 did not respond to the treatment. While this is not a high level study, it does suggest that arthritis of the first rib may be able to produce thoracic outlet-like symptoms. These findings highlight the importance of performing a diligent search for the pain generator when presented with upper quadrant pain.

A low level observational study by Lipschitz et al. evaluated thoracic sympathetic trunk compression by costovertebral joint osteophytes in over 1000 cadavers. (64) Costovertebral arthritis with associated impingement of sympathetic trunks, rami communicantes, and/or the splanchinic nerves was found to be very common; noted in 84.3% of the cadavers. The authors further reported their observations on 34 specially dissected cadavers regarding the degree and location of compression of sympathetic nerve structures secondary to hyperostosis of the costovertebral joints. The highest frequency of compression appeared at the upper thoracic levels. The compressed ganglia

were found to be sclerotic, enlarged, and infiltrated with connective tissue. The authors hypothesized that the symptoms expected would vary according to the level of compression. Upper thoracic involvement could be expected to produce symptoms affecting the head, neck, upper limb, and thorax itself. The middle and lower portions of the sympathetic trunk are associated with the abdominal and pelvic walls, visceral structures, and the lower extremities. Sympathetic nerve derangement might result in altered vasomotor, pilomotor, or sudomotor events; pain and sensory disturbances; or Horner syndrome. The authors opined that the elderly are often diagnosed with neurovegetative dystonias or neurovegetative dyskinesias that might actually be the result of sympathetic nerve damage secondary to costovertebral joint arthritis. While these findings and theories are fascinating, clinical application is limited. More study would be needed regarding the associated symptoms and value of potential treatments, including manual medicine.

A low level observational study by Pascual et al. evaluated costovertebral joint changes in 17 patients with painful ankylosing spondylitis. (197) Fourteen of the 17 subjects had costovertebral abnormalities identified on CT scans. The changes included erosion, joint widening, bony proliferation, and anterior bridging, with moderate to marked sclerosis, and in some cases joint fusion. Deep breathing, coughing, and other forceful movements caused pain that was generally felt at the base of the thorax and radiated to the lower anterior region. The pain was reported to simulate a kidney disorder.

**Clinical Questions / Graded Practice Options**

***1. Is manipulative therapy an effective treatment for costovertebral joint pain?***

> **Grade D (I)** Yes - There are (3/4) low level data supporting consideration of manual therapies for the treatment of costovertebral joint.

**Key Point Summary:** There is a quantity of positive low level studies supporting the necessity for additional research into the diagnosis and treatment of costovertebral dysfunction.

### *T4 Syndrome*

**High & Moderate Level/Quality Literature Summary**

None indentified.

**Low level/Quality Literature Summary**

T4 syndrome is not addressed in the higher quality literature; however, low level clinical observations and reports have been made in the medical, chiropractic, and physical therapy literature. (168, 198-205) Despite the lack of quality information, the clinician and researcher might benefit from a short summary of the lower level literature regarding T4 syndrome.

Evans opined that the term "upper thoracic disorder" might be a more accurate name for the condition, since it generally includes T1 to T7. (198) Nonetheless, the common designation for the condition is T4 (or sometimes T3) syndrome. Matthisjs et al. attributed the first description of the disorder to Maitland and Burnell in 1957, and reported that an English medical doctor and Dutch physiotherapists had subsequently described a similar condition. (201)

The condition is reported to present with a unique constellation of signs and symptoms. The history is generally unremarkable and a non-traumatic onset is common. Reported symptoms include paresthesia in a glove-like pattern, and an altered sensation of the hands feeling hot, cold, heavy, or swollen. Inter-scapular pain, upper quadrant pain, and suboccipital headache are commonly reported. The condition may display elements mimicking complex regional pain syndrome, thoracic outlet syndrome, and even chest or cardiac pain. The timing of T4 syndrome pain is reportedly different from that of cardiac pain. Whereas cardiac pain generally comes on with exercise and improves with rest, T4 syndrome pain is thought to be aggravated with resting postures but not by exercise.

Examination is generally unremarkable with no hard neurological symptoms. The condition has no reported radiographic findings. Stiffness in the upper thoracic spine and costovertebral/costo-transverse joints is commonly reported. There have been reports of hand discoloration, weakness, and thermosensory loss.

The etiology of the condition is unknown. A possible pathophysiological mechanism put forth involves autonomic nerve dysfunction of the sympathetics to head and neck and/or upper trunk and limb. (168, 198) The condition could be related to irritation and dysfunction of afferent sympathetic spinal nerve fibers, sympathetic nerve entrapment, or ischemic events from rib or osteophytic involvement. Vascular changes might be related to sympathetic motor control changes. The lack of literature and understanding do not allow for definitive conclusions.

T4 syndrome has been reported to respond well to manual therapies, including mobilization and manipulative treatment to the upper thoracic spine, lower cervical spine, and ribs. Relief has also been reported with intramuscular injections of bupivacaine at the T4 level. Breathing, ergonomic, and postural instruction may also be helpful. Additional research is needed to determine whether T4 syndrome actually is a diagnostic entity, and if so, how it responds to manual medicine and other treatments.

**Clinical Questions / Graded Practice Options**

***1. Is manipulative therapy an effective treatment for T4 syndrome referred pain?***

> **Grade D (I)** Yes - There are (3/4) low level data supporting consideration of manual therapies for the treatment of T4 related pain.

**Key Point Summary:** Low level studies support the need for additional research into the diagnosis and treatment of T4 syndrome. The clinician might consider referred pain patterns and kinetic chain assessment for the purpose of identification of upper thoracic pain generators as a source of referred pain.

### *Thoracolumbar junction syndrome*

**High & Moderate Level/Quality Literature Summary**

None identified.

**Low level/Quality Literature Summary**

Although there is not any high quality literature regarding the diagnosis and/or treatment of thoracolumbar junction (TLJ) syndrome, lower level studies indicate that the condition and various treatments might have scientific plausibility. The condition is thought to involve the transitional thoracic and lumbar spine, usually the T10-11, T11-12 and T12-L1 motion segments. Facet dysfunction at these levels is considered to be the source of pain in this syndrome, which is characterized by referred pain to the related dermatomes (T10 to L1). Although Judovich and Bates (206) reportedly were the first to document referral of low back and groin pain from the TLJ, Robert Maigne further defined the syndrome and introduced the term "thoracolumbar syndrome". Due to the extensive work of Dr. Robert Maigne in this area, the condition is often referred to as "Maigne syndrome". (207-212) He found a high frequency of this syndrome among those suffering low back pain and advocated treatment by spinal manipulation of the thoracolumbar junction.

Jean-Yves Maigne summarized the low level literature and anecdotal reports regarding thoracolumbar syndrome (Maigne Syndrome) in a non-systematic report. (210) Additional basic science work by the author studied the anatomy of the region in cadavers, finding the skin of the low back to be innervated by the lateral branches of the dorsal rami of T12 and LI in 22 cadavers (60%), or T12 L1 and L2 in 10 cadavers (27%). In 5 cadavers (13%), T12 L1 and L2 were found to receive an anastomosis from L3. The anatomy and associated symptoms are varied. (211) This work would appear to provide an anatomical rationale for TLJ syndrome. Although the symptoms of TLJ syndrome reportedly vary according to the anatomical variation, the condition usually causes referred pain to the sacroiliac area, and less frequently to the lateral thigh and/or groin. Interestingly, pain is seldom reported at the TLJ itself. Maigne reported that clinical signs include tenderness at the mid-point of the posterior iliac crest and pain on skin-rolling over the involved dermatome. Provocative tests include lateral pressure to the involved spinous and friction pressure over the involved facet joint and a pinch-roll test. The pinch-roll test is done by grasping the skin between the thumbs and forefingers, lifting it away from the trunk and rolling the raised skin and subcutaneous tissues. The skin over the involved side will be painfully hypersensitive. Imaging studies are reported to be non-contributory. Reduction or abolition of pain via an anesthetic block of the dorsal ramus and involved facet can reportedly confirm the diagnosis. Maigne indicated that the

condition responds well to manipulation, with good results in just a few sessions. The condition has also been treated with facet injections of anesthetic and steroid.

Additional higher level studies assessing this syndrome and possible treatments are warranted.

**Clinical Questions / Graded Practice Options**

***1. Is manipulative therapy an effective treatment for thoracolumbar related referred pain?***

**Graded Options:**

> **Grade D (I)** Yes - There are (2-/3/4) low level data supporting consideration of manual therapies for the treatment of thoracolumbar junction-related pain.

**Key Point Summary:** Basic science and low level studies support additional research into the diagnosis and treatment of thoracolumbar junction syndrome. The clinician might consider kinetic chain assessment for the purpose of identification of a thoracolumbar pain generator causing referred pain.

## *Organic Referred Pain and Conditions*

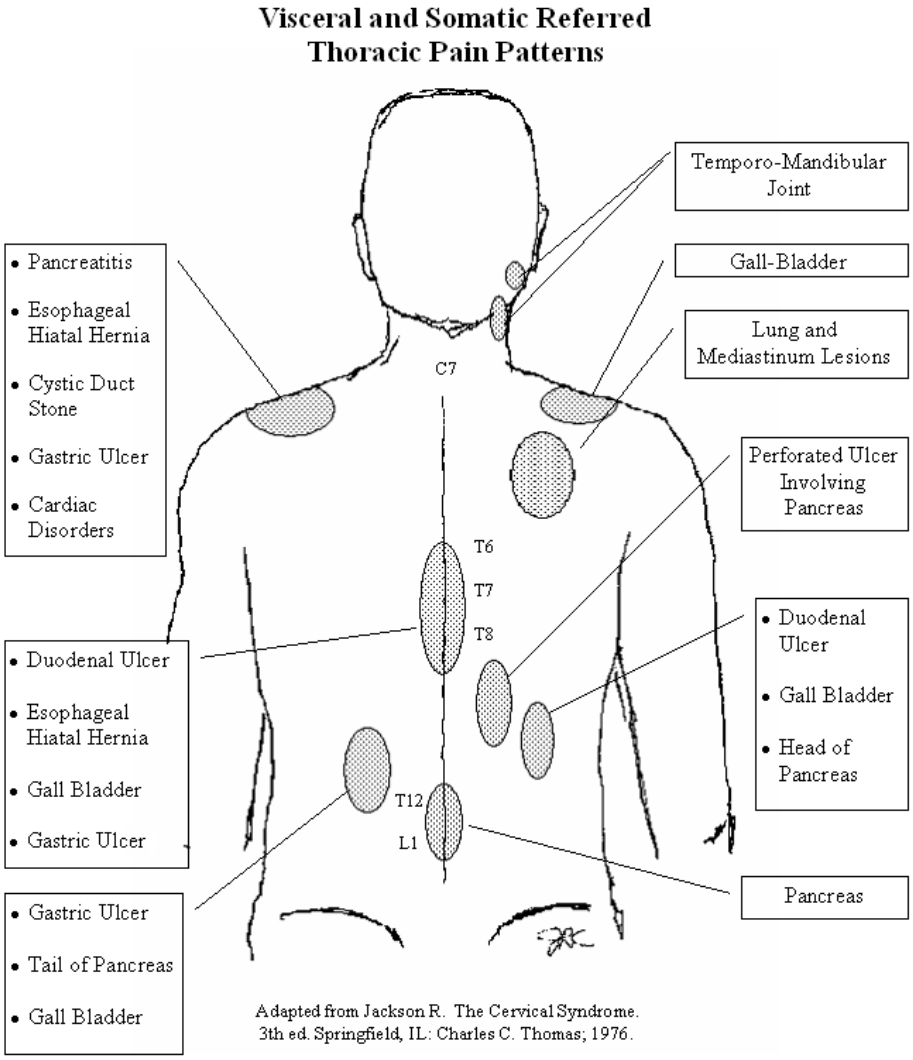



**Figure 6.**

## *Chest*

### High & Moderate Level/Quality Literature Summary

The task of sorting out cardiac from non-cardiac chest pain has long plagued physicians of all schools. Chest pain can be the result of heart disease, gastric problems, mechanical dysfunction, and many other disorders; some serious, some not. Chest pain that results from a temporal gastric irritation is much less ominous than pain resulting from a cardiac infarct. The ability to clinically differentiate cardiac pain from non-cardiac pain could save money and worry by reducing unnecessary testing and invasive procedures. A remarkable body of high quality work focusing on evaluation of cardiac and musculoskeletal chest pain has been generated by Henrik Wulff Christensen and other colleagues associated with the University of Southern Denmark. (35, 38, 213-222) Christensen et al. evaluated the reliability of various spine and chest palpation techniques and their potential use in combination with case history evaluation for diagnosing stable

angina pectoris, (38, 213, 215) as well as the efficacy of manual therapy as a treatment for patients with stable cervicothoracic angina pectoris. (216) Christensen et al. evaluated 3 palpation techniques and found good inter-observer reliability for paraspinal tenderness, but not for sitting or prone motion palpation. (38) In a separate study, Christensen et al. evaluated the inter-observer reliability of palpation for muscle tenderness in the anterior chest wall in hopes of developing a procedure to differentiate patients with cardiac pain from those with non-cardiac pain and categorize chest pain. The authors found poor agreement between examiners and concluded that the clinical usefulness of anterior chest wall palpation is questionable. (213)

In a mid-level high quality prospective nonrandomized trial involving 275 people, Christensen et al. assessed the chiropractic evaluation and decision-making process in diagnosing non-cardiac musculoskeletal chest pain. (215) The diagnosis of cervicothoracic angina, a form of stable angina pectoris, was established by a complex assessment of the patient's history and examination. The authors hoped to develop an objective diagnostic rule set and methodology to establish and/or confirm the diagnosis of cervicothoracic angina. Myocardial perfusion and coronary angiography were used for validation. The authors found that a chiropractor could distinguish cervicothoracic angina as a distinct subset of angina pectoris by using a combination of history, clinical examination, and cardiological variables. The decision tree included palpation of the cervical and thoracic spine for pain and joint end-play, and cardiac evaluation and classification according to the Canadian Cardiovascular Society for angina severity. (See Table 9) While there is no widely accepted operational definition of chest pain originating from the musculoskeletal system, this study provides a foundation for the development of one, and calls for the integration of resources and cooperation between professions to achieve a functional working definition.

**Table 9. Canadian Cardiovascular Society Angina Classifications**

- Class I

  Stable angina - CCS I - Ordinary physical activity such as walking, climbing stairs does not cause angina. Angina (occurs) with strenuous, rapid or prolonged exertion at work or recreation

- Class II

  Stable angina - CCS II - Slight limitation of ordinary activity. Angina occurs on walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals, or in cold, or in wind, or under emotional stress, or only during the few hours after awakening. Walking more than 2 blocks on the level and climbing more than 1 flight of ordinary stairs at a normal pace and in normal conditions

- Class III

  Stable angina - CCS III - Marked limitations of ordinary physical activity. Angina occurs on walking 1 to 2 blocks on the level and climbing 1 flight of stairs in normal conditions and at a normal pace.

- Class IV

  Class IV- (A,B,C) - Inability to carry on any physical activity without discomfort - angina symptoms may be present at rest.

  - Class IV-A Stable angina - CCS lV or unstable angina, pain resolved with intensified medical therapy and now stable on oral medication.
  - Class IV-B Unstable angina, on oral therapy, symptoms improved but angina with minimal provocation.
  - Class IV-C Unstable angina, not manageable on oral therapy, required parenteral medication, may be hemodynamically unstable.

A mid-level high quality nonrandomized prospective study by Christensen et al. assessed the efficacy of chiropractic manual therapy for non-cardiac related angina diagnosed as cervicothoracic angina. (216) The authors reported that the chest pain in up to 50% of patients admitted to a cardiology ward was non-cardiac in nature. While non-cardiac chest pain sufferers have a low mortality rate, the majority continue to have pain, leaving half unemployed or significantly disabled. In this study, 96% of patients diagnosed with cervicothoracic angina reported positive results from chiropractic manual therapy. The authors opined that the general practitioner and cardiologist should become familiar with examination procedures to better diagnosis cervicothoracic angina, and might consider referral of appropriate candidates for chiropractic manual therapy. While this is a well done study, it has notable limitations that are clearly delineated by the authors. Additional

studies would be needed to confirm the existence and prevalence of cervicothoracic angina and the value of manual therapy in its treatment.

A high quality mid-level diagnostic cohort study by Davies et al. evaluated the thoracic spinal curve in relationship to a condition called straight back syndrome. (223) The syndrome is thought to be an inherited autosomal dominant disorder, and consists of the loss of the normal upper thoracic kyphosis with resulting decrease in the AP diameter of the chest. It is also associated with cardiac murmurs and radiographic cardiomegaly. In this study, 67% of 58 subjects had evidence of mitral valve prolapse. On lateral radiographs, the distance to a vertical line drawn from the anterior superior margin of the T4 vertebra and anterior inferior margin of the T12 to the mid-point of the T8 vertebral body was significantly reduced in the straight back cohort, as compared to the control group (P = 0.0005). A measurement of less than 1-2 cm is suggestive of straight back syndrome. The authors recommended that patients with straight back syndrome and their relatives be screened for cardiac anomalies, especially mitral valve prolapse.

In a 1992 mid-level moderate quality prospective study, Wise et al. explored the frequency of chest wall syndromes in 100 patients with non-cardiac chest pain. (224) The authors reported that chest wall pain, including sternal, xiphoid, costosternal and left anterior chest wall tenderness, was most common. Sixty-nine of the 100 non-cardiac pain patients had reproducible chest wall tenderness. Fibrositis was uncommon and was diagnosed in only 6 of the 100 patients. While the findings suggest that cardiac-like chest pain can arise from chest wall structures, the quality of the study is lacking. The statistics are mainly descriptive in nature, and therefore the findings cannot be considered conclusive. More work would be needed to identify methods of differentiating cardiac from musculoskeletal pain.

**Low level/Quality Literature Summary**

In 2000, Haneline did a low level case report that included a non-systematic literature review on the topic of chest pain of non-coronary origin seen in chiropractic practices. (225) Haneline reported that up to 50% of non-cardiac pseudoangina may be attributed to the spine. Other reported causes of non-coronary chest pain included rib syndromes, trigger points, sternal syndrome, and other neuromusculoskeletal sources. While the cause of non-coronary pain is not well understood, 4 possible causes were offered:

1. Radicular pain secondary to nerve root compression by arthritic spurring, herniated discs, or other causes of foraminal narrowing.
2. Ventral motor root compression with associated protopathic pain.
3. Referred pain from ligamentous or muscular structures.
4. Autonomic symptoms mediated by the sympathetic nervous system.

Differential diagnosis can be difficult, especially without expensive and invasive testing. The author did offer some subtle clinical signs to aid in differential diagnosis:

- Pseudoangina appears to lack exacerbation upon exertion, whereas cardiac pain is exacerbated by exertion.

- Rest does not relieve pseudoangina but does commonly relieve cardiac-induced angina.
- Nitroglycerin does relieve cardiac induced angina but not pseudoangina.
- Electrocardiograms (ECG) are usually normal with pseudoangina but abnormal with cardiac angina.
- Faulty posture may aggravate pseudoangina symptoms but not cardiac induced angina.

The effect of cardiac dysfunction can be devastating, but the author opined that once a cardiac etiology is ruled out with appropriate testing, the chiropractic physician is capable of managing these cases.

**Clinical Questions / Graded Practice Options**

***1. Is manipulative therapy an effective treatment for non-cardiac pseudo-angina chest pain?***

> **Grade B** Yes - There is (1++/2+) a sufficient level of data supporting that chiropractic physicians can effectively participate in the diagnosis and treatment of non-cardiac pseudo-angina chest pain.

**Key Point Summary:** Inter-professional cooperation is essential when cardiac health is considered. Chiropractors should refer all suspected cardiac cases for additional evaluation and management. Patients identified with non-cardiac pseudo-angina and persistent thoracic pain should be referred for evaluation for a somatic cause, which could include a therapeutic trial of manipulative therapy.

## *Cancer and Metastatic Disease*

**High & Moderate Level/Quality Literature Summary**

No high level literature regarding chiropractic management of metastatic disease was identified.

**Low level/Quality Literature Summary:**

A low level observational study by Deyo et al. evaluated the clinical frequency and presentation of cancer as a cause of back (both thoracic and lumbar) pain in 1975 walk-in patients at a public hospital. (226) Thirteen (0.66%) of these patients proved to have cancer. The authors utilized multivariate analysis of the data to create a cost-effective algorithm distinguishing cancers from mechanical back pain. The authors found that underlying malignancies are difficult to diagnosis, as they have few suggestive signs. Selective use of an erythrocyte sedimentation rate (ESR) was found to be a useful screening tool when coupled with a history of cancer and/or consideration of patient age. The authors noted that in the face of a suggestive history and elevated ESR, negative radiography should be interpreted with caution, and additional testing might be

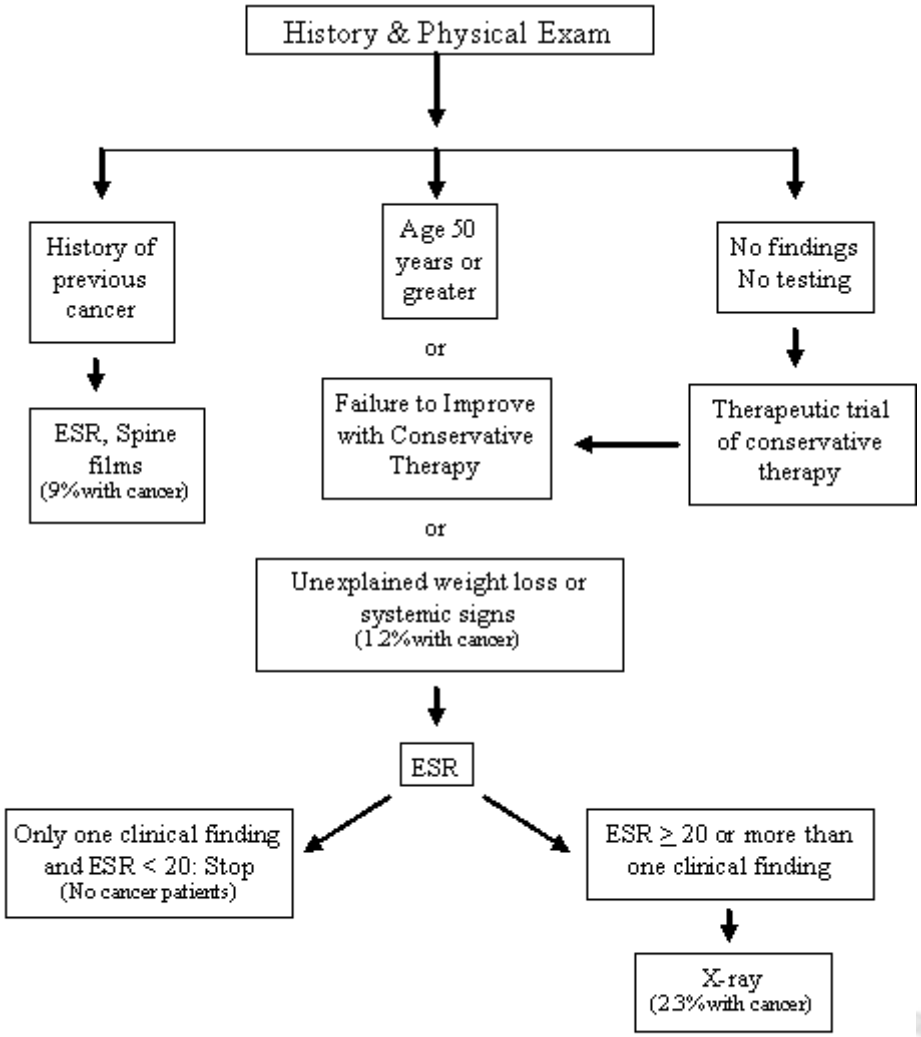
warranted. Since the majority of mechanical pain is thought to improve within 30 days, longitudinal observation is an important diagnostic tool that can be employed for low risk patients. The authors suggested that failure of conservative therapy might be an indication for additional testing. (See figure 7.)

**Clinical Questions / Graded Practice Options**

***1. Does failure of a conservative treatment trial warrant additional testing for cancer/metastatic disease?***

> **Grade D (I)** Equivocal/Yes -There are low level data (3/4) indicating that a failure of conservative therapy may be an indication for additional testing.

**Key Point Summary:** There is no reliable high level evidence on directing chiropractic management of cancer/metastatic disease. Standard medical management, such as history/red flag assessment with appropriate diagnostic and/or referrals, would be a reasonable approach.




An algorithm for detecting underlying cancer with frequency experience from Deyo et al. Adapted from Deyo R, Diehl A. Cancer as a cause of back pain: frequency, clinical presentation, and diagnostic strategies. J Gen Intern Med 1988;3(3):230-8.

**Figure 7**

# Other Conditions

## Shoulder Pain

### High & Moderate Level/Quality Literature Summary

A high level, high quality randomized controlled trial by Bergman et al. assessed the efficacy of adjunctive manipulation in addition to standard medical care for shoulder pain and shoulder girdle dysfunction. (227) The cervical spine, upper thoracic spine, and ribs were mobilized with high-amplitude, low velocity and/or manipulated with low-amplitude, high velocity treatments by a physiotherapist. The findings of this study support that manual treatment directed to the spine and ribs might aid in the accelerated recovery of shoulder dysfunction.

A 1997 mid-quality randomized controlled trial by Winters et al. evaluated the efficacy of physiotherapy, manipulation, and corticosteroid injection for shoulder complaints. (228) One hundred and seventy-two subjects were divided into 2 diagnostic groups: a shoulder girdle group (functional disorders of the cervical spine, the upper thoracic spine, or the adjoining ribs), and a synovial group (complaints diagnosed as originating from the glenohumeral joint, the subacromial space, or the acromioclavicular joint). Manipulation consisted of mobilization and manipulation of the cervical spine, upper thoracic spine, upper ribs, acromioclavicular joint, and the glenohumeral joint, provided once-weekly, with up to 6 treatments. The shoulder girdle group's resolution of complaints was notably quickest with manipulation. Additionally, those patients receiving manipulation had the lowest treatment failure. The duration of complaints in the synovial group was shortest after corticosteroid injections. The authors concluded that manipulation was the preferred treatment for shoulder girdle disorders, while synovial disorders responded best to corticosteroid injections. A 1999 mid-quality follow-up study by Winters et al re-examined patients 2 to 3 years after the original study to assess the various treatments in the long term. (229) No significant differences between treatment groups were found, with approximately half of patients experiencing new or recurrent shoulder complaints. The authors noted that the diagnostic categories of shoulder pain did change over time, and recommended additional studies to analyze factors causing persistent shoulder problems.

**Low level/Quality Literature Summary**

None identified.

**Clinical Questions / Graded Practice Options**

***1. Is there evidence supporting the use of manipulative therapies for shoulder dysfunction?***

> **Grade A** Yes - There is evidence (1++) that manipulation/mobilization of the cervical spine, thoracic spine, ribs, adjacent joints, and tissues may effectively hasten the resolution of shoulder/shoulder girdle dysfunction.

**Key Point Summary:** Manipulative therapy for the cervical and thoracic spine and shoulder girdle, in addition to usual medical care, accelerates recovery of shoulder symptoms, and is superior to corticosteroid injection and physical therapy for shoulder girdle dysfunction. There appears to be no difference between therapies in long-term outcome studies, and recurrent problems are common.

## *Spinal Stenosis*

**High & Moderate Level/Quality Literature Summary**

None identified.

### Low level/Quality Literature Summary

A low level study by Epstein et al. reported that thoracic stenosis may be defined by a narrowing of the anteroposterior diameter of the thoracic spinal canal to < 10 mm. (230) It was noted that primary thoracic stenosis is most frequently associated with lumbar stenosis, whereas secondary stenosis more typically involves the entire spinal canal and is usually attributed to endocrinopathies and systemic diseases. The authors opined that it is important to differentiate between primary and secondary thoracic stenosis, and consider attendant diseases and possible involvement in the cervical or lumbar regions.

Rosenbloom did a low level report on disc herniation and stenosis in the thoracic spine. He noted that these disorders are relatively uncommon compared with their occurrence in the cervical or lumbar spine. (178, 231) Stenosis is generally the result of degenerative disease; however, it can be caused or aggravated by trauma. Local and/or radicular pain, with or without signs and symptoms of cord dysfunction, is a common presentation. Mechanical soft tissue compression or vascular impingement is thought to be the cause of radicular pain.

**Clinical Questions / Graded Practice Options**

**No recommendations.**

## *Flat-Back syndrome*

### High & Moderate Level/Quality Literature Summary

None identified.

### Low level/Quality Literature Summary

In a low level paper, Wiggens et al. wrote that iatrogenic loss of lordosis is now recognized as a complication following placement of thoracolumbar instrumentation to correct scoliosis. (3) This is especially true with distraction instrumentation. Flat-Back syndrome is characterized by forward inclination of the trunk, inability to stand upright, and back pain. Evaluation of the deformity should include a full-spine lateral radiograph obtained with the patient's knees and hips fully extended.

**Clinical Questions / Graded Practice Options**

**No recommendations**

**Key Point Summary:** Additional research, including case studies, is needed to document prevalence, significance, and treatment options for flat-back syndrome.

## *Ankylosing spondylitis*

### High & Moderate Level/Quality Literature Summary

A 2008 high quality systematic review titled "Physiotherapy interventions for ankylosing spondylitis" by the Cochrane Musculoskeletal Group noted that supervised group physiotherapeutic exercises had greater short-term benefit than home exercises. (232) Group exercises fared better than home exercises in producing improved range and overall well-being. Exercise in a spa resort setting in addition to weekly group exercises provided better results than weekly group exercises alone. More information regarding the types, duration, and intensity of physiotherapy and exercise would be needed to establish optimal treatment programs for AS sufferers.

A 2005 moderate quality randomized controlled trial by Fernadez-de-las-Penas found that the Global Posture Re-education (GPR) protocol worked slightly better than conventional therapy. (233) Functional and mobility outcomes were measured using instruments developed by the Bath group. (234) These included the BASMI (tragus to wall distance, modified Schober test, cervical rotation, lumbar side flexion, and intermalleolar distance), BASDAI (The Bath Ankylosing Spondylitis Disease Activity Index), and BASFI (The Bath Ankylosing Spondylitis Functional Index). The authors reported that these instruments have been assessed as valid and have good inter-observer reliability scores. Global Postural Re-education (aka Mezieres method, or Souchard's global postural re-education) is a sustained full body stretch involving the maintenance of symmetry of both sides of the body at all times. The GPR technique is mainly taught in French, Portuguese, Italian, and Spanish, and is not commonly employed in the English-speaking world. GPR was developed in France and has only recently been introduced in the United States. Other studies have looked at medical management of tumor necrosis factor alpha, a pro-inflammatory cytokine associated with AS; however, effective treatments remain to be developed.

### Low Level/Quality Literature Summary

Two low level non-systematic reviews by Sigler and Khan noted that ankylosing spondylitis, a chronic rheumatic disorder that limits spinal and thoracic mobility, is seen in 0.1% to 1.4% of the population. It is thought to be 2 to 3 times more common in males. The painful nature of the condition results in antalgic posture, an increased thoracic kyphosis, flattening of the lumbar lordosis, protraction of the scapular girdle, and flexion and internal rotation of the pelvic girdle. The severity of the condition is variable and it is subject to spontaneous remission and exacerbations. (235, 236)

A 1979 low level non-systematic review by Smythe noted there is no definitive treatment for AS; however, maintaining mobility is thought to be essential. (237)

In a 1989 low level retrospective review of spinal injuries in patients with previously diagnosed ankylosing spondylitis, Graham et al. noted that spinal fractures can occur with relatively minimal forces and are often unstable and subject to neurological compromise. Severe neurologic deficits were noted in 75% of cases. (238) Although this is a low level

study, these data would tend to preclude the use of high force manipulation due to the risk of fracture and associated complications.

There is limited low level outcome-measured support for chiropractic manipulative therapy in the management of ankylosing spondylitis. (239) Rutherford et al. did a prospective case study that documented symptomatic improvement in function and disease activity in a patient with ankylosing spondylitis who had a course of chiropractic therapy. A 34-year-old male suffering ankylosing spondylitis for a period of 10 years received chiropractic treatment for spinal pain and stiffness. His radiographic findings included increased atlantodental interspace and cervical vertebral ankylosis. Bath Ankylosing Spondylitis Functional Index (BASFI), Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) scores, finger-tip-to-floor distance and chest expansion were assessed during an 18-week course of chiropractic spinal manipulation and mobilization therapy. There was a 90% improvement in the disease activity index and an 85% improvement in the functional index from the pre-treatment baseline, as measured by the BASDAI and BASFI respectively. These findings support the need for additional higher level research.

**Clinical Questions / Graded Practice Options**

***1. Are exercises an effective treatment for AS?***

> **Grade A** Yes - There is evidence (1++) indicating that AS patients may benefit from structured exercise programs.

**Key Point Summary:** For treatment of AS, global posture re-education exercise protocols worked slightly better than conventional therapy; spa resort therapies worked better than supervised group exercise, which worked better than home exercise.

***2. Is high velocity low amplitude manipulation a suitable treatment option for AS?***

> **Grade D (I)** Insufficient data - while there is low level research (3) supporting the efficacy of a well designed and monitored trial of chiropractic care for AS, there is low level (3/4) literature indicating a potential risk of fracture and neurological compromise with minimal forces.

**Key Point Summary:** A chiropractic practitioner might be called upon to diagnose, refer, monitor, and/or co-manage patients with AS. Care should be taken to avoid application of forces that might induce fracture.

Third-party healthcare fund management brokers should be aware that chiropractic physicians often provide a wide range of services beyond high velocity manual manipulation. Chiropractic treatment often consists of physiotherapy, low force techniques, massage, mobilization, exercise training, gait training, myofascial release

work, neuromuscular re-education, casting, taping, splinting, and other physical therapies and orthopedic procedures. Diagnostic services can include any physician service allowable under the chiropractic physician's state scope of practice law.

# Evidence Tables

The studies considered in this literature synthesis were divided into the following groups based on SIGN evidence grading protocol. (18)

- ***HIGH LEVEL LITERATURE OF HIGH AND MODERATE QUALTIY***

  ***Guidelines***

  ***Systematic reviews and meta-analyses of randomized controlled trials***

  ***Randomized Controlled Trials***

- ***MID-LEVEL LITERATURE OF HIGH AND MODERATE QUALTIY***

  ***Non-randomized intervention studies***

  ***Observational studies***

- ***LOW LEVEL LITERATURE ASSESSED FOR RELEVANCE***

  ***Non-experimental studies evaluated but not graded***

  ***Case studies evaluated but not graded***

  ***Expert opinion evaluated but not graded***

The rating scales divides the study quality into High ++, Moderate +, and Low -.

## *HIGH LEVEL LITERATURE OF HIGH AND MODERATE QUALTIY*

### *Guidelines*

| Reviewer | Author | Title | Assessment Type | # | Q Rating |
|---|---|---|---|---|---|
| BC | Negrini, S et al | Italian guidelines on rehabilitation treatment of adolescents with scoliosis or other spinal deformities | Agree | (9) | ++ |
| CT | Australian Acute Musculoskeletal Pain Guidelines Group | Australian Acute Musculoskeletal Pain Guidelines | Agree | (2) | ++ |

| AGREE Domain Scores for Australian Acute Thoracic Spinal Pain Guideline | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Reviewer** | *Domain 1* | *Domain 2* | *Domain 3* | *Domain 4* | *Domain 5* | *Domain 6* | *Recommendation* |
| | Scope | Stakeholder | Rigour | Clarity | Applicable | Editorial | |
| **C** | 88.89 | 83.33 | 90.48 | 91.67 | 88.89 | 83.33 | Strongly Recommended |
| **T** | 100 | 83.33 | 90.48 | 91.67 | 88.89 | 83.33 | Strongly Recommended |
| **Mean Score** | 94.44 | 83.33 | 90.48 | 91.67 | 88.89 | 83.33 | |

| AGREE Domain Scores for Italian guidelines on rehabilitation treatment of adolescents with scoliosis or other spinal deformities Negrini, S et al | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Reviewer** | *Domain 1* | *Domain 2* | *Domain 3* | *Domain 4* | *Domain 5* | *Domain 6* | *Recommendation* |
| | Scope | Stakeholder | Rigour | Clarity | Applicable | Editorial | |
| **C** | 100.00 | 83.33 | 85.71 | 91.67 | 77.78 | 100.00 | Strongly Recommended |
| **B** | 100.00 | 83.33 | 85.71 | 91.67 | 77.78 | 100.00 | Strongly Recommended |
| **Mean Score** | 100.00 | 83.33 | 85.71 | 91.67 | 77.78 | 100.00 | |

Strongly Recommend - the guideline rates high 3 or 4 on the majority of items and most domain scores are above 60%. This indicates that the guideline has a high overall quality and that it could be considered for use in practice without provisos or alterations

Recommend - the guideline rates high 3 or 4 or low 1 or 2 on a similar with provisos number of items and most domain scores are between 30 and or alterations 60%. This indicates that the guideline has a moderate overall quality. This could also be due to insufficient or lacking information in the guideline for some of the items. If provisos or alterations are made – and sufficient information is provided on the guideline development method - the guideline could still be considered for use in practice, in particular when no other guidelines on the same clinical topic are available.

Would not recommend - the guideline rated low 1 or 2 on the majority of items and most domain scores are below 30%. This indicates that the guideline has a low overall quality and serious shortcomings. Therefore it should not be recommended for use in practice.

## *HIGH LEVEL LITERATURE OF HIGH AND MODERATE QUALTIY*

### *Systematic reviews and meta-analyses of randomized controlled trials*

| Reviewer | Author | High Level Studies - Systematic Reviews | # | Q Rating |
|---|---|---|---|---|
| YK | Negrini et al. 2003 | Physical exercises as a treatment for adolescent idiopathic scoliosis. A systematic review. | (93) | ++ |
| KY | Stochkendahl 2006 | Manual Examination of the Spine: A Systematic Critical Literature Review of Reproducibility | (35) | ++ |
| BM | Huijbregts 2002 | Spinal Motion Palpation: A Review of Reliability Studies | (16) | ++ |
| BM | Everett, Patel 2007 | A Systematic Literature Review of Nonsurgical Treatment in Adult Scoliosis | (75) | ++ |
| CK | Romano, Negrini. 2008 | Manual therapy as a conservative treatment for adolescent idiopathic scoliosis | (78) | ++ |
| KC | Simpson et al. 2006 | Accuracy of spinal orthopaedic tests: a systematic review. | (68) | ++ |
| YK | Focarile 1991 | Effectiveness of nonsurgical treatment for idiopathic scoliosis. Overview of available evidence. | (94) | ++ |
| CY | Dagfinrud et al. 2008 | Physiotherapy interventions for ankylosing spondylitis. | (232) | ++ |
| KY | Christensen et al. 2008 | Spinal curves and health: a systematic critical review of the epidemiological literature dealing with associations between sagittal spinal curves and health. | (59) | ++ |
| YK | Haws 2003 | The use of exercises in the treatment of scoliosis: an evidence-based critical review of the literature. | (95) | + |
| KJ | Rowe et al.1997 | A meta-analysis of the efficacy of non-operative treatments for idiopathic scoliosis. | (79) | + |
| MJ | Meyer et al. 1993 | The Current Status on Validity of Thoracolumbar Paraspinal Scanning EMG as a Diagnostic Test: A Literature Review | (43) | + |

### *Randomized Controlled Trials*

| Reviewer | Author | High Level Studies - RCT's | # | Q Rating |
|---|---|---|---|---|
| CY | Haas et al. 1995 | Short-term responsiveness of manual thoracic end-play assessment to spinal manipulation: a randomized controlled trial of construct validity. J Manipulative Physiol Ther 1995; 18 9:582-9. | (37) | ++ |
| BM | Cleland et al 2004 | Immediate effects of thoracic manipulation in patients w/ neck pain: a randomized clinical trial | (28) | ++ |
| CB | Bergman GJD, et al. 2004 | Manipulative Therapy in Addition to Usual Medical Care for Patients with Shoulder Dysfunction and Pain: A Randomized, Controlled Trial. | (227) | ++ |
| CY | Winters et al 1997 | Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomized, single blind study. | (228) | + |
| CY | Winters et al 1999 | Treatment of shoulder complaints in general practice: long-term results of a randomized, single blind study comparing physiotherapy, manipulation, and corticosteroid injection | (229) | + |
| BJ | Schiller, L 2001 | Effectiveness of Spinal Manipulative Therapy in the Treatment of Mechanical Thoracic Spine Pain: A Pilot Randomized Clinical Trial | (29) | + |
| JB | O'Leary et al. 2002 | The effect of soft tissue deloading tape on thoracic spine pressure pain thresholds in asymptomatic subjects | (33) | + |
| JM | Giles et al. 2003 | Chronic Spinal Pain | (56) | + |
| YC | Allison 2002 | A randomized clinical trial of manual therapy for cervico-brachial pain syndrome -- a pilot study | (32) | + |
| YK | Fernandez de Las Penas 2005 | Two Exercise Interventions for the Management of Patients with Ankylosing Spondylitis A Randomized Controlled Trail | (233) | + |
| JM | Liebler et al. 2001 | Effects of Thoracic Spine Mobilization the Lower Trapezius Strength Testing | (17) | + |
| BK | Savolainen, A et al. 2004 | Active or passive treatment for neck-shoulder pain in occupational health care? a randomized controlled trial | (31) | + |

## *MID-LEVEL LITERATURE OF HIGH AND MODERATE QUALTIY*

### *Non-randomized intervention studies - Observational studies*

| Reviewer | Author | Moderate Level Studies Non-randomized intervention studies / Observational studies | # | Q Rating |
|---|---|---|---|---|
| KM | Schwab FJ et al 2002 | Adult scoliosis A Quantitative Radiographic and Clinical Analysis | (102) | ++ |
| MJ | Davies et al 1980 | The Straight Back Syndrome | (223) | ++ |
| MB | Christensen et al 2003 | Palpation for Muscular Tenderness in the Anterior Chest Wall: An Observer Reliability Study | (213) | ++ |
| KY | Christensen 2005 | Manual Therapy for Patients with Stable Angina Pectoris: A Nonrandomized Open Prospective Trial | (216) | ++ |
| KY | Christensen 2005 | Cervicothoracic Angina Identified by Case History and Palpation Findings in Patients with Stable Angina Pectoris | (215) | ++ |
| YK | Christensen 2002 | Palpation of the Upper Thoracic Spine: An Observer Reliability Study | (38) | ++ |
| BM | Magni et al. 1994 | Prospective study on the relationship between depressive symptoms and chronic musculoskeletal pain | (57) | ++ |
| YK | Milgrom 1993 | Over-exertional lumbar and thoracic back pain among recruits: a prospective study of risk factors and treatment regimens. | (240) | ++ |
| BK | Musgrave et al. 2001 | Back Problems Among Postmenopausal Women Taking Estrogen Replacement Therapy | (23) | ++ |
| KY | Bryner 1989 | Thoracic Paraspinal Tenderness in Chronic Pain Suffers | (60) | ++ |
| BK | Kuklo et al. 2005 | Vertebral Rotation and Thoracic Torsion in Adolescent Idiopathic Scoliosis. What is the Best Radiographic Correlate? | (97) | ++ |
| JK | Kuklo et al. 2005 | Reliability analysis for digital adolescent idiopathic scoliosis measurements. | (98) | ++ |
| MB | Kuklo et al 2005 | Reliability Analysis for Manual Adolescent Idiopathic Scoliosis Measurements | (134) | ++ |
| KY | Mannion 2004 | A new skin-surface device for measuring the curvature and global segmental ranges of motion of the spine: reliability of measurements and comparison with data reviewed from the literature | (44) | ++ |
| YK | Cleland 2004 | Short-term Effects of Thoracic Manipulation on Lower Trapezius Muscle Strength | (13) | ++ |
| BM | Danielsson et al. 2007 | A Prospective Study of Brace Treatment Vs Observation Alone in Adolescent Idiopathic Scoliosis: A Follow up Mean of 16 Years After Maturity | (100) | ++ |
| BK | Nachemson et al. 1995 | Effectiveness of Treatment with a Brace in Girls Who Have Adolescent Idiopathic Scoliosis | (80) | ++ |
| BM | Danielsson et al. 2007 | A Prospective Study of Brace Treatment Vs Observation Alone in Adolescent Idiopathic Scoliosis: A Follow up Mean of 16 Years After Maturity | (100) | ++ |
| BC | Peterson et al. 1995 | Prediction of progression of the curve in girls who have adolescent idiopathic scoliosis of moderate severity. Logistic regression analysis based on data from The Brace Study of the Scoliosis Research Society | (99) | ++ |
| YC | Gillard et al. 2001 | Diagnosing thoracic outlet syndrome: contribution of provocative tests, ultrasonography, electrophysiology, and helical computed tomography in 48 patients. | (166) | + |
| JB | Hsu et al. 2003 | Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging | (241) | + |
| JB | Landauer et al. 2003 | Estimating the final outcome of brace treatment for idiopathic thoracic scoliosis at 6-month follow up | (119) | + |
| KM | Healey et al. 1985 | Structural Scoliosis in Osteoporotic Women | (106) | + |
| JB | El-Sayyad et al. 1994 | Effect of exercise, bracing and electrical surface stimulation on idiopathic scoliosis: a preliminary study | (96) | + |
| JM | Durham et al. 1990 | Surface Electrical Stimulation Versus Brace in Treatment of Idiopathic Scoliosis | (116) | + |
| JB | Shen et al. 2001 | Nonoperative Treatment vs Posterior Fixation for Thoracolumbar Junction Burst Fractures w/o Neurologic Deficit | (139) | + |
| BK | Ettinger et al.l 1994 | Kyphosis in Older Women and its Relation to Back Pain, Disability and Osteopenia: The Study of Osteoporotic Fractures | (58) | + |
| BK | Evans 2000 | Vertebral fractures and bone mineral density in idiopathic, secondary and corticosteroid associated osteoporosis in men | (242) | + |

| | | | | |
|---|---|---|---|---|
| CJ | Harreby 1995 | Are radiologic changes in the thoracic and lumbar spine of adolescents risk factors for low back pain in adults? | (27) | + |
| JY | Wise et al. 1992 | Musculoskeletal chest wall syndromes in patients with noncardiac chest pain: a study of 100 patients. | (224) | + |
| JY | Burwell et al. 2002 | The early detection of adolescent idiopathic scoliosis in three positions using the scoliometer and real-time ultrasound: should the prone position also be used? | (101) | + |
| MJ | Carr et al. 1989 | Surface stereophotogrammetry of thoracic kyphosis | (108) | + |
| JY | Keating et al. 2001 | Mid-thoracic tenderness: a comparison of pressure pain threshold between spinal regions, in asymptomatic subjects. | (40) | + |
| BK | Wood et al. 1995 | Magnetic Resonance Imaging of the Thoracic Spine | (25) | + |
| JY | Wood et al 1999 | Thoracic discography in healthy individuals. A controlled prospective study of magnetic resonance imaging and discography in asymptomatic and symptomatic individuals. | (45) | + |
| JM | Potter et al. 2006 | Intraexaminer Reliability of Identifying a Dysfunctional Segment in the Thoracic and Lumbar Spine. | (39) | + |
| BM | Brismee et al. 2004 | Rate of False Positive Using the Cyriax Release Test for Thoracic Outlet Syndrome in an Asymptomatic Population | (12) | + |
| YJ | Johnston 1983 | Inter-rexaminer study of palpation in detecting location of spinal segmental dysfunction | (41) | + |
| YJ | Love 1987 | Inter- and intra-examiner reliability of motion palpation for the thoracolumbar spine. | (42) | + |
| JM | Lindgren et al. 1992 | Cervical Rotation Lateral Flexion Test in Brachialgia | (154) | + |
| YK | Perret 2004 | Electromyographic Responses of Paraspinal Muscles to Postural Disturbance with Special Reference to Scoliotic Children | (105) | + |

# REFERENCES


1. Haldeman S, Chapman-Smith D, Petersen DM. Guidelines for chiropractic quality assurance and practice parameters : proceedings of the Mercy Center Consensus Conference. Gaithersburg, Md.: Aspen Publishers; 1993.
2. Group AAMPG. Acute Thoracic Spinal Pain: Evidence-Based Management. In: Evidence-Based Management of Acute Musculoskeletal Pain. Brisbane: Australian Academic Press; 2003. p. 63-92.
3. Wiggins G, Ondra S, Shaffrey C. Management of iatrogenic flat-back syndrome. Neurosurg Focus 2003;15(3):E8.
4. Scottish Intercollegiate Guidelines Network. Sign 50: A guideline developers' handbook. Edinburgh: SIGN; 2002.
5. AGREE Collaboration [Appraisal of Guidelines R, and Evaluation in Europe (AGREE) Collaborative Group.]. Appraisal of Guidelines for Research & Evaluation (AGREE) Instrument. 2001.
6. Christensen MG, Delle Morgan DR, National Board of Chiropractic Examiners. Job analysis of chiropractic by state : a state-by-state statistical report on the nationwide NBCE survey of chiropractic practice and companion volume to "Job analysis of chiropractic". Greeley, Colo.: National Board of Chiropractic Examiners; 1994.
7. Weiss H, Negrini S, Rigo M, Kotwicki T, Hawes M, Grivas T, et al. Indications for conservative management of scoliosis (guidelines). Scoliosis 2006;1:5.
8. Weiss H-R. RE: SOSORT scoliosis guidelines. In: Cates e-mtJ, editor. Oregon; 2007.
9. Negrini S, Aulisa L, Ferraro C, Fraschini P, Masiero S, Simonazzi P, et al. Italian guidelines on rehabilitation treatment of adolescents with scoliosis or other spinal deformities. Eura Medicophys 2005;41(2):183-201.
10. Negrini S. Scoliosis Guidelines. In: Cates J, editor. Italy; 2007.
11. Refshauge K, Bolst L, Goodsell M. The relationship Between Cervicothoracic Posture and the Presence of Pain. The Journal of Manual & Manipulative Therapy 1995;3(1):21 - 24.
12. Brismée J-M, Gilbert K, Isom K, Hall R, Leathers B, Sheppard N, et al. Rate of False Positive Using the Cyriax Release Test for Thoracic Outlet Syndrome in an Asymptomatic Population. The Journal of Manual & Manipulative Therapy 2004;12( 2):73 - 81.
13. Cleland J, Selleck B, Stowell T, Browne L, Alberini S, St. Cyr H, et al. Short-Term Effects of Thoracic Manipulation on Lower Trapezius Muscle Strength. The Journal of Manual & Manipulative Therapy 2004;12(2):82 - 90.
14. Cleland J, Flynn T, Palmer J. Incorporation of Manual Therapy Directed at the Cervicothoracic Spine in Patients with Lateral Epicondylalgia: A Pilot Clinical Trial. The Journal of Manual & Manipulative Therapy 2005;13(3):143 - 151.
15. Gavin D. The Effect of Joint Manipulation Techniques on Active Range of Motion in the Mid-Thoracic Spine of Asymptomatic Subjects. The Journal of Manual & Manipulative Therapy 1999;7(3):114 - 122.
16. Huijbregts P. Spinal motion palpation: a review of reliability studies. Journal of Manual & Manipulative Therapy 2002;10(1):24-39.
17. Liebler E, Tufano-Coors L, Douris P, Makofsky H, McKenna R, Michels C, et al. The Effect of Thoracic Spine Mobilization On Lower Trapezius Strength Testing. The Journal of Manual & Manipulative Therapy 2001;9(4):207 - 212.
18. Harbour R, Miller J. A new system for grading recommendations in evidence based guidelines. BMJ 2001;323(Aug. 11):334-6.
19. Verkerk K, Van Veenendaal H, Severens JL, Hendriks EJM, Burgers JS. Considered judgement in evidence-based guideline development. Int. J. Qual. Health Care 2006;18(5):365-369.
20. Niemelainen R, Videman T, Battie M. Prevalence and characteristics of upper or mid-back pain in Finnish men. Spine 2006;31(16):1846-9.
21. Nakling J, Buhaug H, Backe B. The biologic error in gestational length related to the use of the first day of last menstrual period as a proxy for the start of pregnancy. Early Hum Dev 2005;81(10):833-9.
22. Atchison J. Manipulation Efficacy: Upper Body. Journal of Back and Musculoskeletal Rehabilitation 2000;15:3-15.

23. Musgrave D, Vogt M, Nevitt M, Cauley J. Back problems among postmenopausal women taking estrogen replacement therapy: the study of osteoporotic fractures. Spine 2001;26(14):1606-12.
24. Wood K, Blair J, Aepple D, Schendel M, Garvey T, Gundry C, et al. The natural history of asymptomatic thoracic disc herniations. Spine 1997;22(5):525-ccc9; discussion 529-30ddd.
25. Wood K, Garvey T, Gundry C, Heithoff K. Magnetic resonance imaging of the thoracic spine. Evaluation of asymptomatic individuals. J. Bone Joint Surg. Am. 1995;77(11):1631-1638.
26. Santavirta S, Konttinen Y, Heliovaara M, Knekt P, Luthje P, Aromaa A. Determinants of osteoporotic thoracic vertebral fracture. Screening of 57,000 Finnish women and men. Acta Orthop Scand 1992;63(2):198-202.
27. Harreby M, Neergaard K, Hesselsoe G, Kjer J. Are radiologic changes in the thoracic and lumbar spine of adolescents risk factors for low back pain in adults? A 25-year prospective cohort study of 640 school children. Spine 1995;20(21):2298-302.
28. Cleland J, Childs J, McRae M, Palmer J, Stowell T. Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. Man Ther 2005;10(2):127-35.
29. Schiller L. Effectiveness of spinal manipulative therapy in the treatment of mechanical thoracic spine pain: a pilot randomized clinical trial. J Manipulative Physiol Ther 2001;24(6):394-ccc401ddd.
30. Triano J, Hondras M, McGregor M. Differences in treatment history with manipulation for acute, subacute, chronic and recurrent spine pain. J Manipulative Physiol Ther 1992;15(1):24-ccc30ddd.
31. Savolainen A, Ahlberg J, Nummila H, Nissinen M. Active or passive treatment for neck-shoulder pain in occupational health care? A randomized controlled trial. Occup. Med. 2004;54(6):422-424.
32. Allison G, Nagy B, Hall T. A randomized clinical trial of manual therapy for cervico-brachial pain syndrome -- a pilot study. Man Ther 2002;7(2):95-102.
33. O' Leary S, Carroll M, Mellor R, Scott A, Vicenzino B. The effect of soft tissue deloading tape on thoracic spine pressure pain thresholds in asymptomatic subjects. Man Ther 2002;7(3):150-3.
34. Ross J, Bereznick D, McGill S. Determining cavitation location during lumbar and thoracic spinal manipulation: is spinal manipulation accurate and specific? Spine 2004;29(13):1452-7.
35. Stochkendahl M, Christensen H, Hartvigsen J, Vach W, Haas M, Hestbaek L, et al. Manual examination of the spine: A systematic, critical literature review of reproducibility. Journal of Manipulative and Physiological Therapeutics 2006;In Press.
36. Najm W, Seffinger M, Mishra S, Dickerson V, Adams A, Reinsch S, et al. Content validity of manual spinal palpatory exams - A systematic review. BMC Complement Altern Med 2003;3:1.
37. Haas M, Panzer D, Peterson D, Raphael R. Short-term responsiveness of manual thoracic end-play assessment to spinal manipulation: a randomized controlled trial of construct validity. J Manipulative Physiol Ther 1995;18(9):582-9.
38. Christensen H, Vach W, Vach K, Manniche C, Haghfelt T, Hartvigsen L, et al. Palpation of the upper thoracic spine: an observer reliability study. J Manipulative Physiol Ther 2002;25(5):285-92.
39. Potter L, McCarthy C, Oldham J. Intraexaminer Reliability of Identifying a Dysfunctional Segment in the Thoracic and Lumbar Spine. Journal of Manipulative and Physiological Therapeutics 2006;29(3):203-207.
40. Keating L, Lubke C, Powell V, Young T, Souvlis T, Jull G. Mid-thoracic tenderness: a comparison of pressure pain threshold between spinal regions, in asymptomatic subjects. Man Ther 2001;6(1):34-9.
41. Johnston W, Allan B, Hendra J, Neff D, Rosen M, Sills L, et al. Interexaminer study of palpation in detecting location of spinal segmental dysfunction. J Am Osteopath Assoc 1983;82(11):839-.
42. Love R, Brodeur R. Inter- and intra-examiner reliability of motion palpation for the thoracolumbar spine. J Manipulative Physiol Ther 1987;10(1):1-4.
43. Meyer J. The Current Status on Validity of Thoracolumbar Paraspinal Scanning EMG as a Diagnostic Test: A Literature Review. In: Transactions of the Consortium for Chiropractic Research; 1993 June, 8th; 1993.
44. Mannion A, Knecht K, Balaban G, Dvorak J, Grob D. A new skin-surface device for measuring the curvature and global and segmental ranges of motion of the spine: reliability of measurements and comparison with data reviewed from the literature. Eur Spine J 2004;13(2):122-36.
45. Wood K, Schellhas K, Garvey T, Aeppli D. Thoracic discography in healthy individuals. A controlled prospective study of magnetic resonance imaging and discography in asymptomatic and symptomatic individuals. Spine 1999;24(15):1548-55.

46. Cates JR, Young DN, Guerriero DJ, Jahn WT, Armine JP, Korbett AB, et al. Independent Guideline Appraisal Summary Report for Guidelines for Chiropractic Quality Assurance and Practice Parameters (Mercy). Journal of Chiropractic Medicine 2002;1(2):70-71.
47. Cates JR, Young DN, Guerriero DJ, Jahn WT, Armine JP, Korbett AB, et al. An independent assessment of chiropractic practice guidelines. J Manipulative Physiol Ther 2003;26(5):282-6.
48. Cates JR, Young DN, Guerriero DJ, Jahn WT, Armine JP, Korbett AB, et al. Evaluating the quality of clinical practice guidelines. Journal of Manipulative and Physiological Therapeutics 2001;24(3):170-6.
49. Wagner A, Murtagh F, Arrington J, Stallworth D. Relationship of Schmorl's nodes to vertebral body endplate fractures and acute endplate disk extrusions. AJNR Am J Neuroradiol 2000;21(2):276-81.
50. Patel U, Skingle S, Campbell GA, Crisp AJ, Boyle IT. Clinical profile of acute vertebral compression fractures in osteoporosis. Rheumatology 1991;30(6):418-421.
51. Dietze D, Fessler R. Thoracic disc herniations. Neurosurg Clin N Am 1993;4(1):75-ccc90ddd.
52. Cantor J, Lebwohl N, Garvey T, Eismont F. Nonoperative management of stable thoracolumbar burst fractures with early ambulation and bracing. Spine 1993;18(8):971-6.
53. Braakman R, Fontijne W, Zeegers R, Steenbeek J, Tanghe H. Neurological deficit in injuries of the thoracic and lumbar spine. A consecutive series of 70 patients. Acta Neurochir (Wien) 1991;111(1-2):11-7.
54. Chow G, Nelson B, Gebhard J, Brugman J, Brown C, Donaldson D. Functional outcome of thoracolumbar burst fractures managed with hyperextension casting or bracing and early mobilization. Spine 1996;21(18):2170-5.
55. Karjalainen M, Aho A, Katevuo K. Painful spine after stable fractures of the thoracic and lumbar spine. What benefit from the use of extension brace? Ann Chir Gynaecol 1991;80(1):45-8.
56. Giles L, Muller R. Chronic spinal pain: a randomized clinical trial comparing medication, acupuncture, and spinal manipulation. Spine 2003;28(14):1490-502; discussion 1502-3.
57. Magni G, Moreschi C, Rigatti-Luchini S, Merskey H. Prospective study on the relationship between depressive symptoms and chronic musculoskeletal pain. Pain 1994;56(3):289-97.
58. Ettinger B, Black D, Palermo L, Nevitt M, Melnikoff S, Cummings S. Kyphosis in older women and its relation to back pain, disability and osteopenia: the study of osteoporotic fractures. Osteoporos Int 1994;4(1):55-60.
59. Christensen S, Hartvigsen J. Spinal curves and health: a systematic critical review of the epidemiological literature dealing with associations between sagittal spinal curves and health. J Manipulative Physiol Ther. 2008;31(9):690-714.
60. Bryner P, Baxter A, Sherwood B. Thoracic paraspinal tenderness in chronic pain sufferers. Journal of the Australian Chiropractic Association 1989;19(4):132-6.
61. Griegel-Morris P, Larson K, Mueller-Klaus K, Oatis C. Incidence of common postural abnormalities in the cervical, shoulder, and thoracic regions and their association with pain in two age groups of healthy subjects. Phys Ther 1992;72(6):425-31.
62. Jamieson W, Merskey H. Representation of the thoracic outlet syndrome as a problem in chronic pain and psychiatric management. Pain 1985;22(2):195-200.
63. Nathan H. Osteophytes of the spine compressing the sympathetic trunk and splanchnic nerves in the thorax. Spine 1987;12(6):527-32.
64. Lipschitz M, Bernstein-Lipschi... L, Nathan H. Thoracic sympathetic trunk compression by osteophytes associated with arthritis of the costovertebral joint. Anatomical and clinical considerations. Acta Anat (Basel) 1988;132(1):48-54.
65. Nathan H. Compression of the sympathetic trunk by osteophytes of the vertebral column in the abdomen: an anatomical study with pathological and clinical considerations. Surgery 1968;63(4):609-25.
66. Nathan H. Relations of the soft structures of the posterior mediastinum in the scoliotic spine. Acta Anat (Basel) 1988;133(3):260-4.
67. Nykoliation J, Cassidy J, Arthur B, Wedge J. An algorithm for the management of scoliosis. J Manipulative Physiol Ther 1986;9(1):1-14.
68. Simpson R, Gemmell H. Accuracy of spinal orthopaedic tests: a systematic review. Chiropr Osteopat 2006;14:26.
69. Cote P, Kreitz BG, Cassidy JD, Dzus AK, Martel J. A study of the diagnostic accuracy and reliability of the Scoliometer and Adam's forward bend test. Spine 1998;23(7):796-802; discussion 803.

70. Karachalios T, Sofianos J, Roidis N, Sapkas G, Korres D, Nikolopoulos K. Ten-year follow-up evaluation of a school screening program for scoliosis. Is the forward-bending test an accurate diagnostic criterion for the screening of scoliosis? Spine 1999;24(22):2318-24.
71. Ogilvie J, Braun J, Argyle V, Nelson L, Meade M, Ward K. The search for idiopathic scoliosis genes. Spine 2006;31(6):679-81.
72. Jahn W, Cupon L. Scoliosis: What Every Chiropractic Orthopedist Needs to Know. The Academy of Chiropractic Orthopedist e-Journal 2007;4(Special Scoliosis Supplement).
73. Weiss H. Rehabilitation of adolescent patients with scoliosis--what do we know? A review of the literature. Pediatr Rehabil 2003;6(3-4):183-94.
74. Lantz C, Chen J. Effect of chiropractic intervention on small scoliotic curves in younger subjects: a time-series cohort design. J Manipulative Physiol Ther 2001;24(6):385-93.
75. Everett C, Patel R. A systematic literature review of nonsurgical treatment in adult scoliosis. Spine 2007;32(19 Suppl):S130-4.
76. Dobosiewicz K, Durmala J, Czernicki K, Jendrzejek H. Pathomechanic basics of conservative treatment of progressive idiopathic scoliosis according to Dobosiewicz method based upon radiologic evaluation. Stud Health Technol Inform 2002;91:336-41.
77. Rigo M, Reiter C, Weiss H. Effect of conservative management on the prevalence of surgery in patients with adolescent idiopathic scoliosis. Pediatr Rehabil 2003;6(3-4):209-14.
78. Romano M, Negrini S. Manual therapy as a conservative treatment for adolescent idiopathic scoliosis: a systematic review. Scoliosis 2008;3(1):2.
79. Rowe D, Bernstein S, Riddick M, Adler F, Emans J, Gardner-Bonneau D. A meta-analysis of the efficacy of non-operative treatments for idiopathic scoliosis. J Bone Joint Surg Am 1997;79(5):664-74.
80. Nachemson A, Peterson L. Effectiveness of treatment with a brace in girls who have adolescent idiopathic scoliosis. A prospective, controlled study based on data from the Brace Study of the Scoliosis Research Society. J. Bone Joint Surg. Am. 1995;77(6):815-822.
81. Goh S, Price RI, Leedman PJ, Singer KP. A comparison of three methods for measuring thoracic kyphosis: implications for clinical studies. Rheumatology (Oxford) 2000;39(3):310-5.
82. Negrini S, Negrini A, Atanasio S, Santambrogio GC. Three-dimensional easy morphological (3-DEMO) classification of scoliosis, part I. Scoliosis 2006;1:20.
83. Bertaina C, Stasiowska B, Benso A, Vannelli S. Is TW3 height prediction more accurate than TW2? Preliminary data. Horm Res 2007;67(5):220-3.
84. Goh S, Tan C, Price R, Edmondston S, Song S, Davis S, et al. Influence of age and gender on thoracic vertebral body shape and disc degeneration: an MR investigation of 169 cases. J Anat 2000;197 Pt 4:647-57.
85. Sanders JO, Browne RH, McConnell SJ, Margraf SA, Cooney TE, Finegold DN. Maturity Assessment and Curve Progression in Girls with Idiopathic Scoliosis. J. Bone Joint Surg. Am. 2007;89(1):64-73.
86. Reamy B, Slakey J. Adolescent idiopathic scoliosis: review and current concepts. Am Fam Physician 2001;64(1):111-6.
87. Frisch H, Riedl S, Waldhor T. Computer-aided estimation of skeletal age and comparison with bone age evaluations by the method of Greulich-Pyle and Tanner-Whitehouse. Pediatr Radiol 1996;26(3):226-31.
88. Lonstein J, Carlson J. The prediction of curve progression in untreated idiopathic scoliosis during growth. J Bone Joint Surg Am 1984;66(7):1061-1071.
89. Stone B, Beekman C, Hall V, Guess V, Brooks HL. The effect of an exercise program on change in curve in adolescents with minimal idiopathic scoliosis. A preliminary study. Phys Ther 1979;59(6):759-63.
90. Coillard C, Vachon V, Circo A, Beausejour M, Rivard C. Effectiveness of the SpineCor brace based on the new standardized criteria proposed by the scoliosis research society for adolescent idiopathic scoliosis. J Pediatr Orthop 2007;27(4):375-9.
91. Richards B, Bernstein R, D'Amato C, Thompson G. Standardization of criteria for adolescent idiopathic scoliosis brace studies: SRS Committee on Bracing and Nonoperative Management. Spine 2005;30(18):2068-75; discussion 2076-7.
92. Amendt L, Ause-Ellias K, Eybers J, Wadsworth C, Nielsen D, Weinstein S. Validity and reliability testing of the Scoliometer. Physical Therapy 1990;70(2):108-117.
93. Negrini S, Antonini G, Carabalona R, Minozzi S. Physical exercises as a treatment for adolescent idiopathic scoliosis. A systematic review. Pediatr Rehabil 2003;6(3-4):227-35.

94. Focarile F, Bonaldi A, Giarolo M, Ferrari U, Zilioli E, Ottaviani C. Effectiveness of nonsurgical treatment for idiopathic scoliosis. Overview of available evidence. Spine 1991;16(4):395-ccc401ddd.
95. Hawes M. The use of exercises in the treatment of scoliosis: an evidence-based critical review of the literature. Pediatr Rehabil 2003;6(3-4):171-82.
96. el-Sayyad M, Conine T. Effect of exercise, bracing and electrical surface stimulation on idiopathic scoliosis: a preliminary study. Int J Rehabil Res 1994;17(1):70-4.
97. Kuklo T, Potter B, Lenke L. Vertebral rotation and thoracic torsion in adolescent idiopathic scoliosis: what is the best radiographic correlate? J Spinal Disord Tech 2005;18(2):139-47.
98. Kuklo T, Potter B, O'Brien M, Schroeder T, Lenke L, Polly D, et al. Reliability analysis for digital adolescent idiopathic scoliosis measurements. J Spinal Disord Tech 2005;18(2):152-9.
99. Peterson L, Nachemson A. Prediction of progression of the curve in girls who have adolescent idiopathic scoliosis of moderate severity. Logistic regression analysis based on data from The Brace Study of the Scoliosis Research Society. J. Bone Joint Surg. Am. 1995;77(6):823-827.
100. Danielsson A, Hasserius R, Ohlin A, Nachemson A. A prospective study of brace treatment versus observation alone in adolescent idiopathic scoliosis: a follow-up mean of 16 years after maturity. Spine 2007;32(20):2198-207.
101. Burwell R, Aujla R, Kirby A, Moulton A, Webb J. The early detection of adolescent idiopathic scoliosis in three positions using the scoliometer and real-time ultrasound: should the prone position also be used? Stud Health Technol Inform 2002;88:74-80.
102. Schwab F, Smith V, Biserni M, Gamez L, Farcy J, Pagala M. Adult scoliosis: a quantitative radiographic and clinical analysis. Spine 2002;27(4):387-92.
103. Wong M, Liu W. Critical review on non-operative management of adolescent idiopathic scoliosis. Prosthet Orthot Int 2003;27(3):242-53.
104. Dobosiewicz K. Neurophysiological mechanism of the unloading reflex as a prognostic factor in the early stages of idiopathic adolescent scoliosis. Eur Spine J 1997;6(2):93-7.
105. Perret C, Robert J. Electromyographic responses of paraspinal muscles to postural disturbance with special reference to scoliotic children. J Manipulative Physiol Ther 2004;27(6):375-80.
106. Healey J, Lane J. Structural scoliosis in osteoporotic women. Clin Orthop 1985(195):216-23.
107. Miyasaki R. Immediate influence of the thoracic flexion exercise on vertebral position in Milwaukee brace wearers. Phys Ther 1980;60(8):1005-9.
108. Carr A, Jefferson R, Turner-Smith A, Weisz I, Thomas D, Stavrakis T, et al. Surface stereophotogrammetry of thoracic kyphosis. Acta Orthop Scand 1989;60(2):177-80.
109. Morningstar M, Woggon D, Lawrence G. Scoliosis treatment using a combination of manipulative and rehabilitative therapy: a retrospective case series. BMC Musculoskelet Disord 2004;5:32.
110. Dobosiewicz K, Durmala J, Jendrzejek H, Czernicki K. Influence of method of asymmetric trunk mobilization on shaping of a physiological thoracic kyphosis in children and youth suffering from progressive idiopathic scoliosis. Stud Health Technol Inform 2002;91:348-51.
111. D'Amato C, Griggs S, McCoy B. Nighttime bracing with the Providence brace in adolescent girls with idiopathic scoliosis. Spine 2001;26(18):2006-12.
112. Goldberg C, Moore D, Fogarty E, Dowling F. Adolescent idiopathic scoliosis: the effect of brace treatment on the incidence of surgery. Spine 2001;26(1):42-7.
113. Edmonson A, Morris J. Follow-up study of Milwaukee brace treatment in patients with idiopathic scoliosis. Clin Orthop Relat Res 1977(126):58-61.
114. Chase A, Bader D, Houghton G. The biomechanical effectiveness of the Boston brace in the management of adolescent idiopathic scoliosis. Spine 1989;14(6):636-42.
115. Ferrari K, Goti P, Sanna A, Misuri G, Gigliotti F, Duranti R, et al. Short-term effects of bracing on exercise performance in mild idiopathic thoracic scoliosis. Lung 1997;175(5):299-ccc310ddd.
116. Durham J, Moskowitz A, Whitney J. Surface electrical stimulation versus brace in treatment of idiopathic scoliosis. Spine 1990;15(9):888-92.
117. Hanks G, Zimmer B, Nogi J. TLSO treatment of idiopathic scoliosis. An analysis of the Wilmington jacket. Spine 1988;13(6):626-9.
118. Karol L. Effectiveness of bracing in male patients with idiopathic scoliosis. Spine 2001;26(18):2001-5.
119. Landauer F, Wimmer C, Behensky H. Estimating the final outcome of brace treatment for idiopathic thoracic scoliosis at 6-month follow-up. Pediatr Rehabil 2003;6(3-4):201-7.

120. Maruyama T, Kitagawa T, Takeshita K, Mochizuki K, Nakamura K. Conservative treatment for adolescent idiopathic scoliosis: can it reduce the incidence of surgical treatment? Pediatr Rehabil 2003;6(3-4):215-9.
121. Rudicel S, Renshaw T. The effect of the Milwaukee brace on spinal decompensation in idiopathic scoliosis. Spine 1983;8(4):385-7.
122. Nicholson G, Ferguson-Pell M, Smith K, Edgar M, Morley T. Quantitative measurement of spinal brace use and compliance in the treatment of adolescent idiopathic scoliosis. Stud Health Technol Inform 2002;91:372-7.
123. van Rhijn L, Veraart B, Plasmans C. Application of a lumbar brace for thoracic and double thoracic lumbar scoliosis: a comparative study. J Pediatr Orthop B 2003;12(3):178-82.
124. Raso V, Lou E, Hill D, Mahood J, Moreau M. Is the Boston brace mechanically effective in AIS? Stud Health Technol Inform 2002;91:378-82.
125. Olafsson Y, Saraste H, Soderlund V, Hoffsten M. Boston brace in the treatment of idiopathic scoliosis. J Pediatr Orthop 1995;15(4):524-7.
126. Beausejour M, Petit Y, Grimard G, Aubin C, Dansereau J, Labelle H. Relationships between strap tension, interface pressures and spine correction in brace treatment of scoliosis. Stud Health Technol Inform 2002;88:207-11.
127. Mamyama T, Kitagawal T, Takeshita K, Nakainura K. Side shift exercise for idiopathic scoliosis after skeletal maturity. Stud Health Technol Inform 2002;91:361-4.
128. Edmondston S, Singer K. Thoracic spine: anatomical and biomechanical considerations for manual therapy. Man Ther 1997;2(3):132-143.
129. Halal F, Gledhill RB, Fraser C. Dominant inheritance of Scheuermann's juvenile kyphosis. Am J Dis Child 1978;132(11):1105-1107.
130. Reid D, Hu R, Davis L, Saboe L. The nonoperative treatment of burst fractures of the thoracolumbar junction. J Trauma 1988;28(8):1188-94.
131. Murray P, Weinstein S, Spratt K. The natural history and long-term follow-up of Scheuermann kyphosis. J. Bone Joint Surg. Am. 1993;75(2):236-248.
132. Singer K, Jones T, Breidahl P. A comparison of radiographic and computer-assisted measurements of thoracic and thoracolumbar sagittal curvature. Skeletal Radiol 1990;19(1):21-6.
133. Sinaki M, Itoi E, Rogers J, Bergstralh E, Wahner H. Correlation of back extensor strength with thoracic kyphosis and lumbar lordosis in estrogen-deficient women. Am J Phys Med Rehabil 1996;75(5):370-4.
134. Kuklo T, Potter B, Polly D, O'Brien M, Schroeder T, Lenke L. Reliability analysis for manual adolescent idiopathic scoliosis measurements. Spine 2005;30(4):444-54.
135. Harrison D, Cailliet R, Harrison D, Janik T. How do anterior/posterior translations of the thoracic cage affect the sagittal lumbar spine, pelvic tilt, and thoracic kyphosis? Eur Spine J 2002;11(3):287-93.
136. Lou E, Raso J, Hill D, Durdle N, Moreau M. Spine-Straight device for the treatment of kyphosis. Stud Health Technol Inform 2002;91:401-4.
137. Sachs B, Bradford D, Winter R, Lonstein J, Moe J, Willson S. Scheuermann kyphosis. Follow-up of Milwaukee-brace treatment. J. Bone Joint Surg. Am. 1987;69(1):50-57.
138. Heithoff K, Gundry C, Burton C, Winter R. Juvenile discogenic disease. Spine 1994;19(3):335-40.
139. Shen W, Liu T, Shen Y. Nonoperative treatment versus posterior fixation for thoracolumbar junction burst fractures without neurologic deficit. Spine 2001;26(9):1038-45.
140. Shen W, Shen Y. Nonsurgical treatment of three-column thoracolumbar junction burst fractures without neurologic deficit. Spine 1999;24(4):412-5.
141. Mumford J, Weinstein J, Spratt K, Goel V. Thoracolumbar burst fractures. The clinical efficacy and outcome of nonoperative management. Spine 1993;18(8):955-70.
142. Bradford D, Moe J, Montalvo F, Winter R. Scheuermann's kyphosis. Results of surgical treatment by posterior spine arthrodesis in twenty-two patients. J. Bone Joint Surg. Am. 1975;57(4):439-448.
143. Ribbe E, Lindgren S. Clinical diagnosis of thoracic outlet sydnrome - evaluation of patient with cervicobrachial symptoms. Manual Med 1986;2:82-85.
144. Weinberg H, Nathan H, Magora F, Robin G, Aviad I. Arthritis of the first costovertebral joint as a cause of thoracic outlet syndrome. Clin Orthop Relat Res 1972;86:159-63.
145. BenEliyahu D, Silverstein G, McHale J, Tartaglia S, Spinelle R. The utility of duplex ultrasonography and evoked potentials in the diagnosis and management of Thoracic Outlet Syndrome. Topics in Clinical Chiropractic 1997;4(1):15-25.

146. Lindgren K. Thoracic outlet syndrome with special reference to the first rib. Ann Chir Gynaecol 1993;82(4):218-30.
147. Lindgren K. [TOS (thoracic outlet syndrome)--a functional disease?]. Duodecim 1994;110(12):1131-9.
148. Lindgren K. Reasons for failures in the surgical treatment of thoracic outlet syndrome. Muscle Nerve 1995;18(12):1484-6.
149. Lindgren K. Conservative treatment of thoracic outlet syndrome: a 2-year follow-up. Arch Phys Med Rehabil 1997;78(4):373-8.
150. Lindgren K. [TOS (thoracic outlet syndrome)--a challenge to conservative treatment]. Nord Med 1997;112(8):283-7.
151. Lindgren K, Leino E. Subluxation of the first rib: a possible thoracic outlet syndrome mechanism. Arch Phys Med Rehabil 1988;69(9):692-5.
152. Lindgren K, Leino E, Hakola M, Hamberg J. Cervical spine rotation and lateral flexion combined motion in the examination of the thoracic outlet. Arch Phys Med Rehabil 1990;71(5):343-4.
153. Lindgren K, Leino E, Lepantalo M, Paukku P. Recurrent thoracic outlet syndrome after first rib resection. Arch Phys Med Rehabil 1991;72(3):208-10.
154. Lindgren K, Leino E, Manninen H. Cervical rotation lateral flexion test in brachialgia. Arch Phys Med Rehabil 1992;73(8):735-7.
155. Lindgren K, Manninen H, Rytkonen H. Thoracic outlet syndrome--a functional disturbance of the thoracic upper aperture? Muscle Nerve 1995;18(5):526-30.
156. Lindgren K, Oksala I. Long-term outcome of surgery for thoracic outlet syndrome. Am J Surg 1995;169(3):358-60.
157. Lindgren S, Ribbe E, Norgren L. Two year follow-up of patients operated on for thoracic outlet syndrome. Effects on sick-leave incidence. Eur J Vasc Surg 1989;3(5):411-5.
158. Ingesson E, Ribbe E, Norgren L. Thoracic Outlet Syndrome-Evaluation of a Physiotherapeutical Method. Manual Medicine 1986;2(3):86-8.
159. Alexandre A, Coro L, Azuelos A, Pellone M. Thoracic outlet syndrome due to hyperextension-hyperflexion cervical injury. Acta Neurochir Suppl 2005;92:21-4.
160. Stark E. Exercise and Heat in the Therapy of Thoracic Outlet Syndrome. Osteopathic Annals 1975;3(3):50-1.
161. Lepantalo M, Lindgren K, Leino E, Lindfors O, von Smitten K, Nuutinen E, et al. Long term outcome after resection of the first rib for thoracic outlet syndrome. Br J Surg 1989;76(12):1255-6.
162. Crosby C, Wehbe M. Conservative treatment for thoracic outlet syndrome. Hand Clin 2004;20(1):43-9, vi.
163. Brantigan C, Roos D. Diagnosing thoracic outlet syndrome. Hand Clin 2004;20(1):27-36.
164. Atasoy E. Recurrent thoracic outlet syndrome. Hand Clin 2004;20(1):99-105.
165. Wishchuk J, Dougherty C. Therapy after thoracic outlet release. Hand Clin 2004;20(1):87-90, vii.
166. Gillard J, Perez-Cousin M, Hachulla E, Remy J, Hurtevent J, Vinckier L, et al. Diagnosing thoracic outlet syndrome: contribution of provocative tests, ultrasonography, electrophysiology, and helical computed tomography in 48 patients. Joint Bone Spine 2001;68(5):416-24.
167. Longley D, Yedlicka J, Molina E, Schwabacher S, Hunter D, Letourneau J. Thoracic outlet syndrome: evaluation of the subclavian vessels by color duplex sonography. Am. J. Roentgenol. 1992;158(3):623-630.
168. Mellick G, Mellick L. Clinical presentation, quantitative sensory testing, and therapy of 2 patients with fourth thoracic syndrome. J Manipulative Physiol Ther 2006;29(5):403-8.
169. Novak C, Collins E, Mackinnon S. Outcome following conservative management of thoracic outlet syndrome. J Hand Surg [Am] 1995;20(4):542-8.
170. Awwad E, Martin D, Smith K, Baker B. Asymptomatic versus symptomatic herniated thoracic discs: their frequency and characteristics as detected by computed tomography after myelography. Neurosurgery 1991;28(2):180-6.
171. Videman T, Battie M, Gill K, Manninen H, Gibbons L, Fisher L. Magnetic resonance imaging findings and their relationships in the thoracic and lumbar spine. Insights into the etiopathogenesis of spinal degeneration. Spine 1995;20(8):928-35.
172. Isla A, Roda J, Bencosme J, Alvarez M, Blazquez M. Intradural herniated dorsal disc: case report and review of the literature. Neurosurgery 1988;22(4):737-9.
173. Russell T. Thoracic intervertebral disc protrusion: experience of 67 cases and review of the literature. Br J Neurosurg 1989;3(2):153-60.

174. Ungersbock K, Perneczky A, Korn A. Thoracic vertebrostenosis combined with thoracic disc herniation. Case report and review of the literature. Spine 1987;12(6):612-5.
175. Miyaguchi M, Nakamura H, Shakudo M, Inoue Y, Yamano Y. Idiopathic spinal cord herniation associated with intervertebral disc extrusion: a case report and review of the literature. Spine 2001;26(9):1090-4.
176. Okada Y, Shimizu K, Ido K, Kotani S. Multiple thoracic disc herniations: case report and review of the literature. Spinal Cord 1997;35(3):183-6.
177. Bose B. Thoracic extruded disc mimicking spinal cord tumor. The Spine Journal 2003;3(1):82-86.
178. Lyu R, Chang H, Tang L, Chen S. Thoracic disc herniation mimicking acute lumbar disc disease. Spine 1999;24(4):416-8.
179. Bhole R, Gilmer R. Two-level thoracic disc herniation. Clin Orthop Relat Res 1984(190):129-31.
180. North R. Thoracic disc herniation at T7-T8. J Spinal Disord 1995;8(4):331; discussion 331-4.
181. Oppenheim J, Rothman A, Sachdev V. Thoracic herniated discs: review of the literature and 12 cases. Mt Sinai J Med 1993;60(4):321-6.
182. Morgan H, Abood C. Disc herniation at T1-2. Report of four cases and literature review. J Neurosurg 1998;88(1):148-50.
183. Wilke A, Wolf U, Lageard P, Griss P. Thoracic disc herniation: a diagnostic challenge. Man Ther 2000;5(3):181-4.
184. Arana E, Marti-Bonmati L, Molla E, Costa S. Upper thoracic-spine disc degeneration in patients with cervical pain. Skeletal Radiol 2004;33(1):29-ccc33ddd.
185. Hirschberg G, Williams K, Byrd J. Diagnosis and Treatment of Iliocostal Friction Syndromes. Journal of Orthopaedic Medicine 1992;14(2):35-9.
186. Aprill C, Dwyer A, Bogduk N. Cervical zygapophyseal joint pain patterns. II: A clinical evaluation. Spine 1990;15(6):458-61.
187. Dwyer A, Aprill C, Bogduk N. Cervical zygapophyseal joint pain patterns. I: A study in normal volunteers. Spine 1990;15(6):453-7.
188. Terrett A, Terrett R. Referred Posterior Thoracic Pain of Cervical Posterior Rami Origin: a Cause of Much Misdirected Treatment. Chiropractic Journal of Australia 2002;32(2):42-51.
189. Hockaday JM, Whitty CWM. Patterns of referred pain in the normal subject. Brain 1967;90(3):481-496.
190. Kellgren JH. On the Distribution of Pain Arising from Deep Somatic Structures with Charts of Segmental Pain Areas. Clinical Science 1939; 4:35-46.
191. Dreyfuss P, Tibiletti C, Dreyer S. Thoracic zygapophyseal joint pain patterns. A study in normal volunteers. Spine 1994;19(7):807-11.
192. Fukui S, Ohseto K, Shiotani M, Ohno K, Karasawa H, Naganuma Y, et al. Referred pain distribution of the cervical zygapophyseal joints and cervical dorsal rami. Pain 1996;68(1):79-83.
193. Fukui S, Ohseto K, Shiotani M. Patterns of pain induced by distending the thoracic zygapophyseal joints. Reg Anesth 1997;22(4):332-6.
194. Norlander S, Nordgren B. Clinical symptoms related to musculoskeletal neck-shoulder pain and mobility in the cervico-thoracic spine. Scand J Rehabil Med 1998;30(4):243-51.
195. Triano J, Erwin M, Hansen D. Costovertebral and costotransverse joint pain: a commonly overlooked pain generator. Topics in Clinical Chiropractic 1999;6:79–92.
196. Arroyo J, Jolliet P, Junod A. Costovertebral joint dysfunction: another misdiagnosed cause of atypical chest pain. Postgrad Med J 1992;68(802):655-9.
197. Pascual E, Castellano JA, Lopez E. Costovertebral Joint Changes in Ankylosing Spondylitis with Thoracic Pain 10.1093/rheumatology/31.6.413. Rheumatology 1992;31(6):413-415.
198. Evans P. The T4 syndrome. Some basis science aspects. Physiotherapy 1997;83(4):186-189.
199. DeFranca G, Levine L. The T4 syndrome. J Manipulative Physiol Ther 1995;18(1):34-7.
200. Fraser D. T-3 Revisited. Journal of Orthopaedic Medicine. 1993;15(1):3-4.
201. Matthijs O, Phelps V. T-4 Syndrome. In: The AAOM Quarterly: International Academy of Orthopedic Medicine; 1997.
202. McGuckin N. The T4 Syndrome. In: Grieve GP, editor. Modern manual therapy of the vertebral column. Edinburgh ; New York: Churchill Livingstone; 1986. p. 370-376.
203. Maitland GD, Edwards BC. Vertebral manipulation. 5th ed. London ; Boston: Butterworths; 1986.
204. Menck J, Requejo S, Kulig K. Thoracic spine dysfunction in upper extremity complex regional pain syndrome type I. J Orthop Sports Phys Ther 2000;30(7):401-9.

205. Grieve GP. Common vertebral joint problems. 2nd ed. Edinburgh ; New York: Churchill Livingstone; 1988.
206. Judovich BD, Bates W. Pain syndromes : treatment by paravertebral nerve block. 3d ed. Philadelphia: F. A. Davis; 1949.
207. Maigne R. Thoraco-Lumbar Junction Syndrome: A Source of Diagnostic Error. Journal of Orthopaedic Medicine 1995;17(3):84-9.
208. Maigne R. [The thoraco-lumbar junction syndrome. Low-back pain, pseudo-visceral pain, pseudo-hip pain and pseudo-pubic pain (author's transl)]. Sem Hop 1981;57(11-12):545-54.
209. Maigne R. Low back pain of thoracolumbar origin. Arch Phys Med Rehabil 1980;61(9):389-95.
210. Maigne J-Y. Thoracolumbar junction and thoracolumbar spinal pain syndromes. In; 1996.
211. Maigne J, Lazareth J, Guerin Surville H, Maigne R. The lateral cutaneous branches of the dorsal rami of the thoraco-lumbar junction. An anatomical study on 37 dissections. Surg Radiol Anat 1989;11(4):289-93.
212. Maigne J, Ellis R. Thoracic back pains in the manual medicine. Manuelle Medizin 2003;41(5):378-80.
213. Christensen H, Vach W, Manniche C, Haghfelt T, Hartvigsen L, Hoilund-Carlsen P. Palpation for muscular tenderness in the anterior chest wall: an observer reliability study. J Manipulative Physiol Ther 2003;26(8):469-75.
214. Christensen H. Musculoskeletal chest pain in patients with stable angina pectoralis - diagnosis and treatment. Odense: University of Southern Denmark; 2004.
215. Christensen H, Vach W, Gichangi A, Manniche C, Haghfelt T, Hoilund-Carlsen P. Cervicothoracic angina identified by case history and palpation findings in patients with stable angina pectoris. J Manipulative Physiol Ther 2005;28(5):303-11.
216. Christensen H, Vach W, Gichangi A, Manniche C, Haghfelt T, Hoilund-Carlsen P. Manual therapy for patients with stable angina pectoris: a nonrandomized open prospective trial. J Manipulative Physiol Ther 2005;28(9):654-61.
217. Christensen H, Haghfelt T, Vach W, Johansen A, Hoilund-Carlsen P. Observer reproducibility and validity of systems for clinical classification of angina pectoris: comparison with radionuclide imaging and coronary angiography. Clin Physiol Funct Imaging 2006;26(1):26-31.
218. Hoilund-Carlsen P, Johansen A, Christensen H, Pedersen L, Johnk I, Vach W, et al. Usefulness of the exercise electrocardiogram in diagnosing ischemic or coronary heart disease in patients with chest pain. Am J Cardiol 2005;95(1):96-9.
219. Hoilund-Carlsen PF, Johansen A, Christensen HW, Vach W, Moldrup M, Bartram P, et al. Potential impact of myocardial perfusion scintigraphy as gatekeeper for invasive examination and treatment in patients with stable angina pectoris: observational study without post-test referral bias. Eur. Heart J. 2006;27(1):29-34.
220. Johansen A, Hoilund-Carlsen P, Christensen H, Vach W, Jorgensen H, Veje A, et al. Diagnostic accuracy of myocardial perfusion imaging in a study population without post-test referral bias. J Nucl Cardiol 2005;12(5):530-7.
221. Johansen A, Hoilund-Carlsen P, Christensen H, Vach W, Moldrup M, Haghfelt T. Use of myocardial perfusion imaging to predict the effectiveness of coronary revascularisation in patients with stable angina pectoris. Eur J Nucl Med Mol Imaging 2005;32(12):1363-70.
222. Christensen HW. Musculoskeletal chest pain in patients with stable angina pectoris - diagnosis and treatment [Ph.D. Thesis]. Odense: University of Southern Denmark; 2004.
223. Davies MK, Mackintosh P, Cayton RM, Page AJF, Shiu MF, Littler WA. The Straight Back Syndrome. QJM 1980;49(4):443-460.
224. Wise C, Semble E, Dalton C. Musculoskeletal chest wall syndromes in patients with noncardiac chest pain: a study of 100 patients. Arch Phys Med Rehabil 1992;73(2):147-9.
225. Haneline M. Chest pain in chiropractic practice. Journal of the Neuromusculoskeletal System 2000;8:84–88.
226. Deyo R, Diehl A. Cancer as a cause of back pain: frequency, clinical presentation, and diagnostic strategies. J Gen Intern Med 1988;3(3):230-8.
227. Bergman G, Winters J, Groenier K, Pool J, Meyboom-de Jong B, Postema K, et al. Manipulative Therapy in Addition to Usual Medical Care for Patients with Shoulder Dysfunction and Pain: A Randomized, Controlled Trial. Ann Intern Med 2004;141(6):432-439.

228. Winters JC, Sobel JS, Groenier KH, Arendzen HJ, Meyboom-de Jong B. Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomised, single blind study. BMJ 1997;314(7090):1320-.
229. Winters JC, Jorritsma W, Groenier KH, Sobel JS, Jong BM-d, Arendzen HJ. Treatment of shoulder complaints in general practice: long term results of a randomised, single blind study comparing physiotherapy, manipulation, and corticosteroid injection. BMJ 1999;318(7195):1395-1396.
230. Epstein N, Schwall G. Thoracic spinal stenosis: diagnostic and treatment challenges. Journal of Spinal Disorders 1994;7(3):259-69.
231. Rosenbloom S. Thoracic disc disease and stenosis. Radiol Clin North Am 1991;29(4):765-75.
232. Dagfinrud H KTK, Hagen K B. Physiotherapy interventions for ankylosing spondylitis. In. Issue 1. Art. No.: CD002822. DOI: 10.1002/14651858.CD002822.pub3. ed: Cochrane Database of Systematic Reviews 2008; 2008.
233. Fernandez-de-Las-... C, Alonso-Blanco C, Morales-Cabezas M, Miangolarra-Page J. Two exercise interventions for the management of patients with ankylosing spondylitis: a randomized controlled trial. Am J Phys Med Rehabil 2005;84(6):407-19.
234. NASS. The Bath indices. Outcome measures for use with ankylosing spondylitis patients. In: National Ankylosing Spondylitis Society www.nass.co.uk; 2004.
235. Sigler J, Bluhm G, Duncan H, Ensign D. Clinical features of ankylosing spondylitis. Clin Orthop Relat Res 1971;74:14-9.
236. Khan MA. Ankylosing spondylitis: introductory comments on its diagnosis and treatment. Ann Rheum Dis 2002;61(90003):3iii-7.
237. Smythe H. Therapy of the spondyloarthropathies. Clin Orthop Relat Res 1979(143):84-9.
238. Graham B, Van Peteghem P. Fractures of the spine in ankylosing spondylitis. Diagnosis, treatment, and complications. Spine 1989;14(8):803-7.
239. Rutherford S, Nicolson C, Crowther E. Symptomatic improvement in function and disease activity in a patient with ankylosing spondylitis utilizing a course of chiropractic therapy: a prospective case study. JCCA J Can Chiropr Assoc 2005;49(2):81-91.
240. Milgrom C, Finestone A, Lev B, Wiener M, Floman Y. Overexertional lumbar and thoracic back pain among recruits: a prospective study of risk factors and treatment regimens. J Spinal Disord 1993;6(3):187-93.
241. Hsu J, Joseph T, Ellis A. Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging. Injury 2003;34(6):426-33.
242. Evans SF, Davie MWJ. Vertebral fractures and bone mineral density in idiopathic, secondary and corticosteroid associated osteoporosis in men. Ann Rheum Dis 2000;59(4):269-275.

# APPENDIX

*CHIROPRACTIC MANAGEMENT*
*OF THORACIC SPINE CONDITIONS*
A Literature Synthesis

**Content:**

- **Work Loss Data Institute (WLDI) List of initial considerations on thoracic spine**
- **NUHS literature search parameters from Russ Iwami – April 27 2006**
- **Russ Iwami's credentials**
- **National Guideline Clearinghouse - Reviews**
- **Additional citations identified**
- **Acute Spine Guidelines**
- **SOSORT Scoliosis Guidelines**
- **Scoliosis Graph**

## INITIAL LIST OF CONSIDERATIONS
## As provided by the Work Loss Data Institute (WLDI)

Most studies and guidelines include "thoracic" with "lumbar" or low back, or only cover low back, so many of these references pertain primarily to low back, and they will be used again in the low back chapter.

Overall, there is strong evidence that manipulation is effective in the treatment of back pain compared to many comparison treatments, definitely in acute cases/early stages and possibly in chronic cases, definitely in non-radicular cases and possibly in disc disorders. See Anderson Assendelft5 BackLetter Dagenais DeFranca Erwin FurlanCochrane Haldeman Haldeman3 Koes2 Manga2 MDConsult Mohseni NASS Nyiendo OrthopedicsToday Schiller Shekelle Shekelle2 Sierpina Triano Triano2

However, some found it to be no better than other effective treatments, while also no more risky and with less medication use. See Andersson Assendelft Cherkin2003 Cherkin2 Hawk Rosomoff

There is also limited evidence on the mechanism of action. See Brennan Colloca Herzog Keller Keller2 McClelland Nelson Osterbauer Shannon

Quality studies support the cost effectiveness of chiropractic. See Burton Hess Horwitz Jarvis Korthals Lehman Manga Manga2 Skargren Stano2 TCA Tuchin (However, a recent study reverses an earlier study by the same author; is chiropractic becoming more expensive as utilization increases? See Stano)

Quality studies also support patient satisfaction with chiropractic. See Carey Coulter OrthopedicsToday Pelletier Smith Smucker Sundararajan

Existing treatment guidelines generally recommend at least an initial course of chiropractic as conservative care. See Bigos Bogduk California ColoradoLBP ColoradoTOS DynamicChiropractic Gow Haldeman2 Hutchinson Koes Manniche Minnesota Rosner vanTulder Waddell Washingtonguide WestVirginia

Not a lot of information about adverse effects of spinal manipulation, other than cervical, which will be covered in another chapter. See Assendelft Balblanc Dan Davidson Haneline Lanska Lee Powell Yoshida

Some references suggest that some chiropractors overuse x-rays. See Frymoyer Assendelft

There is a limited number of quality references for some of the less common conditions:

Some studies support use for scoliosis. See Aspegren Blum Danbert Feise Lantz Nykoliation Rowe Tarola

There is also some support for use in Thoracic Outlet Syndrome. See ColoradoTOS Dobrusin Knutson Liebenson Sucher Sucher2 Sucher3

As well as lordosis. See Harrison

Plus chest pain. See Nansel Polkinghorn Wells

## Work Loss Data Institute
## REFERENCES


Aker PD, McDermaid C, Opitz BG, White MW, Searching chiropractic literature: a comparison of three computerized databases, *J Manipulative Physiol Ther*. 1996 Oct;19(8):518-24.

Andersson GB, Lucente T, Davis AM, Kappler RE, Lipton JA, Leurgans S, A comparison of osteopathic spinal manipulation with standard care for patients with low back pain, *N Engl J Med*. 1999 Nov 4;341(19):1426-31.

Anderson R, Meeker WC, Wirick BE, Mootz RD, Kirk DH, Adams A, A meta-analysis of clinical trials of spinal manipulation, *J Manipulative Physiol Ther*. 1992 Mar-Apr;15(3):181-94. [Primarily Low Back]

Aspegren DD, Cox JM, Correction of progressive idiopathic scoliosis utilizing neuromuscular stimulation and manipulation: a case report, *J Manipulative Physiol Ther.* 1987 Aug;10(4):147-56.

Assendelft WJ, Morton SC, Yu EI, Suttorp MJ, Shekelle PG, Spinal manipulative therapy for low back pain. A meta-analysis of effectiveness relative to other therapies, *Ann Intern Med*. 2003 Jun 3;138(11):871-81. [Primarily Low Back]

Assendelft WJJ, Shekelle PG. Spinal manipulative therapy for low -back pain (Protocol for a Cochrane Review). In: *The Cochrane Library*, Issue 2, 2003. Oxford: Update Software [Primarily Low Back]

Assendelft WJ, Bouter LM, Knipschild PG, Wilmink JT, Reliability of lumbar spine radiograph reading by chiropractors, *Spine*. 1997 Jun 1;22(11):1235-41.

Assendelft WJ, Bouter LM, Knipschild PG, Complications of spinal manipulation: a comprehensive review of the literature, *J Fam Pract*. 1996 May;42(5):475-80.

Assendelft WJ, Koes BW, Knipschild PG, Bouter LM, The relationship between methodological quality and conclusions in reviews of spinal manipulation, *JAMA*. 1995 Dec 27;274(24):1942-8.

BackLetter. Spinal manipulation for low back pain: what are the benefits? 2002;17(8):85-94

Balblanc JC, Pretot C, Ziegler F, Vascular complication involving the conus medullaris or cauda equina after vertebral manipulation for an L4-L5 disk herniation, *Rev Rhum Engl Ed.* 1998 Apr;65(4):279-82.

Bigos SJ, editors. Acute low back problems in adults: clinical practice guidelines, number 14 Rockville, MD: US Department of Health and Human Services; 1994.

Blum CL, Chiropractic and pilates therapy for the treatment of adult scoliosis, *J Manipulative Physiol Ther*. 2002 May;25(4):E3

Bogduk N. for the Australasian Faculty of Musculoskeletal Medicine for the National Musculoskeletal Medicine Initiative. Evidence-based clinical guidelines for the management of acute low back pain. Canberra, Australia: National Medical Research Council; 1999.

Boukobza M, Tebeka A, Sichez JP, Capelle L, Thoracic disc herniation and spinal cord compression. MRI and gadolinium-enhancement. [Article in English, French], *J Neuroradiol.* 1993 Dec;20(4):272-9.

Brennan PC, Kokjohn K, Kaltinger CJ, Lohr GE, Glendening C, Hondras MA, McGregor M, Triano JJ, Enhanced phagocytic cell respiratory burst induced by spinal manipulation: potential role of substance P, *J Manipulative Physiol Ther.* 1991 Sep;14(7):399-408.

Brodeur RR, Delre L. Stiffness of the thoracolumbar spine for subjects with and without low back pain. JNMS 1999;7:127-133. [unable to get electronic article/abstract]

Burton AK, Tillotson KM, Cleary J, Single-blind randomised controlled trial of chemonucleolysis and manipulation in the treatment of symptomatic lumbar disc herniation, *Eur Spine J.* 2000 Jun;9(3):202-7.

California Industrial Medical Council, Treatment Guidelines, Low Back Problems, April 17, 1997

Carey, T.S., Garrett, J.M., Jackman, A., and Hadler, N. (1999). "Recurrence and care seeking after acute back pain: Results of a long-term follow-up study." *Medical Care* 37(2), pp. 157-164.

Cherkin DC, Sherman KJ, Deyo RA, Shekelle PG, A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain, *Ann Intern Med.* 2003 Jun 3;138(11):898-906. [Primarily Low Back]

Cherkin DC, Deyo RA, Battie M, Street J, Barlow W. A Comparison of Physical Therapy, Chiropractic Manipulation, and Provision of an Educational Booklet for the Treatment of Patients with Low Back Pain. *NEJM* 1998;339:1021-9.

Colloca CJ, Keller TS, Gunzburg R, Vandeputte K, Fuhr AW, Neurophysiologic response to intraoperative lumbosacral spinal manipulation, *J Manipulative Physiol Ther.* 2000 Sep;23(7):447-57.

Colorado Division of Workers' Compensation, Medical Treatment Guidelines, Rule XVII**,** Low Back Pain, 12/1/01

Colorado Division of Workers' Compensation, Medical Treatment Guidelines, Rule XVII, Thoracic Outlet Syndrome, 3/15/98

Coulter ID, Hurwitz EL, Adams AH, Genovese BJ, Hays R, Shekelle PG, Patients using chiropractors in North America: who are they, and why are they in chiropractic care? *Spine.* 2002 Feb 1;27(3):291-6; discussion 297-8.

Dagenais S, Haldeman S, Chiropractic, Prim Care. 2002 Jun;29(2):419-37

Danbert RJ, Scoliosis: biomechanics and rationale for manipulative treatment, *J Manipulative Physiol Ther.* 1989 Feb;12(1):38-45.

Dan NG, Saccasan PA, Serious complications of lumbar spinal manipulation, *Med J Aust.* 1983 Dec 10-24;2(12):672-3.

Davidson KC, Weiford EC, Dixon GD, Traumatic vertebral artery pseudoaneurysm following chiropractic manipulation, *Radiology*. 1975 Jun;115(3):651-2.

DeFranca GG, Levine LJ, The T4 syndrome, J Manipulative Physiol Ther. 1995 Jan;18(1):34-7.

Dobrusin R, An osteopathic approach to conservative management of thoracic outlet syndromes, *J Am Osteopath Assoc*. 1989 Aug;89(8):1046-50, 1053-7.

Dynamic Chiropractic staff writer. Congress passes historic chiropractic legislation. Dynamic Chiropractic, November 15, 2000.

Erwin WM, Jackson PC, Homonko DA, Innervation of the human costovertebral joint: implications for clinical back pain syndromes, *J Manipulative Physiol Ther*. 2000 Jul-Aug;23(6):395-403.

Feise RJ, An inquiry into chiropractors' intention to treat adolescent idiopathic scoliosis: a telephone survey, *J Manipulative Physiol Ther.* 2001 Mar-Apr;24(3):177-82.

Frymoyer JW, Phillips RB, Newberg AH, MacPherson BV, A comparative analysis of the interpretations of lumbar spinal radiographs by chiropractors and medical doctors, *Spine.* 1986 Dec;11(10):1020-3.

Furlan AD, Brosseau L, Imamura M, Irvin E, Massage for low-back pain: a systematic review within the framework of the Cochrane Collaboration Back Review Group, Spine. 2002 Sep 1;27(17):1896-910. [Primarily Low Back]

Gow P, Griffiths R, Kendall N, et al. New Zealand acute low back pain guide. Auckland, New Zealand: Enigma Publishing; 1998.

Haldeman S, The Evolution of Chiropractic-Science & Theory, Excerpt from Keynote Presentation September 21, 2000, 2000 International Conference on Spinal Manipulation, Reprinted from *FCER Advance*, Winter 2001 issue.

Haldeman S, Chapman-Smith D, Petersen DM Jr. Guidelines for Chiropractic Quality Assurance and Practice Parameters. Proceedings of a consensus conference commissioned by the Congress of Chiropractic State Associations, held at the Mercy Conference Center, Jan. 25-30, 1992. Gaithersburg, MD: Aspen, 1993.

Haldeman S, Cole A, Zigler J, et al. Spinal manipulation in spine care: who? why? when? Presented at the North American Spine Society 17th Annual Meeting, Oct. 29-Nov. 2, 2002, Montreal.

Haneline MT, Croft AC, Frishberg BM, Association of internal carotid artery dissection and chiropractic manipulation, *Neurolog*. 2003 Jan;9(1):35-44.

Harrison DE, Harrison DD, Betz JJ, Janik TJ, Holland B, Colloca CJ, Haas JW, Increasing the cervical lordosis with chiropractic biophysics seated combined extension-compression and transverse load cervical traction with cervical manipulation: Nonrandomized clinical control trial, *J Manipulative Physiol Ther*. 2003 Mar-Apr;26(3):139-51

Hawk C, Long CR, Boulanger KT, Morschhauser E, Fuhr AW, Chiropractic care for patients aged 55 years and older: report from a practice-based research program, *J Am Geriatr Soc*. 2000 May;48(5):534-45.

Herzog W, Kats M, Symons B, The effective forces transmitted by high-speed, low-amplitude thoracic manipulation, *Spine*. 2001 Oct 1;26(19):2105-10; discussion 2110-1.

Herzog W, Conway PJ, Zhang YT, Gal J, Guimaraes AC, Reflex responses associated with manipulative treatments on the thoracic spine: a pilot study, *J Manipulative Physiol Ther.* 1995 May;18(4):233-6.

Hess JA, Mootz RD, Comparison of work and time estimates by chiropractic physicians with those of medical and osteopathic providers, *J Manipulative Physiol Ther.* 1999 Jun;22(5):280-91

Horwitz AD, Hosek R, Boyle J, Cianciulli A, Glass J, Codario R, A new gatekeeper for back pain, *Am J Manag Care.* 1998 Apr;4(4):576-9.

Hutchinson, et al. Clinical guidelines for the management of acute low back pain, London: Quality Improvement Group, The Royal College of General Practitioners; 1999. Also available at: www.rcgp.org.uk

Jarvis KB, Phillips RB, Morris EK, Cost per case comparison of back injury claims of chiropractic versus medical management for conditions with identical diagnostic codes, *J Occup Med.* 1991 Aug;33(8):847-52

Keller TS, Colloca CJ, Mechanical force spinal manipulation increases trunk muscle strength assessed by electromyography: a comparative clinical trial, *J Manipulative Physiol Ther*. 2000 Nov-Dec;23(9):585-95

Keller TS, Colloca CJ, Fuhr AW, In vivo transient vibration assessment of the normal human thoracolumbar spine, *J Manipulative Physiol Ther*. 2000 Oct;23(8):521-30.

Knutson GA, Thermal asymmetry of the upper extremity in scalenus anticus syndrome, leg-length inequality and response to chiropractic adjustment, *J Manipulative Physiol Ther.* 1997 Sep;20(7):476-81.

Koes BW, van Tulder MW, Ostelo R, Kim Burton A, Waddell G, Clinical guidelines for the management of low back pain in primary care: an international comparison, *Spine.* 2001 Nov 15;26(22):2504-13; discussion 2513-4.

Koes BW, Assendelft WJ, van der Heijden GJ, Bouter LM, Knipschild PG, Spinal manipulation and mobilisation for back and neck pain: a blinded review, *BMJ*. 1991 Nov 23;303(6813):1298-303.

Korthals-de Bos IB, Hoving JL, van Tulder MW, Rutten-van Molken MP, Ader HJ, de Vet HC, Koes BW, Vondeling H, Bouter LM, Cost effectiveness of physiotherapy, manual therapy, and general practitioner care for neck pain: economic evaluation alongside a randomised controlled trial, *BMJ*. 2003 Apr 26;326(7395):911.

Lamb K. Thoracic disc herniation: a case report. J Manipulative Physiol Ther 2001;24:58-62. [unable to get electronic article/abstract]

Lanska DJ, Lanska MJ, Fenstermaker R, Selman W, Mapstone T, Thoracic disk herniation associated with chiropractic spinal manipulation, *Arch Neurol*. 1987 Oct;44(10):996-7.

Lantz CA, Chen J, Effect of chiropractic intervention on small scoliotic curves in younger subjects: a time-series cohort design, *J Manipulative Physiol Ther*. 2001 Jul-Aug;24(6):385-93

Lee KP, Carlini WG, McCormick GF, Albers GW, Neurologic complications following chiropractic manipulation: a survey of California neurologists, *Neurology*. 1995 Jun;45(6):1213-5.

Lehman GJ, McGill SM, Spinal manipulation causes variable spine kinematic and trunk muscle electromyographic responses, *Clin Biomech* (Bristol, Avon). 2001 May;16(4):293-9.

Liebenson CS, Thoracic outlet syndrome: diagnosis and conservative management, *J Manipulative Physiol Ther.* 1988 Dec;11(6):493-9.

Manga P, Economic case for the integration of chiropractic services into the health care system, *J Manipulative Physiol Ther*. 2000 Feb;23(2):118-22

Manga P, Angus DE, Papadopoulos C, Swan WR, The Manga Report: A Study to Examine the Effectiveness and Cost-Effectiveness of Chiropractic Management of Low-Back Pain, Funded By The Ontario Ministry Of Health, August 1993. [Primarily Low Back]

Manniche C, editors. Low-back pain: frequency, management and prevention from an HTA perspective Copenhagen, Denmark: Danish Institute for Health Technology Assessment Publishing; 1999.

McClelland G, Chiropractic Research Retrospective, Journal of the American Chiropractic Association, March 2000.

MDConsult, Patient Handouts: Low Back Pain and Sciatica, 2003

Minnesota Rules, Department Of Labor And Industry, 5221.6200, Low Back Pain, 11/01/01

Mohseni-Bandpei MA, Stephenson R, Richardson B, Spinal manipulation in the treatment of low back pain: a review of the literature with particular emphasis on randomized controlled clinical trials. *Physical Therapy Reviews* 1998, 3(4), 185-194.

Mootz RD, Talmage DM. Clinical Assessment Strategies for the Thoracic Area. Top Clinical Chiro 1999; 6(3): 1-19. [unable to get electronic article/abstract]

Nansel D, Szlazak M, Somatic dysfunction and the phenomenon of visceral disease simulation: a probable explanation for the apparent effectiveness of somatic therapy in patients presumed to be suffering from true visceral disease, *J Manipulative Physiol Ther*. 1995 Jul-Aug;18(6):379-97.

NASS learns about chiropractic. Over 2,400 surgeons and other specialists learn how to work with DCs. Dynamic Chiropractic, Dec. 16, 2002

Nelson CF, "Spinal Manipulation and Chiropractic: Views of a Reformist Chiropractor", ACSH: American Council on Science and Health, Volume 11 Number 2 1999

Nyiendo J, Haas M, Goodwin P, Patient characteristics, practice activities, and one-month outcomes for chronic, recurrent low-back pain treated by chiropractors and family medicine physicians: a practice-based feasibility study, *J Manipulative Physiol Ther.* 2000 May;23(4):239-45.

Nykoliation JW, Cassidy JD, Arthur BE, Wedge JH, An algorithm for the management of scoliosis, J Manipulative Physiol Ther. 1986 Mar;9(1):1-14.

Orthopedics Today, Time to recognize value of chiropractic care? Science and patient satisfaction surveys cite usefulness of spinal manipulation. *Orthopedics Today* February 2003:23(2), pp14-15.

Osterbauer PJ, Fuhr AW, Hildebrandt RW, Mechanical force, manually assisted short lever chiropractic adjustment, *J Manipulative Physiol Ther*. 1992 Jun;15(5):309-17.

Pelletier KR, Marie A, Krasner M, Haskell WL, Current trends in the integration and reimbursement of complementary and alternative medicine by managed care, insurance carriers, and hospital providers, *Am J Health Promot*. 1997 Nov-Dec;12(2):112-22.

Polkinghorn BS, Colloca CJ, Chiropractic management of chronic chest pain using mechanical force, manually assisted short-lever adjusting procedures, *J Manipulative Physiol Ther*. 2003 Feb;26(2):108-15.

Powell FC, Hanigan WC, Olivero WC, A risk/benefit analysis of spinal manipulation therapy for relief of lumbar or cervical pain, *Neurosurgery.* 1993 Jul;33(1):73-8; discussion 78-9.

Rosner AL, Delivering the Research Message Effectively, FCER Director of Research and Education, December, 2001

Rosomoff HL, Rosomoff RS, Low back pain. Evaluation and management in the primary care setting, *Med Clin North Am.* 1999 May;83(3):643-62. [Primarily Low Back]

Rowe DE, Bernstein SM, Riddick MF, Adler F, Emans JB, Gardner-Bonneau D, A meta-analysis of the efficacy of non-operative treatments for idiopathic scoliosis, *J Bone Joint Surg Am*. 1997 May;79(5):664-

74. [Note: Manipulation not looked at]

Scariange, J., Ketner C. Manual Methods for the Treatment of Rib Dysfunctions and Associated Lesions. Top Clin Chiro 1999;6(3):20-38. [unable to get electronic article/abstract]

Schiller L, Effectiveness of spinal manipulative therapy in the treatment of mechanical thoracic spine pain: a pilot randomized clinical trial, *J Manipulative Physiol Ther*. 2001 Jul-Aug;24(6):394-401

Shannon R, Respiratory pattern changes during costovertebral joint movement, *J Appl Physiol.* 1980 May;48(5):862-7

Shekelle PG, Coulter I, Hurwitz EL, Genovese B, Adams AH, Mior SA, Brook RH, Congruence between decisions to initiate chiropractic spinal manipulation for low back pain and appropriateness criteria in North America, *Ann Intern Med*. 1998 Jul 1;129(1):9-17.

Shekelle PG, Adams AH, Chassin MR, Hurwitz EL, Brook RH, Spinal manipulation for low-back pain, *Ann Intern Med*. 1992 Oct 1;117(7):590-8.

Sierpina VS, Curtis P, Doering J, AN INTEGRATIVE APPROACH TO LOW BACK PAIN, Review article, Clinics in Family Practice, W. B. Saunders Company, Volume 4 Number 4 December 2002

Skargren EI, Oberg BE, Carlsson PG, Gade M, Cost and effectiveness analysis of chiropractic and physiotherapy treatment for low back and neck pain. Six-month follow-up, *Spine*. 1997 Sep 15;22(18):2167-77.

Smith M, Stano M, Costs and recurrences of chiropractic and medical episodes of low-back care, *J Manipulative Physiol Ther*. 1997 Jan;20(1):5-12.

Smucker, D.R., Konrad, T.R., Curtis, P., and Carey, T.S. (1998). "Practitioner self-confidence and patient outcomes in acute low back pain." *Archives of Family Medicine* 7, pp. 223-228.

Stano M, Haas M, Goldberg B, Traub PM, Nyiendo J, Chiropractic and medical care costs of low back care: results from a practice-based observational study, *Am J Manag Care*. 2002 Sep;8(9):802-9.

Stano M, Smith M, Chiropractic and medical costs of low back care, *Med Care*. 1996 Mar;34(3):191-204

Sucher BM, Palpatory diagnosis and manipulative management of carpal tunnel syndrome: Part 2. 'Double crush' and thoracic outlet syndrome, *J Am Osteopath Assoc*. 1995 Aug;95(8):471-9.

Sucher BM, Thoracic outlet syndrome--a myofascial variant: Part 2. Treatment, *J Am Osteopath Assoc.* 1990 Sep;90(9):810-2, 817-23.

Sucher BM, Thoracic outlet syndrome--a myofascial variant: Part 1. Pathology and diagnosis, J Am Osteopath Assoc. 1990 Aug;90(8):686-96, 703-4.

Sundararajan, V., Konrad, T.R., Garrett, J., and Carey, T. (1998, August). "Patterns and determinants of multiple provider use in patients with acute low back pain." *Journal of General Internal Medicine* 13, pp. 528-533.

Tarola GA, Manipulation for the control of back pain and curve progression in patients with skeletally mature idiopathic scoliosis: two cases, *J Manipulative Physiol Ther.* 1994 May;17(4):253-7.

Texas Chiropractic Association (TCA), Chiropractic Treatment of Workers' Compensation Claimants in the State of Texas. Submitted to the Texas Chiropractic Association by MGT of America, Austin, Texas, February 2003. [Primarily Low Back]

Triano JJ, McGregor M, Hondras MA, Brennan PC, Manipulative therapy versus education programs in chronic low back pain, *Spine.* 1995 Apr 15;20(8):948-55.

Triano JJ, Hondras MA, McGregor M, Differences in treatment history with manipulation for acute, subacute, chronic and recurrent spine pain, *J Manipulative Physiol Ther.* 1992 Jan;15(1):24-30.

Triano, J.J., Erwin, M., Hansen, D.T. Costovertebral and Costotransverse Joint Pain: A Commonly Overlooked Pain Generator. Top Clin Chiro 1999; 6(3): 79-92. [unable to get electronic article/abstract]

Tuchin PJ, Bonello R, Preliminary findings of analysis of chiropractic utilization and cost in the workers' compensation system of New South Wales, Australia, *J Manipulative Physiol Ther*. 1995 Oct;18(8):503-11.

van Tulder MW, Goossens M, Waddell G, Nachemson A, Conservative treatment of chronic low back pain. In: NachemsonA, JonssonE, editors. Swedish SBU report: evidence based treatment for back pain Stockholm/Philadelphia: Swedish Council on Technology Assessment in Health Care (SBU)/Lippincott Williams & Wilkins; 2000.

Waddell G. Chiropractic for low back pain: evidence for manipulation is stronger than that for most orthodox medical treatments. BMJ 1999;318:262.

Washington State Department of Labor and Industries, Medical Treatment Guidelines, Date Introduced: Nov. '95

Wells KA, Nephrolithiasis with unusual initial symptoms, *J Manipulative Physiol Ther*. 2000 Mar-Apr;23(3):196-201.

West Virginia Workers Compensation Treatment Guideline, Low Back Musculoligamentous Injury, 10/1/95

Wilson TA, Branch CL Jr, Thoracic disk herniation, *Am Fam Physician*. 1992 May;45(5):2162-8.

Wood KB, Garvey TA, Gundry C, Heithoff KB, Magnetic resonance imaging of the thoracic spine. Evaluation of asymptomatic individuals, *J Bone Joint Surg Am*. 1995 Nov;77(11):1631-8.

Yoshida S, Nakazawa K, Oda Y, Spontaneous vertebral arteriovenous fistula--case report, *Neurol Med Chir* (Tokyo). 2000 Apr;40(4):211-5.

# NCC Search Parameters
# Reported by Russ Iwami

Search ((((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Humans[Mesh])) NOT (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Letter[ptyp]) AND (Humans[Mesh])) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Editorial[ptyp]) AND (Humans[Mesh]))) AND (Practice Guideline[ptyp])) OR (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Humans[Mesh])) NOT (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Letter[ptyp]) AND (Humans[Mesh])) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Editorial[ptyp]) AND (Humans[Mesh]))) AND (Clinical Trial[ptyp])) OR (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Humans[Mesh])) NOT (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Letter[ptyp]) AND (Humans[Mesh])) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Editorial[ptyp]) AND (Humans[Mesh]))) AND (Meta-Analysis[ptyp])) OR (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Humans[Mesh])) NOT (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Letter[ptyp]) AND (Humans[Mesh])) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Editorial[ptyp]) AND (Humans[Mesh]))) AND (Randomized Controlled Trial[ptyp])) OR (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Humans[Mesh])) NOT (((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Letter[ptyp]) AND (Humans[Mesh])) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("therapy"[Subheading] OR "diagnosis"[Subheading])) NOT ("Case Reports"[Publication Type]) AND (Editorial[ptyp]) AND (Humans[Mesh]))) AND (Review[ptyp]))) OR ((((("Thorax"[MeSH]) OR ("Thoracic Outlet Syndrome"[MeSH]) OR ("Thoracic Wall"[MeSH]) OR ("Thoracic Vertebrae"[MeSH]) OR ("Thoracic Cavity"[MeSH]) OR ("Sternoclavicular Joint"[MeSH]) OR ("Sternocostal Joints"[MeSH]) OR ("Rib Fractures"[MeSH]) OR ("Ribs"[MeSH])) AND ("Posture"[MeSH] OR "Physical Examination"[MeSH major topic] OR "Diagnostic Tests, Routine"[MeSH major topic] OR "Cineradiography"[MeSH major topic] OR "Fluoroscopy"[MeSH major topic] OR "Neuroradiography"[MeSH major topic] OR "Radiographic Image Enhancement"[MeSH major topic] OR "Radiographic Image Enhancement"[MeSH major topic] OR "Radiography, Thoracic"[MeSH major topic] OR "Tomography"[MeSH major topic] OR "Radionuclide Imaging"[MeSH major topic] OR "Ultrasonography"[MeSH major topic] OR "Laboratory Techniques and Procedures"[MeSH major topic] OR "Chiropractic"[MeSH] OR "Complementary Therapies"[MeSH] OR "Exercise Movement Techniques"[MeSH] OR "Physical Therapy Modalities"[MeSH] OR "Activities of Daily Living"[MeSH] OR "Nutrition Therapy"[MeSH major topic] OR "Orthotic Devices"[MeSH] OR "Bed Rest"[MeSH] OR "Relaxation Techniques"[MeSH] OR "Human Engineering"[MeSH] OR "Behavior Therapy"[MeSH] OR "Behavior Control"[MeSH] OR "work hardenable"[All Fields]

OR "work hardened"[All Fields] OR "work hardening"[All Fields] OR "back school"[All Fields] OR "back schools"[All Fields] OR "self care"[MeSH Major Topic] OR "videofluorogram"[All Fields] OR "videofluorograms"[All Fields] OR "videofluorographic"[All Fields] OR "videofluorographically"[All Fields] OR "videofluorographs"[All Fields] OR "videofluorography"[All Fields] OR "videofluorometer"[All Fields] OR "videofluorometry"[All Fields] OR "videofluoroscope"[All Fields] OR "videofluoroscopic"[All Fields] OR "videofluoroscopically"[All Fields] OR "videofluoroscopies"[All Fields] OR "videofluoroscopy"[All Fields] OR "cinefluorogram"[All Fields] OR "cinefluorograms"[All Fields] OR "cinefluorographic"[All Fields] OR "cinefluorographically"[All Fields] OR "cinefluorographs"[All Fields] OR "cinefluorography"[All Fields] OR "cinefluoroscopic"[All Fields] OR "cinefluoroscopically"[All Fields] OR "cinefluoroscopy"[All Fields])) NOT ("Case Reports"[Publication Type]) AND (Clinical Trial[ptyp] OR Meta-Analysis[ptyp] OR Practice Guideline[ptyp] OR Randomized Controlled Trial[ptyp] OR Review[ptyp]) AND (Humans[Mesh]))) NOT ("Geographic Locations"[MeSH])

Search Performed by Russell Iwami
Reference Librarian National University of Health Sciences
200 East Roosevelt Road
Lombard IL 60148-4539
(630)889-6617 (630)495-6658 (fax) riwami@nuhs.edu

## EDUCATIONAL BACKGROUND

1979 University of Illinois, Urbana, Illinois, M.A.L.S. (Library Science)
1976 Northern Illinois University, DeKalb, Illinois, B.A.
Major: English Minor: Journalism

## WORK EXPERIENCE

Full-Time

1988 - present **Reference Librarian** (at Rank of Associated Professor, March 15, 1988-.), National University of Health Sciences (formerly National College of Chiropractic

1986 - 1988 **Reference Librarian** (at Rank of Assistant Professor; at Rank of Associated Professor, March 15, 1988-.), National College of Chiropractic;

1984 - 1986 **Public Services Librarian** (at rank of Instructor, September 1, 1984-August 31, 1985; at rank of Assistant Professor, September 1, 1985-August 31, 1986), National College of Chiropractic

1982 - 1984 **Librarian** (at rank of Instructor), National College of Chiropractic

1979 - 1982 **Assistant Librarian** (without faculty status), National College of Chiropractic

**National Guideline Clearinghouse**
**Reviewed March 28, 2006**

NGC Search Results
Your search criteria: Keyword: Thoracic spine
Your search found 39 related guidelines, which are listed below by relevance.

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. American College of Radiology - Medical Specialty Society. 1998 (revised 2001). 5 pages. [NGC Update Pending] NGC:002480

Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. American Society of Interventional Pain Physicians - Medical Specialty Society. 2003 (revised 2005). 47 pages. NGC:004173

Assessment and management of chronic pain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2005 Nov. 77 pages. NGC:004684

Neck and upper back (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 175 pages. NGC:004692

Guidelines for collaborative practice in endoscopic/thoracoscopic spinal surgery for the general surgeon. Society of American Gastrointestinal Endoscopic Surgeons - Medical Specialty Society. 2003 Oct. 6 pages. NGC:003472

Summary of recommendations for clinical preventive services. American Academy of Family Physicians - Medical Specialty Society. 1996 Nov (revised 2005 Aug). 15 pages. NGC:004570

Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. American Society of Interventional Pain Physicians - Medical Specialty Society. 2003. 79 pages. NGC:002824

K/DOQI clinical practice guidelines for cardiovascular disease in dialysis patients. National Kidney Foundation - Disease Specific Society. 2005 Apr. 153 pages. NGC:004281

Follow-up of renal cell carcinoma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004643

ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. American College of Radiology - Medical Specialty Society. 1998 (revised 2001). 17 pages. NGC:002489

Clinical practice guideline for the management of postoperative pain. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2001 Jul (revised 2002 May). Various pagings. NGC:002510

Diagnosis and treatment of osteoporosis. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2002 Aug (revised 2005 Sep). 61 pages. NGC:004544

Respiratory management following spinal cord injury: a clinical practice guideline for health-care professionals. Consortium for Spinal Cord Medicine - Private Nonprofit Organization. 2005 Jan. 49 pages. NGC:004301

American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. American Gastroenterological Association Institute - Medical Specialty Society. 2003 Sep. 4 pages. NGC:003373

Initial evaluation of the patient with lung cancer: symptoms, signs, laboratory tests, and paraneoplastic syndromes. American College of Chest Physicians - Medical Specialty Society. 2003 Jan. 8 pages. NGC:002865

Lung cancer. Palliative care. American College of Chest Physicians - Medical Specialty Society. 2003 Jan. 28 pages. NGC:002879

Guidelines on diagnosis and treatment of pulmonary arterial hypertension. The Task Force on Diagnosis and Treatment of Pulmonary Arterial Hypertension of the European Society of Cardiology. European Society of Cardiology - Medical Specialty Society. 2004. 36 pages. NGC:004058

Rib fractures. American College of Radiology - Medical Specialty Society. 1995 (revised 2005). 5 pages. NGC:004640

Palliative treatment of cancer. Finnish Medical Society Duodecim - Professional Association. 2001 Dec 27 (revised 2005 Jun 26). Various pagings. NGC:004598

Rotator cuff tear. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003741

Diagnosis of breast disease. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1994 Jan (revised 2005 Nov). 51 pages. NGC:004681

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2004 Nov (revised 2005 Oct). 78 pages. NGC:004683

Follow-up of renal cell carcinoma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004643

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. Canadian Chiropractic Association
Canadian Federation of Chiropractic Regulatory Boards. 2005. 52 pages. NGC:004700

American Association of Clinical Endocrinologists medical guidelines for clinical practice for the prevention and treatment of postmenopausal osteoporosis: 2001 edition, with selected updates for 2003. American Association of Clinical Endocrinologists - Medical Specialty Society
American College of Endocrinology - Medical Specialty Society. 1996 Mar-Apr (updated 2003 Nov-Dec). 21 pages. NGC:003185

Adult basic life support: 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. American Heart Association - Professional Association. 2005 Nov 29. 12 pages. NGC:004731

Fibromyalgia treatment guideline. University of Texas at Austin School of Nursing, Family Nurse Practitioner Program - Academic Institution. 2005 May. 13 pages. NGC:004350

Diagnostic approach to renal trauma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004634

Resuscitation and defibrillation in the health care setting — 2004 revision & update. American Association for Respiratory Care - Professional Association. 1993 Dec (revised 2004 Sep). 15 pages. NGC:004081

Advanced life support: 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. American Heart Association - Professional Association. 2005 Nov 29. 30 pages. NGC:004733

VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2002 Aug. Various pagings. NGC:002641

ACR Appropriateness Criteria™ for bone metastases. American College of Radiology - Medical Specialty Society. 1996 Sep (revised 2003). 28 pages. NGC:003897

Guidelines for the assessment and management of chronic pain. Wisconsin Medical Society - Private Nonprofit Research Organization. 2004. 30 pages. NGC:004040

The pharmacologic management of chronic obstructive pulmonary disease. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2002 Sep. 31 pages. NGC:003568

Low back - lumbar & thoracic (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 430 pages. NGC:004690

Guidelines for emergency tracheal intubation immediately following traumatic injury. Eastern Association for the Surgery of Trauma - Professional Association. 2002. 80 pages. NGC:002448

ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. American College of Radiology - Medical Specialty Society. 1998 (revised 2002). 10 pages. NGC:002782

Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. Consortium for Spinal Cord Medicine - Private Nonprofit Organization
Paralyzed Veterans of America - Private Nonprofit Organization. 1997 Feb (updated 2001 Jul). 29 pages. NGC:002190

Ultrasound scanning during pregnancy. Finnish Medical Society Duodecim - Professional Association. 2000 Apr 3 (revised 2004 Jun 28). Various pagings. NGC:004106

**Guidelines Assessed as potentially Relevant**

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. NGC:2480

Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. NGC:4173

Assessment and management of chronic pain. NGC:4684

American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. NGC:3373

Rib fractures. NGC:4640

Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. NGC:2824

Management of postmenopausal osteoporosis: position statement of The North American Menopause Society. NGC:2405

ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. NGC:2489

Clinical practice guideline for the management of postoperative pain. NGC:2510

Neck and upper back (acute & chronic). NGC:4692

Diagnosis and treatment of osteoporosis. NGC:4544

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). NGC:4683

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. NGC:4700

Fibromyalgia treatment guideline. NGC:4350

VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. NGC:2641

ACR Appropriateness Criteria™ for bone metastases. NGC:3897

Guidelines for the assessment and management of chronic pain. NGC:4040

Low back - lumbar & thoracic (acute & chronic). NGC:4690

ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. NGC:2782

Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. NGC:2190

Your search criteria:

**Keyword:** *chiropractic*

Your search found 38 related guidelines

Overview of implementation of outcome assessment case management in the clinical practice. Washington State Chiropractic Association - Professional Association. 2001. 54 pages. NGC:002012

Vertebral subluxation in chiropractic practice. Council on Chiropractic Practice - Private Nonprofit Organization. 1998 (revised 2003). 201 pages. NGC:003438

Manual medicine guidelines for musculoskeletal injuries. Academy for Chiropractic Education. 2004 Dec 1. 25 pages. NGC:004054

Guideline for the management of fibromyalgia syndrome pain in adults and children. American Pain Society - Professional Association. 2005. 109 pages. NGC:004342

Shoulder (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 162 pages. NGC:004694

Forearm, wrist, & hand. Work Loss Data Institute - Public For Profit Organization. 2004 (revised 2005 Oct 10). 69 pages. NGC:004697

Pain management in the long-term care setting. American Medical Directors Association - Professional Association. 2003. 36 pages. NGC:003522

Carpal tunnel syndrome. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 154 pages. NGC:004687

Elbow (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 115 pages. NGC:004688

Low back - lumbar & thoracic (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 430 pages. NGC:004690

Neck and upper back (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 175 pages. NGC:004692

Knee & leg (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 190 pages. NGC:004691

Ankle and foot. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 124 pages. NGC:004686

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. Canadian Chiropractic Association
Canadian Federation of Chiropractic Regulatory Boards. 2005. 52 pages. NGC:004700

Rotator cuff tear. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003741

The management of persistent pain in older persons. American Geriatrics Society - Medical Specialty Society. 1998 Oct (revised 2002 Jun). 20 pages. NGC:002591

The diagnosis and management of soft tissue knee injuries: internal derangements. New Zealand Guidelines Group - Private Nonprofit Organization. 2003 Jul. 100 pages . NGC:003270

Adult low back pain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1994 Jun (revised 2005 Sep). 64 pages. NGC:004543

Calcaneal/hindfoot injury. Intracorp - Public For Profit Organization. 2005. Various pagings. NGC:004392

Special treatment situations: alternative headache treatments. Standards of care for headache diagnosis and treatment. National Headache Foundation - Private Nonprofit Organization. 2004. 8 pages. NGC:004148

Chronic fatigue syndrome. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003912

Fibromyalgia. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003913

Management of fibromyalgia syndrome. American Pain Society Fibromyalgia Panel - Independent Expert Panel. 2004 Nov 17. 8 pages. NGC:004057

Cyclic perimenstrual pain and discomfort: nursing management. Evidence-based clinical practice guideline. Association of Women's Health, Obstetric, and Neonatal Nurses - Professional Association. 2003. 48 pages. NGC:004302

Allergic rhinitis and its impact on asthma. Allergic Rhinitis and its Impact on Asthma Workshop Group - Independent Expert Panel. 2001 Nov. 188 pages. NGC:002647

North American Spine Society Phase III: clinical guidelines for multidisciplinary spine care specialists. Spinal stenosis version 1.0. North American Spine Society - Medical Specialty Society. 2002. 91 pages. NGC:002835

Intradiscal electrotherapy. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003745

Low back. Expert Clinical Benchmarks - Private For Profit Organization. 2003. 52 pages. NGC:003946

Upper extremity (shoulder and elbow). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003996

Lower extremity (hip, knee and ankle). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 55 pages. NGC:003997

Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for neck pain. Philadelphia Panel - Independent Expert Panel. 2001 Oct. 17 pages. NGC:004017

Cervical/thoracic. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 49 pages. NGC:003995

Hand-wrist. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003998

Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain. Philadelphia Panel - Independent Expert Panel. 2001 Oct. 34 pages. NGC:004016

Pain management guidelines. Health Care Association of New Jersey - Private Nonprofit Organization. 2005 Jan. 18 pages. NGC:004177

AAOS clinical guideline on shoulder pain. American Academy of Orthopaedic Surgeons - Medical Specialty Society
American Academy of Physical Medicine and Rehabilitation - Medical Specialty Society
American College of Rheumatology - Medical Specialty Society. 2001. 24 pages. NGC:002224

Evidence based clinical practice guideline for medical management of otitis media with effusion in children 2 months to 13 years of age. Cincinnati Children's Hospital Medical Center - Hospital/Medical Center. 1999 (revised 2004 Oct). 11 pages. NGC:003957

Evidence based clinical practice guideline for medical management of acute otitis media in children 2 months to 13 years of age. Cincinnati Children's Hospital Medical Center - Hospital/Medical Center. 1999 (2004 Oct 29). 16 pages. NGC:003958

Considered Guidelines

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. NGC:2480
Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. NGC:4173
Assessment and management of chronic pain. NGC:4684
American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. NGC:3373
Rib fractures. NGC:4640
Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. NGC:2824
Management of postmenopausal osteoporosis: position statement of The North American Menopause Society. NGC:2405
ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. NGC:2489
Clinical practice guideline for the management of postoperative pain. NGC:2510
Neck and upper back (acute & chronic). NGC:4692
Diagnosis and treatment of osteoporosis. NGC:4544
Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). NGC:4683
Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. NGC:4700
Fibromyalgia treatment guideline. NGC:4350
VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. NGC:2641
ACR Appropriateness Criteria™ for bone metastases. NGC:3897
Guidelines for the assessment and management of chronic pain. NGC:4040
Low back - lumbar & thoracic (acute & chronic). NGC:4690
ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. NGC:2782
Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. NGC:2190
Overview of implementation of outcome assessment case management in the clinical practice. NGC:2012
Manual medicine guidelines for musculoskeletal injuries. NGC:4054
Guideline for the management of fibromyalgia syndrome pain in adults and children. NGC:4342
Shoulder (acute & chronic). NGC:4694
Pain management in the long-term care setting. NGC:3522
Chronic fatigue syndrome. NGC:3912
Fibromyalgia. NGC:3913
Management of fibromyalgia syndrome. NGC:4057
Allergic rhinitis and its impact on asthma. NGC:2647
North American Spine Society Phase III: clinical guidelines for multidisciplinary spine care specialists. Spinal stenosis version 1.0. NGC:2835
Cervical/thoracic. NGC:3995
Pain management guidelines. NGC:4177

NGC search April 25, 2006
Keyword: Manipulation

Your search found 112 related guidelines, which are listed below by relevance. Use the "Limit Search" button to sort by publication date.

To view a guideline summary, click on a title below.

Items 1 to 112

Title

Manual medicine guidelines for musculoskeletal injuries. Academy for Chiropractic Education. 2004 Dec 1. 25 pages. NGC:004054
Other Guidelines from this Developer

Vertebral subluxation in chiropractic practice. Council on Chiropractic Practice - Private Nonprofit Organization. 1998 (revised 2003). 201 pages. NGC:003438
Other Guidelines from this Developer

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. Canadian Chiropractic Association
Canadian Federation of Chiropractic Regulatory Boards. 2005. 52 pages. NGC:004700
Other Guidelines from this Developer

Fibromyalgia. Washington State Department of Labor and Industries - State/Local Government Agency [U.S.]. 1998 Nov (revised 1999 Jun; republished 2002 Aug). 5 pages. NGC:003224
Other Guidelines from this Developer

Chronic ankle pain. American College of Radiology - Medical Specialty Society. 1998 (revised 2005). 8 pages. NGC:004617
Other Guidelines from this Developer

Shoulder (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 162 pages. [NGC Update Pending] NGC:004694
Other Guidelines from this Developer

Pain management guidelines. Health Care Association of New Jersey - Private Nonprofit Organization. 2005 Jan. 18 pages. NGC:004177
Other Guidelines from this Developer

Knee & leg (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 190 pages. NGC:004691
Other Guidelines from this Developer

Overview of implementation of outcome assessment case management in the clinical practice. Washington State Chiropractic Association - Professional Association. 2001. 54 pages. NGC:002012
Other Guidelines from this Developer

Guideline for the management of fibromyalgia syndrome pain in adults and children. American Pain Society - Professional Association. 2005. 109 pages. NGC:004342
Other Guidelines from this Developer

Neck and upper back (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 175 pages. [NGC Update Pending] NGC:004692
Other Guidelines from this Developer

Pain management in the long-term care setting. American Medical Directors Association - Professional Association. 2003. 36 pages. NGC:003522
Other Guidelines from this Developer

Forearm, wrist, & hand. Work Loss Data Institute - Public For Profit Organization. 2004 (revised 2005 Oct 10). 69 pages. NGC:004697
Other Guidelines from this Developer

Elbow (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 115 pages. NGC:004688
Other Guidelines from this Developer

Carpal tunnel syndrome. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 154 pages. NGC:004687
Other Guidelines from this Developer

Low back - lumbar & thoracic (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 430 pages. [NGC Update Pending] NGC:004690
Other Guidelines from this Developer

Ankle and foot. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 124 pages. [NGC Update Pending] NGC:004686
Other Guidelines from this Developer

Diagnosis and treatment of pediatric flatfoot. American College of Foot and Ankle Surgeons - Medical Specialty Society. 2004 Nov/Dec. 33 pages. NGC:004086
Other Guidelines from this Developer

Hand-wrist. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003998
Other Guidelines from this Developer

Upper extremity (shoulder and elbow). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003996
Other Guidelines from this Developer

Lower extremity (hip, knee and ankle). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 55 pages. NGC:003997
Other Guidelines from this Developer

Screening for developmental dysplasia of the hip: recommendation statement. United States Preventive Services Task Force - Independent Expert Panel. 2006. 10 pages. NGC:004705
Other Guidelines from this Developer

Pain. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 182 pages. NGC:004693
Other Guidelines from this Developer

Prevention of Rh D alloimmunization. American College of Obstetricians and Gynecologists - Medical Specialty Society. 1999 May (reviewed 2004). 8 pages. NGC:003092
Other Guidelines from this Developer

Clinical policy guidelines. National Abortion Federation - Professional Association. 1996 (revised 2005) . 52 pages. [NGC Update Pending] NGC:004087
Other Guidelines from this Developer

Placenta previa: antepartum hemorrhage. Intracorp - Public For Profit Organization. 2005. Various pagings. NGC:004413
Other Guidelines from this Developer

Practice parameter for the assessment and treatment of children and adolescents with enuresis. American Academy of Child and Adolescent Psychiatry - Medical Specialty Society. 2004. 18 pages. NGC:004079
Other Guidelines from this Developer

Guidelines for the management of leg ulcers in Ireland. Smith and Nephew, Ltd. - Private For Profit Organization. 2002. 44 pages. NGC:002842
Other Guidelines from this Developer

Gestational diabetes. American College of Obstetricians and Gynecologists - Medical Specialty Society. 2001 Sep . 14 pages. NGC:003118
Other Guidelines from this Developer

Operative vaginal delivery. American College of Obstetricians and Gynecologists - Medical Specialty Society. 2000 Jun (reviewed 2005). 8 pages. NGC:003105
Other Guidelines from this Developer

Screening for HIV: recommendation statement. United States Preventive Services Task Force - Independent Expert Panel. 2005 Jul 1. 13 pages. NGC:004292
Other Guidelines from this Developer

Perinatal care at the threshold of viability. American Academy of Pediatrics - Medical Specialty Society. 2002 Nov. 4 pages. NGC:002754
Other Guidelines from this Developer

Management of labor. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2005 Oct. 73 pages. NGC:004596
Other Guidelines from this Developer

Domestic violence. A guide to screening and intervention. Brigham and Women's Hospital (Boston) - Hospital/Medical Center. 2004. 11 pages. NGC:004074
Other Guidelines from this Developer

Management of herpes in pregnancy. American College of Obstetricians and Gynecologists - Medical Specialty Society. 1999 Oct (reviewed 2004). 10 pages. NGC:003096
Other Guidelines from this Developer

Trial of labor after cesarean (TOLAC), formerly trial of labor versus elective repeat cesarean section for the woman with a previous cesarean section. American Academy of Family Physicians - Medical Specialty Society. 1995 Apr (revised 2005 Mar). 18 pages. NGC:004454
Other Guidelines from this Developer

Cervical/thoracic. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 49 pages. NGC:003995
Other Guidelines from this Developer

Care of women with breech presentation or previous caesarean birth. New Zealand Guidelines Group - Private Nonprofit Organization. 2004 Nov. 80 pages. NGC:003986
Other Guidelines from this Developer

Fibromyalgia. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003913
Other Guidelines from this Developer

Multiple gestation. Intracorp - Public For Profit Organization. 2005. Various pagings. NGC:004408
Other Guidelines from this Developer

Hypertensive disorders of pregnancy: pre-eclampsia, eclampsia. Intracorp - Public For Profit Organization. 2005. Various pagings. NGC:004403
Other Guidelines from this Developer

Fetal macrosomia. American College of Obstetricians and Gynecologists - Medical Specialty Society. 2000 Nov (reviewed 2005). 11 pages. NGC:003110
Other Guidelines from this Developer

Thrombocytopenia in pregnancy. American College of Obstetricians and Gynecologists - Medical Specialty Society. 1999 Sep (reviewed 2004). 12 pages. NGC:003094
Other Guidelines from this Developer

Expert consensus document on management of cardiovascular diseases during pregnancy. European Society of Cardiology - Medical Specialty Society. 2003 Apr. 21 pages. NGC:002993
Other Guidelines from this Developer

Thyroid disease in pregnancy. American College of Obstetricians and Gynecologists - Medical Specialty Society. 2001 (revised 2002 Aug). 10 pages. NGC:003124
Other Guidelines from this Developer

2002 national guideline for the management of genital herpes. British Association of Sexual Health and HIV - Medical Specialty Society. 1999 Aug (revised 2002). Various pagings. NGC:002261
Other Guidelines from this Developer

Management of HIV in pregnancy. Royal College of Obstetricians and Gynaecologists - Medical Specialty Society. 2004 Apr. 12 pages. NGC:004475
Other Guidelines from this Developer

Public Health Service Task Force recommendations for use of antiretroviral drugs in pregnant HIV-1-infected women for maternal health and interventions to reduce perinatal HIV-1 transmission in the United States. Centers for Disease Control and Prevention - Federal Government Agency [U.S.]
Department of Health and Human Services (U.S.) - Federal Government Agency [U.S.]
Public Health Service (U.S.) - Federal Government Agency [U.S.]. 1998 Jan 30 (revised 2005 Nov 17). 57 pages. NGC:004685
Other Guidelines from this Developer

Caesarean section. National Collaborating Centre for Women's and Children's Health - National Government Agency [Non-U.S.]. 2004 Apr. 38 pages. NGC:003544
Other Guidelines from this Developer

Ankle sprain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1997 Aug (revised 2003 Jul). 26 pages. [NGC Update Pending] NGC:003191
Other Guidelines from this Developer

Diagnosis and management of preeclampsia and eclampsia. American College of Obstetricians and Gynecologists - Medical Specialty Society. 2002 Jan. 9 pages. NGC:003120
Other Guidelines from this Developer

Antepartum fetal surveillance. American College of Obstetricians and Gynecologists - Medical Specialty Society. 1999 Oct (reviewed 2004). 12 pages. NGC:003097
Other Guidelines from this Developer

American Gastroenterological Association medical position statement: perianal Crohn's disease. American Gastroenterological Association Institute - Medical Specialty Society. 2003 Nov. 5 pages. NGC:003372
Other Guidelines from this Developer

Special populations. Sexually transmitted diseases treatment guidelines 2002. Centers for Disease Control and Prevention - Federal Government Agency [U.S.]. 1993 (revised 2002 May 10). 3 pages. NGC:002457

Other Guidelines from this Developer

AASLD position paper: the management of acute liver failure. American Association for the Study of Liver Diseases - Private Nonprofit Research Organization. 2005 May. 19 pages. NGC:004332
Other Guidelines from this Developer

Diagnosis and treatment of adult degenerative joint disease (DJD) of the knee. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1996 Jun (revised 2004 Nov). 43 pages. NGC:003972
Other Guidelines from this Developer

American Gastroenterological Association medical position statement: diagnosis and treatment of gastroparesis. American Gastroenterological Association Institute - Medical Specialty Society. 2004 Nov. 3 pages. NGC:003938
Other Guidelines from this Developer

Cancer pain. Singapore Ministry of Health - National Government Agency [Non-U.S.]. 2003 Mar. 88 pages. NGC:002974
Other Guidelines from this Developer

Shoulder dystocia. American College of Obstetricians and Gynecologists - Medical Specialty Society. 1997 (revised 2002 Nov). 6 pages. NGC:003127
Other Guidelines from this Developer

Low back. Expert Clinical Benchmarks - Private For Profit Organization. 2003. 52 pages. NGC:003946
Other Guidelines from this Developer

Adult low back pain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1994 Jun (revised 2005 Sep). 64 pages. NGC:004543
Other Guidelines from this Developer

VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2002 Aug. Various pagings. NGC:002641
Other Guidelines from this Developer

The diagnosis and management of soft tissue knee injuries: internal derangements. New Zealand Guidelines Group - Private Nonprofit Organization. 2003 Jul. 100 pages . NGC:003270
Other Guidelines from this Developer

Treatment of menopause-associated vasomotor symptoms: position statement of The North American Menopause Society. The North American Menopause Society - Private Nonprofit Organization. 2004 Jan. 23 pages. NGC:003358
Other Guidelines from this Developer

Practice parameters for the management of anal fissures (revised). American Society of Colon and Rectal Surgeons - Medical Specialty Society. 1992 (revised 2004 Dec). 5 pages. NGC:004075
Other Guidelines from this Developer

(1) Part I. Guidelines for the management of severe traumatic brain injury. In: Management and prognosis of severe traumatic brain injury. (2) Update notice. Guidelines for the management of severe traumatic brain injury: cerebral perfusion pressure. American Association of Neurological Surgeons - Medical Specialty Society
Brain Trauma Foundation - Disease Specific Society. 2000 (revised 2003). 165 pages. NGC:003020

Other Guidelines from this Developer

Metabolic measurement using indirect calorimetry during mechanical ventilation — 2004 revision & update. American Association for Respiratory Care - Professional Association. 1994 Dec (revised 2004 Sep). 7 pages. NGC:004084
Other Guidelines from this Developer

Deep venous thrombosis. Finnish Medical Society Duodecim - Professional Association. 2001 Apr 30 (revised 2005 Feb 8). Various pagings. NGC:004098
Other Guidelines from this Developer

Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. Centers for Disease Control and Prevention - Federal Government Agency [U.S.]. 2005 Dec 30. 142 pages. NGC:004748
Other Guidelines from this Developer

Acute low back pain. University of Michigan Health System - Academic Institution. 1997 (revised 2003 Apr; modified 2004 Oct following FDA drug withdrawal). 13 pages. NGC:003157
Other Guidelines from this Developer

Guidelines for surgical treatment of gastroesophageal reflux disease (GERD). Society of American Gastrointestinal Endoscopic Surgeons - Medical Specialty Society. 1998 Feb (revised 2001 Jun). 6 pages. NGC:002373
Other Guidelines from this Developer

Diagnosis and treatment of headache. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1998 Aug (revised 2006 Jan). 70 pages. NGC:004769
Other Guidelines from this Developer

Difficult Airway Society guidelines for management of the unanticipated difficult intubation. Difficult Airway Society - Medical Specialty Society. 2004 Jul. 20 pages. NGC:003982
Other Guidelines from this Developer

American Gastroenterological Association medical position statement: guidelines for the evaluation of food allergies. American Gastroenterological Association Institute - Medical Specialty Society. 2000 Nov 12 (reviewed 2001). 3 pages. NGC:002285
Other Guidelines from this Developer

Clinical guideline on antibiotic prophylaxis for dental patients at risk for infection. American Academy of Pediatric Dentistry - Professional Association. 2002 (revised 2005). 3 pages. NGC:004441
Other Guidelines from this Developer

Practice parameter: management of dementia (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology. American Academy of Neurology - Medical Specialty Society. 2001 May. 13 pages. NGC:002044
Other Guidelines from this Developer

Safe handling of hazardous drugs. Oncology Nursing Society - Professional Association. 1997 (revised 2003). 26 pages. NGC:003180
Other Guidelines from this Developer

Guideline on diagnostic facet medial nerve branch blocks and facet neurotomy. Washington State Department of Labor and Industries - State/Local Government Agency [U.S.]. 2003 Sep 15 (revised 2005 Aug). 6 pages. NGC:004706
Other Guidelines from this Developer

Screening for Rh(D) incompatibility: recommendation statement. United States Preventive Services Task Force - Independent Expert Panel. 2004 Feb 24. 4 pages. NGC:003455
Other Guidelines from this Developer

AACE/AAES medical/surgical guidelines for clinical practice: management of thyroid carcinoma. American Association of Clinical Endocrinologists - Medical Specialty Society
American Association of Endocrine Surgeons - Medical Specialty Society
American College of Endocrinology - Medical Specialty Society. 1997 (updated 2001 May-Jun). 19 pages. NGC:002074
Other Guidelines from this Developer

British guideline on the management of asthma. A clinical national guideline. British Thoracic Society - Medical Specialty Society
Scottish Intercollegiate Guidelines Network - National Government Agency [Non-U.S.]. 2003 Jan (revised 2005 Nov). 94 pages. NGC:004671
Other Guidelines from this Developer

Upper extremity musculoskeletal disorders. Brigham and Women's Hospital (Boston) - Hospital/Medical Center. 2003. 9 pages. NGC:002920
Other Guidelines from this Developer

Guidelines of care for atopic dermatitis. American Academy of Dermatology - Medical Specialty Society. 2004 Mar. 14 pages. NGC:003286
Other Guidelines from this Developer

Inpatient treatment of headache: an evidence-based assessment. US Headache Guidelines Consortium - Private Nonprofit Research Organization. 2004 Apr. 19 pages. NGC:003927
Other Guidelines from this Developer

Suspected small bowel obstruction. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 5 pages. NGC:004782
Other Guidelines from this Developer

Head. Work Loss Data Institute - Public For Profit Organization. 2006. 133 pages. NGC:004889
Other Guidelines from this Developer

Tularemia as a biological weapon. Medical and public health management. Center for Biosecurity - Academic Institution. 2001 June 6. 11 pages. NGC:002207
Other Guidelines from this Developer

ACC/AHA 2004 guideline update for coronary artery bypass graft surgery: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1999 Guidelines for Coronary Artery Bypass Graft Surgery). American College of Cardiology Foundation - Medical Specialty Society
American Heart Association - Professional Association. 1999 Oct (revised 2004). 99 pages. NGC:003768
Other Guidelines from this Developer

Imaging strategies in the initial evaluation of the jaundiced patient. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 6 pages. NGC:004626
Other Guidelines from this Developer

Practice parameter for the assessment and treatment of youth in juvenile detention and correctional facilities. American Academy of Child and Adolescent Psychiatry - Medical Specialty Society. 2004. 19 pages. NGC:004077
Other Guidelines from this Developer

Common gynecologic problems: a guide to diagnosis and treatment. Brigham and Women's Hospital (Boston) - Hospital/Medical Center. 2002. 11 pages. NGC:002712
Other Guidelines from this Developer

Clinical guideline on behavior guidance for the pediatric dental patient. American Academy of Pediatric Dentistry - Professional Association. 2000 (revised 2005). 12 pages. NGC:004438
Other Guidelines from this Developer

Clinical practice guideline (second edition) for the diagnosis, treatment, and management of reflex sympathetic dystrophy/complex regional pain syndrome (RSD/CRPS). Reflex Sympathetic Dystrophy Syndrome Association - Private Nonprofit Organization. 2002 Feb. 46 pages. NGC:002430
Other Guidelines from this Developer

ACR Appropriateness Criteria™ for bone metastases. American College of Radiology - Medical Specialty Society. 1996 Sep (revised 2003). 28 pages. NGC:003897
Other Guidelines from this Developer

Smallpox vaccination and adverse reactions. Guidance for clinicians. Centers for Disease Control and Prevention - Federal Government Agency [U.S.]. 2003 Jan 24. 29 pages. NGC:002823
Other Guidelines from this Developer

Infection control. Prevention of healthcare-associated infection in primary and community care. National Collaborating Centre for Nursing and Supportive Care - National Government Agency [Non-U.S.]. 2003 Jun. 257 pages. NGC:003553
Other Guidelines from this Developer

Recommendations for the management of intracranial arteriovenous malformations: a statement for healthcare professionals from a special writing group of the Stroke Council, American Stroke Association. American Heart Association - Professional Association
American Stroke Association - Disease Specific Society. 2001 Jun. 14 pages. NGC:003660
Other Guidelines from this Developer

ASGE guideline: the role of ERCP in diseases of the biliary tract and the pancreas. American Society for Gastrointestinal Endoscopy - Medical Specialty Society. 2005 Jul. 8 pages. NGC:004486
Other Guidelines from this Developer

The vulvodynia guideline. American Society for Colposcopy and Cervical Pathology - Medical Specialty Society. 2005 Jan. 12 pages. NGC:004188
Other Guidelines from this Developer

Contraception and family planning. A guide to counseling and management. Brigham and Women's Hospital (Boston) - Hospital/Medical Center. 2005. 15 pages. NGC:004298
Other Guidelines from this Developer

Medical management of the acute radiation syndrome: recommendations of the Strategic National Stockpile Radiation Working Group. Strategic National Stockpile - Federal Government Agency [U.S.]. 2004 Jun 15. 15 pages. NGC:003921
Other Guidelines from this Developer

Reflex sympathetic dystrophy/complex regional pain syndrome clinical practice guidelines - third edition. International Research Foundation for RSD/CRPS - Private Nonprofit Research Organization. 2003 Jan 1. 48 pages. NGC:003162
Other Guidelines from this Developer

Diagnosis and treatment of first metatarsophalangeal joint disorders. American College of Foot and Ankle Surgeons - Medical Specialty Society. 2003 May-Jun. 43 pages. NGC:003064

Other Guidelines from this Developer

Practice parameters for colon cancer. American Society of Colon and Rectal Surgeons - Medical Specialty Society. 2004 Aug. 16 pages. NGC:003956
Other Guidelines from this Developer

Health supervision for children with achondroplasia. American Academy of Pediatrics - Medical Specialty Society. 2005 Sep. 13 pages. NGC:004494
Other Guidelines from this Developer

Medication-assisted treatment for opioid addiction in opioid treatment programs: Clinical pharmacotherapy. Substance Abuse and Mental Health Services Administration (U.S.) - Federal Government Agency [U.S.]. 2005. 23 pages. NGC:004672
Other Guidelines from this Developer

Medication-assisted treatment for opioid addiction in opioid treatment programs: Associated medical problems in patients who are opioid addicted. Substance Abuse and Mental Health Services Administration (U.S.) - Federal Government Agency [U.S.]. 2005. 18 pages. NGC:004677
Other Guidelines from this Developer

Guidelines for collaborative practice in endoscopic/thoracoscopic spinal surgery for the general surgeon. Society of American Gastrointestinal Endoscopic Surgeons - Medical Specialty Society. 2003 Oct. 6 pages. NGC:003472
Other Guidelines from this Developer

ACC/AHA/ESC guidelines for the management of patients with supraventricular arrhythmias. A report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients with Supraventricular Arrhythmias). American College of Cardiology Foundation - Medical Specialty Society
American Heart Association - Professional Association
European Society of Cardiology - Medical Specialty Society. 2003. 62 pages. NGC:003183
Other Guidelines from this Developer

Evidence based clinical practice guideline for managing an acute exacerbation of asthma. Cincinnati Children's Hospital Medical Center - Hospital/Medical Center. 1998 Jul 20 (revised 2002 Sep 3). 21 pages. NGC:002670
Other Guidelines from this Developer

Non-pharmacologic management of agitated behaviors in persons with Alzheimer disease and other chronic dementing illnesses. University of Iowa Gerontological Nursing Interventions Research Center, Research Dissemination Core - Academic Institution. 1996 (revised 2004). 54 pages. NGC:003992
Other Guidelines from this Developer

Cyclic perimenstrual pain and discomfort: nursing management. Evidence-based clinical practice guideline. Association of Women's Health, Obstetric, and Neonatal Nurses - Professional Association. 2003. 48 pages. NGC:004302
Other Guidelines from this Developer

NGC: March 28, 2006
NGC Search Results
Your search criteria: Keyword: Thoracic spine

Your search found 39 related guidelines, which are listed below by relevance.

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. American College of Radiology - Medical Specialty Society. 1998 (revised 2001). 5 pages. [NGC Update Pending] NGC:002480

Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. American Society of Interventional Pain Physicians - Medical Specialty Society. 2003 (revised 2005). 47 pages. NGC:004173

Assessment and management of chronic pain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2005 Nov. 77 pages. NGC:004684

Neck and upper back (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 175 pages. NGC:004692

Guidelines for collaborative practice in endoscopic/thoracoscopic spinal surgery for the general surgeon. Society of American Gastrointestinal Endoscopic Surgeons - Medical Specialty Society. 2003 Oct. 6 pages. NGC:003472

Summary of recommendations for clinical preventive services. American Academy of Family Physicians - Medical Specialty Society. 1996 Nov (revised 2005 Aug). 15 pages. NGC:004570

Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. American Society of Interventional Pain Physicians - Medical Specialty Society. 2003. 79 pages. NGC:002824

K/DOQI clinical practice guidelines for cardiovascular disease in dialysis patients. National Kidney Foundation - Disease Specific Society. 2005 Apr. 153 pages. NGC:004281

Follow-up of renal cell carcinoma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004643

ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. American College of Radiology - Medical Specialty Society. 1998 (revised 2001). 17 pages. NGC:002489

Clinical practice guideline for the management of postoperative pain. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2001 Jul (revised 2002 May). Various pagings. NGC:002510

Diagnosis and treatment of osteoporosis. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2002 Aug (revised 2005 Sep). 61 pages. NGC:004544

Respiratory management following spinal cord injury: a clinical practice guideline for health-care professionals. Consortium for Spinal Cord Medicine - Private Nonprofit Organization. 2005 Jan. 49 pages. NGC:004301

American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. American Gastroenterological Association Institute - Medical Specialty Society. 2003 Sep. 4 pages. NGC:003373

Initial evaluation of the patient with lung cancer: symptoms, signs, laboratory tests, and paraneoplastic syndromes. American College of Chest Physicians - Medical Specialty Society. 2003 Jan. 8 pages. NGC:002865

Lung cancer. Palliative care. American College of Chest Physicians - Medical Specialty Society. 2003 Jan. 28 pages. NGC:002879

Guidelines on diagnosis and treatment of pulmonary arterial hypertension. The Task Force on Diagnosis and Treatment of Pulmonary Arterial Hypertension of the European Society of Cardiology. European Society of Cardiology - Medical Specialty Society. 2004. 36 pages. NGC:004058

Rib fractures. American College of Radiology - Medical Specialty Society. 1995 (revised 2005). 5 pages. NGC:004640

Palliative treatment of cancer. Finnish Medical Society Duodecim - Professional Association. 2001 Dec 27 (revised 2005 Jun 26). Various pagings. NGC:004598

Rotator cuff tear. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003741

Diagnosis of breast disease. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1994 Jan (revised 2005 Nov). 51 pages. NGC:004681

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Institute for Clinical Systems Improvement - Private Nonprofit Organization. 2004 Nov (revised 2005 Oct). 78 pages. NGC:004683

Follow-up of renal cell carcinoma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004643

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. Canadian Chiropractic Association
Canadian Federation of Chiropractic Regulatory Boards. 2005. 52 pages. NGC:004700

American Association of Clinical Endocrinologists medical guidelines for clinical practice for the prevention and treatment of postmenopausal osteoporosis: 2001 edition, with selected updates for 2003. American Association of Clinical Endocrinologists - Medical Specialty Society
American College of Endocrinology - Medical Specialty Society. 1996 Mar-Apr (updated 2003 Nov-Dec). 21 pages. NGC:003185

Adult basic life support: 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. American Heart Association - Professional Association. 2005 Nov 29. 12 pages. NGC:004731

Fibromyalgia treatment guideline. University of Texas at Austin School of Nursing, Family Nurse Practitioner Program - Academic Institution. 2005 May. 13 pages. NGC:004350

Diagnostic approach to renal trauma. American College of Radiology - Medical Specialty Society. 1996 (revised 2005). 4 pages. NGC:004634

Resuscitation and defibrillation in the health care setting — 2004 revision & update. American Association for Respiratory Care - Professional Association. 1993 Dec (revised 2004 Sep). 15 pages. NGC:004081

Advanced life support: 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. American Heart Association - Professional Association. 2005 Nov 29. 30 pages. NGC:004733

VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2002 Aug. Various pagings. NGC:002641

ACR Appropriateness Criteria™ for bone metastases. American College of Radiology - Medical Specialty Society. 1996 Sep (revised 2003). 28 pages. NGC:003897

Guidelines for the assessment and management of chronic pain. Wisconsin Medical Society - Private Nonprofit Research Organization. 2004. 30 pages. NGC:004040

The pharmacologic management of chronic obstructive pulmonary disease. Department of Defense - Federal Government Agency [U.S.]
Department of Veterans Affairs - Federal Government Agency [U.S.]
Veterans Health Administration - Federal Government Agency [U.S.]. 2002 Sep. 31 pages. NGC:003568

Low back - lumbar & thoracic (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 430 pages. NGC:004690

Guidelines for emergency tracheal intubation immediately following traumatic injury. Eastern Association for the Surgery of Trauma - Professional Association. 2002. 80 pages. NGC:002448

ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. American College of Radiology - Medical Specialty Society. 1998 (revised 2002). 10 pages. NGC:002782

Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. Consortium for Spinal Cord Medicine - Private Nonprofit Organization
Paralyzed Veterans of America - Private Nonprofit Organization. 1997 Feb (updated 2001 Jul). 29 pages. NGC:002190

Ultrasound scanning during pregnancy. Finnish Medical Society Duodecim - Professional Association. 2000 Apr 3 (revised 2004 Jun 28). Various pagings. NGC:004106

**Guidelines Assessed for Relevance**

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. NGC:2480

Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. NGC:4173

Assessment and management of chronic pain. NGC:4684

American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. NGC:3373

Rib fractures. NGC:4640

Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. NGC:2824

Management of postmenopausal osteoporosis: position statement of The North American Menopause Society. NGC:2405

ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. NGC:2489

Clinical practice guideline for the management of postoperative pain. NGC:2510

Neck and upper back (acute & chronic). NGC:4692

Diagnosis and treatment of osteoporosis. NGC:4544

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). NGC:4683

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. NGC:4700

Fibromyalgia treatment guideline. NGC:4350

VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. NGC:2641

ACR Appropriateness Criteria™ for bone metastases. NGC:3897

Guidelines for the assessment and management of chronic pain. NGC:4040

Low back - lumbar & thoracic (acute & chronic). NGC:4690

ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. NGC:2782

Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. NGC:2190

Your search criteria:
**Keyword:** *chiropractic*
Your search found 38 related guidelines

Overview of implementation of outcome assessment case management in the clinical practice. Washington State Chiropractic Association - Professional Association. 2001. 54 pages. NGC:002012

Vertebral subluxation in chiropractic practice. Council on Chiropractic Practice - Private Nonprofit Organization. 1998 (revised 2003). 201 pages. NGC:003438

Manual medicine guidelines for musculoskeletal injuries. Academy for Chiropractic Education. 2004 Dec 1. 25 pages. NGC:004054

Guideline for the management of fibromyalgia syndrome pain in adults and children. American Pain Society - Professional Association. 2005. 109 pages. NGC:004342

Shoulder (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 162 pages. NGC:004694

Forearm, wrist, & hand. Work Loss Data Institute - Public For Profit Organization. 2004 (revised 2005 Oct 10). 69 pages. NGC:004697

Pain management in the long-term care setting. American Medical Directors Association - Professional Association. 2003. 36 pages. NGC:003522

Carpal tunnel syndrome. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 154 pages. NGC:004687

Elbow (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 115 pages. NGC:004688

Low back - lumbar & thoracic (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 430 pages. NGC:004690

Neck and upper back (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 175 pages. NGC:004692

Knee & leg (acute & chronic). Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 190 pages. NGC:004691

Ankle and foot. Work Loss Data Institute - Public For Profit Organization. 2003 (revised 2005). 124 pages. NGC:004686

Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. Canadian Chiropractic Association
Canadian Federation of Chiropractic Regulatory Boards. 2005. 52 pages. NGC:004700

Rotator cuff tear. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003741

The management of persistent pain in older persons. American Geriatrics Society - Medical Specialty Society. 1998 Oct (revised 2002 Jun). 20 pages. NGC:002591

The diagnosis and management of soft tissue knee injuries: internal derangements. New Zealand Guidelines Group - Private Nonprofit Organization. 2003 Jul. 100 pages . NGC:003270

Adult low back pain. Institute for Clinical Systems Improvement - Private Nonprofit Organization. 1994 Jun (revised 2005 Sep). 64 pages. NGC:004543

Calcaneal/hindfoot injury. Intracorp - Public For Profit Organization. 2005. Various pagings. NGC:004392

Special treatment situations: alternative headache treatments. Standards of care for headache diagnosis and treatment. National Headache Foundation - Private Nonprofit Organization. 2004. 8 pages. NGC:004148

Chronic fatigue syndrome. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003912

Fibromyalgia. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003913

Management of fibromyalgia syndrome. American Pain Society Fibromyalgia Panel - Independent Expert Panel. 2004 Nov 17. 8 pages. NGC:004057

Cyclic perimenstrual pain and discomfort: nursing management. Evidence-based clinical practice guideline. Association of Women's Health, Obstetric, and Neonatal Nurses - Professional Association. 2003. 48 pages. NGC:004302

Allergic rhinitis and its impact on asthma. Allergic Rhinitis and its Impact on Asthma Workshop Group - Independent Expert Panel. 2001 Nov. 188 pages. NGC:002647

North American Spine Society Phase III: clinical guidelines for multidisciplinary spine care specialists. Spinal stenosis version 1.0. North American Spine Society - Medical Specialty Society. 2002. 91 pages. NGC:002835

Intradiscal electrotherapy. Intracorp - Public For Profit Organization. 1997 (revised 2004). Various pagings. NGC:003745

Low back. Expert Clinical Benchmarks - Private For Profit Organization. 2003. 52 pages. NGC:003946

Upper extremity (shoulder and elbow). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003996

Lower extremity (hip, knee and ankle). Expert Clinical Benchmarks - Private For Profit Organization. 2004. 55 pages. NGC:003997

Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for neck pain. Philadelphia Panel - Independent Expert Panel. 2001 Oct. 17 pages. NGC:004017

Cervical/thoracic. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 49 pages. NGC:003995

Hand-wrist. Expert Clinical Benchmarks - Private For Profit Organization. 2004. 56 pages. NGC:003998

Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain. Philadelphia Panel - Independent Expert Panel. 2001 Oct. 34 pages. NGC:004016

Pain management guidelines. Health Care Association of New Jersey - Private Nonprofit Organization. 2005 Jan. 18 pages. NGC:004177

AAOS clinical guideline on shoulder pain. American Academy of Orthopaedic Surgeons - Medical Specialty Society
American Academy of Physical Medicine and Rehabilitation - Medical Specialty Society
American College of Rheumatology - Medical Specialty Society. 2001. 24 pages. NGC:002224

Evidence based clinical practice guideline for medical management of otitis media with effusion in children 2 months to 13 years of age. Cincinnati Children's Hospital Medical Center - Hospital/Medical Center. 1999 (revised 2004 Oct). 11 pages. NGC:003957

Evidence based clinical practice guideline for medical management of acute otitis media in children 2 months to 13 years of age. Cincinnati Children's Hospital Medical Center - Hospital/Medical Center. 1999 (2004 Oct 29). 16 pages. NGC:003958

Considered Guidelines

ACR Appropriateness Criteria™ for acute chest pain--no ECG evidence of myocardial ischemia/infarction. NGC:2480
Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. NGC:4173
Assessment and management of chronic pain. NGC:4684
American Gastroenterological Association medical position statement: osteoporosis in hepatic disorders. NGC:3373

Rib fractures. NGC:4640
Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. NGC:2824
Management of postmenopausal osteoporosis: position statement of The North American Menopause Society. NGC:2405
ACR Appropriateness Criteria™ for osteoporosis and bone mineral density. NGC:2489
Clinical practice guideline for the management of postoperative pain. NGC:2510
Neck and upper back (acute & chronic). NGC:4692
Diagnosis and treatment of osteoporosis. NGC:4544
Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). NGC:4683
Chiropractic clinical practice guideline: evidence-based treatment of adult neck pain not due to whiplash. NGC:4700
Fibromyalgia treatment guideline. NGC:4350
VHA/DoD clinical practice guideline for the management of medically unexplained symptoms: chronic pain and fatigue. NGC:2641
ACR Appropriateness Criteria™ for bone metastases. NGC:3897
Guidelines for the assessment and management of chronic pain. NGC:4040
Low back - lumbar & thoracic (acute & chronic). NGC:4690
ACR Appropriateness Criteria™ for follow-up examinations for bone tumors, soft-tissue tumors, and suspected metastasis post therapy. NGC:2782
Acute management of autonomic dysreflexia: individuals with spinal cord injury presenting to health-care facilities. NGC:2190
Overview of implementation of outcome assessment case management in the clinical practice. NGC:2012
Manual medicine guidelines for musculoskeletal injuries. NGC:4054
Guideline for the management of fibromyalgia syndrome pain in adults and children. NGC:4342
Shoulder (acute & chronic). NGC:4694
Pain management in the long-term care setting. NGC:3522
Chronic fatigue syndrome. NGC:3912
Fibromyalgia. NGC:3913
Management of fibromyalgia syndrome. NGC:4057
Allergic rhinitis and its impact on asthma. NGC:2647
North American Spine Society Phase III: clinical guidelines for multidisciplinary spine care specialists. Spinal stenosis version 1.0. NGC:2835
Cervical/thoracic. NGC:3995
Pain management guidelines. NGC:4177

## Additional Material Identified with Second Literature Search


1. Zachman Z, Bolles S, Bergmann T, Traina A. Understanding the anterior thoracic adjustment: (A concept of a sectional subluxation). Chiropractic Technique 1989;1:30-3.
2. Woodruff L, Bounkeo J, Brannon W, Dawes K, Barham C, Waddell D, et al. The efficacy of laser therapy in wound repair: a meta-analysis of the literature. Photomed Laser Surg 2004;22(3):241-7.
3. Wood K, Blair J, Aepple D, Schendel M, Garvey T, Gundry C, et al. The natural history of asymptomatic thoracic disc herniations. Spine 1997;22(5):525-ccc9; discussion 529-30ddd.
4. Wishchuk J, Dougherty C. Therapy after thoracic outlet release. Hand Clin 2004;20(1):87-90, vii.
5. Winter R, Moe J. Idiopathic scoliosis. Current concepts in the treatment. Minn Med 1972;55(6):529-35.
6. Williams M, Cherryman G, Husband J. Significance of thoracic disc herniation demonstrated by MR imaging. J Comput Assist Tomogr 1989;13(2):211-4.
7. Wiggins G, Ondra S, Shaffrey C. Management of iatrogenic flat-back syndrome. Neurosurg Focus 2003;15(3):E8.
8. Weiss HR, Negrini S, Hawes MC, Rigo M, Kotwicki T, Grivas TB, et al. Physical exercises in the treatment of idiopathic scoliosis at risk of brace treatment - SOSORT consensus paper 2005. Scoliosis 2006;1:6.
9. Wedderkopp N, Leboeuf-Yde C, Andersen L, Froberg K, Hansen H. Back pain reporting pattern in a Danish population-based sample of children and adolescents. Spine 2001;26(17):1879-83.
10. Vignolo M, Milani S, DiBattista E, Naselli A, Mostert M, Aicardi G. Modified Greulich-Pyle, Tanner-Whitehouse, and Roche-Wainer-Thissen (knee) methods for skeletal age assessment in a group of Italian children and adolescents. Eur J Pediatr 1990;149(5):314-7.
11. Verkerk K, Van Veenendaal H, Severens JL, Hendriks EJM, Burgers JS. Considered judgement in evidence-based guideline development 10.1093/intqhc/mzl040. Int. J. Qual. Health Care 2006;18(5):365-369.
12. Vanichkachorn JS, Vaccaro AR. Thoracic Disk Disease: Diagnosis and Treatment. J. Am. Acad. Ortho. Surg. 2000;8(3):159-169.
13. Tolson T. "EMG" for thoracic outlet syndrome. Hand Clin 2004;20(1):37-42, vi.
14. Timgren J, Soinila S. Reversible pelvic asymmetry: an overlooked syndrome manifesting as scoliosis, apparent leg-length difference, and neurologic symptoms. J Manipulative Physiol Ther 2006;29(7):561-5.
15. Sward L, Hellstrom M, Jacobsson B, Karlsson L. Vertebral ring apophysis injury in athletes. Is the etiology different in the thoracic and lumbar spine? Am. J. Sports Med. 1993;21(6):841-845.
16. Stone B, Beekman C, Hall V, Guess V, Brooks HL. The effect of an exercise program on change in curve in adolescents with minimal idiopathic scoliosis. A preliminary study. Phys Ther 1979;59(6):759-63.
17. Stehno-Bittel L, Reddy G, Gum S, Enwemeka C. Biochemistry and biomechanics of healing tendon: Part I. Effects of rigid plaster casts and functional casts. Med Sci Sports Exerc 1998;30(6):788-93.
18. Stark E. Exercise and Heat in the Therapy of Thoracic Outlet Syndrome. Osteopathic Annals 1975;3(3):50-1.
19. Smith M, Greene B, Haas M, Allareddy V. Intra-professional and inter-professional referral patterns of chiropractors. Chiropr Osteopat 2006;14:12.
20. Simpson R, Gemmell H. Accuracy of spinal orthopaedic tests: a systematic review. Chiropr Osteopat 2006;14:26.
21. Scottish Intercollegiate Guidelines Network. Sign 50: A guideline developers' handbook. Edinburgh: SIGN; 2002.
22. Scottish Intercollegiate Guidelines Network. SIGN 50 : a guideline developers' handbook. Edinburgh: Scottish Intercollegiate Guidelines Network; 2001.
23. Saunders DR, Thompson AJ. The Gut Course: HuBio 551. In: Chapter 8: Pain from the Digestive Organs. 39th ed. Seattle, WA: University of Washington Division of Gastroenterology; 2008. p. 265-275.
24. Sanders JO, Browne RH, McConnell SJ, Margraf SA, Cooney TE, Finegold DN. Maturity Assessment and Curve Progression in Girls with Idiopathic Scoliosis 10.2106/JBJS.F.00067. J. Bone Joint Surg. Am. 2007;89(1):64-73.

25. Safran MR. Nerve Injury About the Shoulder in Athletes, Part 2: Long Thoracic Nerve, Spinal Accessory Nerve, Burners/Stingers, Thoracic Outlet Syndrome. Am. J. Sports Med. 2004;32(4):1063-1076.
26. Ross J, Bereznick D, McGill S. Determining cavitation location during lumbar and thoracic spinal manipulation: is spinal manipulation accurate and specific? Spine 2004;29(13):1452-7.
27. Romano M, Negrini S. Manual therapy as a conservative treatment for adolescent idiopathic scoliosis: a systematic review. Scoliosis 2008;3(1):2.
28. Roche A, Davila G, Eyman S. A comparison between Greulich-Pyle and Tanner-Whitehouse assessments of skeletal maturity. Radiology 1971;98(2):273-280.
29. Ribbe E, Lindgren S. Clinical diagnosis of thoracic outlet sydnrome - evaluation of patient with cervicobrachial symptoms. Manual Med 1986;2:82-85.
30. Reddy G, Gum S, Stehno-Bittel L, Enwemeka C. Biochemistry and biomechanics of healing tendon: Part II. Effects of combined laser therapy and electrical stimulation. Med Sci Sports Exerc 1998;30(6):794-800.
31. Raine S, Twomey L. Head and shoulder posture variations in 160 asymptomatic women and men. Arch Phys Med Rehabil 1997;78(11):1215-23.
32. Peterson L, Nachemson A. Prediction of progression of the curve in girls who have adolescent idiopathic scoliosis of moderate severity. Logistic regression analysis based on data from The Brace Study of the Scoliosis Research Society. J. Bone Joint Surg. Am. 1995;77(6):823-827.
33. Ozaki T, Liljenqvist U, Hillmann A, Halm H, Lindner N, Gosheger G, et al. Osteoid osteoma and osteoblastoma of the spine: experiences with 22 patients. Clin Orthop Relat Res 2002(397):394-402.
34. Ombregt L. A system of orthopaedic medicine. London: Saunders,; 1995.
35. Niitsu M, Takeda T. Solitary hot spots in the ribs on bone scan: value of thin-section reformatted computed tomography to exclude radiography-negative fractures. J Comput Assist Tomogr 2003;27(4):469-74.
36. Niesluchowski W, Dabrowska A, Kedzior K, Zagrajek T. The potential role of brain asymmetry in the development of adolescent idiopathic scoliosis: a hypothesis. J Manipulative Physiol Ther 1999;22(8):540-4.
37. Negrini S, Atanasio S, Fusco C, Zaina F, Negrini A. 3-DEMO classification of scoliosis: a useful understanding of the 3(rd) dimension of the deformity. Stud Health Technol Inform 2008;135:139-53.
38. Negrini S, Negrini A. The three-dimensional easy morphological (3-DEMO) classification of scoliosis - Part III, correlation with clinical classification and parameters. Scoliosis 2007;2:5.
39. Negrini S, Negrini A, Atanasio S, Santambrogio GC. Three-dimensional easy morphological (3-DEMO) classification of scoliosis, part I. Scoliosis 2006;1:20.
40. Negrini A, Negrini S. The three-dimensional easy morphological (3-DEMO) classification of scoliosis, part II: Repeatability. Scoliosis 2006;1:23.
41. Nathan M, Pope M, Grobler L. Osteophyte formation in the vertebral column: a review of the etiologic factors--Part II. Contemp Orthop 1994;29(2):113-9.
42. Nathan H. Relations of the soft structures of the posterior mediastinum in the scoliotic spine. Acta Anat (Basel) 1988;133(3):260-4.
43. Nathan H. Compression of the sympathetic trunk by osteophytes of the vertebral column in the abdomen: an anatomical study with pathological and clinical considerations. Surgery 1968;63(4):609-25.
44. Najm W, Seffinger M, Mishra S, Dickerson V, Adams A, Reinsch S, et al. Content validity of manual spinal palpatory exams - A systematic review. BMC Complement Altern Med 2003;3:1.
45. Morningstar M, Woggon D, Lawrence G. Scoliosis treatment using a combination of manipulative and rehabilitative therapy: a retrospective case series. BMC Musculoskelet Disord 2004;5:32.
46. Mootz R. The Neglected Thoracic Region. Topics in Clinical Chiropractic 1999;6(3):v.
47. Mootz R. Interprofessional referral protocol. Today-s Chiro. 1987(Sept/Oct):37-39.
48. Moe J. Indications for Milwaukee brace non-operative treatment in idiopathic scoliosis. Clin Orthop Relat Res 1973(93):38-43.
49. Moe J, Kettleson D. Idiopathic scoliosis. Analysis of curve patterns and the preliminary results of Milwaukee-brace treatment in one hundred sixty-nine patients. J. Bone Joint Surg. Am. 1970;52(8):1509-1533.
50. Moe J. The management of idiopathic scoliosis. Clin Orthop 1957;9:169-84.
51. Mirtz TA. Acute respiratory distress syndrome: Clinical recognition and preventive management in chiropractic acute care practice. Journal of Manipulative and Physiological Therapeutics 2001;24(7):467-473.

52. Menon M, Nansel D. Effects of Cervico-Thoracic Spinal Posture on Central Versus Peripheral Ventilatory Functions. In: 5th annual International Conference on Spinal Manipulation; 1992 May; Chicago, IL,; 1992. p. 52.
53. McGuckin N. The T4 Syndrome. In: Grieve GP, editor. Modern manual therapy of the vertebral column. Edinburgh ; New York: Churchill Livingstone; 1986. p. 370-376.
54. Matthijs O, Phelps V. T-4 Syndrome. In: The AAOM Quarterly: International Academy of Orthopedic Medicine; 1997.
55. Maitland GD, Edwards BC. Vertebral manipulation. 5th ed. London ; Boston: Butterworths; 1986.
56. Maigne J, Ellis R. Thoracic back pains in the manual medicine. Manuelle Medizin 2003;41(5):378-80.
57. Maigne J-Y. Thoracolumbar junction and thoracolumbar spinal pain syndromes. In; 1996.
58. Maigne R. Thoraco-Lumbar Junction Syndrome: A Source of Diagnostic Error. Journal of Orthopaedic Medicine 1995;17(3):84-9.
59. Maigne R. [The thoraco-lumbar junction syndrome. Low-back pain, pseudo-visceral pain, pseudo-hip pain and pseudo-pubic pain (author's transl)]. Sem Hop 1981;57(11-12):545-54.
60. Mackenzie C, Shin B, Hadi F, Imle P. Changes in total lung/thorax compliance following chest physiotherapy. Anesth Analg 1980;59(3):207-10.
61. Lonstein J, Carlson J. The prediction of curve progression in untreated idiopathic scoliosis during growth. J Bone Joint Surg Am 1984;66(7):1061-1071.
62. Longley D, Yedlicka J, Molina E, Schwabacher S, Hunter D, Letourneau J. Thoracic outlet syndrome: evaluation of the subclavian vessels by color duplex sonography. Am. J. Roentgenol. 1992;158(3):623-630.
63. Lindgren K. [TOS (thoracic outlet syndrome)--a challenge to conservative treatment]. Nord Med 1997;112(8):283-7.
64. Lindgren K, Oksala I. Long-term outcome of surgery for thoracic outlet syndrome. Am J Surg 1995;169(3):358-60.
65. Lindgren K. Reasons for failures in the surgical treatment of thoracic outlet syndrome. Muscle Nerve 1995;18(12):1484-6.
66. Lindgren K. [TOS (thoracic outlet syndrome)--a functional disease?]. Duodecim 1994;110(12):1131-9.
67. Lindgren K. Thoracic outlet syndrome with special reference to the first rib. Ann Chir Gynaecol 1993;82(4):218-30.
68. Lindgren K, Leino E, Lepantalo M, Paukku P. Recurrent thoracic outlet syndrome after first rib resection. Arch Phys Med Rehabil 1991;72(3):208-10.
69. Lepantalo M, Lindgren K, Leino E, Lindfors O, von Smitten K, Nuutinen E, et al. Long term outcome after resection of the first rib for thoracic outlet syndrome. Br J Surg 1989;76(12):1255-6.
70. Leider L, Moe J, Winter R. Early ambulation after the surgical treatment of idiopathic scoliosis. J. Bone Joint Surg. Am. 1973;55(5):1003-1015.
71. Leboeuf-Yde C, Pedersen E, Bryner P, Cosman D, Hayek R, Meeker W, et al. Self-reported nonmusculoskeletal responses to chiropractic intervention: a multination survey. J Manipulative Physiol Ther 2005;28(5):294-ccc302; discussion 365-6ddd.
72. Koc A, Karaoglanoglu M, Erdogan M, Kosecik M, Cesur Y. Assessment of bone ages: is the Greulich-Pyle method sufficient for Turkish boys? Pediatr Int 2001;43(6):662-5.
73. Khan MA. Ankylosing spondylitis: introductory comments on its diagnosis and treatment. Ann Rheum Dis 2002;61(90003):3iii-7.
74. Kessler T, Brunner F, Kunzer S, Crippa M, Kissling R. [Effects of Maitland's Manual Mobilization on the Thoracic Spine.]. Rehabilitation (Stuttg) 2005;44(6):361-6.
75. Kellgren JH. On the Distribution of Pain Arising from Deep Somatic Structures with Charts of Segmental Pain Areas. Clinical Science 1939; 4:35-46.
76. Karachalios T, Sofianos J, Roidis N, Sapkas G, Korres D, Nikolopoulos K. Ten-year follow-up evaluation of a school screening program for scoliosis. Is the forward-bending test an accurate diagnostic criterion for the screening of scoliosis? Spine 1999;24(22):2318-24.
77. Kandabarow A. Injuries of the thoracolumbar spine. Topics in Emergency Medicine 1997;19:65–80.

78. Johansen A, Hoilund-Carlsen P, Christensen H, Vach W, Moldrup M, Haghfelt T. Use of myocardial perfusion imaging to predict the effectiveness of coronary revascularisation in patients with stable angina pectoris. Eur J Nucl Med Mol Imaging 2005;32(12):1363-70.
79. Johansen A, Hoilund-Carlsen P, Christensen H, Vach W, Jorgensen H, Veje A, et al. Diagnostic accuracy of myocardial perfusion imaging in a study population without post-test referral bias. J Nucl Cardiol 2005;12(5):530-7.
80. Jahn W, Cupon L. Scoliosis: What Every Chiropractic Orthopedist Needs to Know. The Academey of Chiropractic Orthopedist e-Journal 2007;4(Special Scoliosis Supplement).
81. Jackson R. The Cervical Syndrome. 3th ed. Springfield, IL: Charles C. Thomas; 1976.
82. Hudak P, Cole D, Frank J. Perspectives on prognosis of soft tissue musculoskeletal disorders. Int J Rehabil Res 1998;21(1):29-40.
83. Hubbard A, Fryer G, Ball K. Resting electromyographic activity of thoracic erector spinae muscles that are tender and appear abnormal to palpation: a pilot study. Journal of Osteopathic Medicine 2003;6(1):36-37.
84. Hoilund-Carlsen PF, Johansen A, Christensen HW, Vach W, Moldrup M, Bartram P, et al. Potential impact of myocardial perfusion scintigraphy as gatekeeper for invasive examination and treatment in patients with stable angina pectoris: observational study without post-test referral bias 10.1093/eurheartj/ehi503. Eur. Heart J. 2006;27(1):29-34.
85. Hoilund-Carlsen P, Johansen A, Christensen H, Pedersen L, Johnk I, Vach W, et al. Usefulness of the exercise electrocardiogram in diagnosing ischemic or coronary heart disease in patients with chest pain. Am J Cardiol 2005;95(1):96-9.
86. Hirschberg G, Williams K, Byrd J. Diagnosis and Treatment of Iliocostal Friction Syndromes. Journal of Orthopaedic Medicine 1992;14(2):35-9.
87. Harrison D, Troyanovich S, Harrison D, Janik T, Murphy D. A normal sagittal spinal configuration: a desirable clinical outcome. J Manipulative Physiol Ther 1996;19(6):398-405.
88. Haldeman S, Chapman-Smith D, Petersen DM. Guidelines for chiropractic quality assurance and practice parameters : proceedings of the Mercy Center Consensus Conference. Gaithersburg, Md.: Aspen Publishers; 1993.
89. Gum S, Reddy G, Stehno-Bittel L, Enwemeka C. Combined ultrasound, electrical stimulation, and laser promote collagen synthesis with moderate changes in tendon biomechanics. Am J Phys Med Rehabil 1997;76(4):288-96.
90. Grieve GP. Common vertebral joint problems. 2nd ed. Edinburgh ; New York: Churchill Livingstone; 1988.
91. Gregory P, Biswas A, Batt M. Musculoskeletal problems of the chest wall in athletes. Sports Med 2002;32(4):235-50.
92. Goldberg C, Moore D, Fogarty E, Dowling F. Adolescent idiopathic scoliosis: the effect of brace treatment on the incidence of surgery. Spine 2001;26(1):42-7.
93. Gillard J, Perez-Cousin M, Hachulla E, Remy J, Hurtevent J, Vinckier L, et al. Diagnosing thoracic outlet syndrome: contribution of provocative tests, ultrasonography, electrophysiology, and helical computed tomography in 48 patients. Joint Bone Spine 2001;68(5):416-24.
94. Frisch H, Riedl S, Waldhor T. Computer-aided estimation of skeletal age and comparison with bone age evaluations by the method of Greulich-Pyle and Tanner-Whitehouse. Pediatr Radiol 1996;26(3):226-31.
95. Fraser D. T-3 Revisited. Journal of Orthopaedic Medicine. 1993;15(1):3-4.
96. Enwemeka C. Evidence-based photomedicine. Photomed Laser Surg 2005;23(4):353.
97. Enwemeka C, Parker J, Dowdy D, Harkness E, Sanford L, Woodruff L. The efficacy of low-power lasers in tissue repair and pain control: a meta-analysis study. Photomed Laser Surg 2004;22(4):323-9.
98. Enwemeka C. The effects of therapeutic ultrasound on tendon healing. A biomechanical study. Am J Phys Med Rehabil 1989;68(6):283-7.
99. Edmondston S, Singer K. Thoracic spine: anatomical and biomechanical considerations for manual therapy. Man Ther 1997;2(3):132-143.
100. Edelson J, Nathan H. Stages in the natural history of the vertebral end-plates. Spine 1988;13(1):21-6.
101. Dolan L, Weinstein S. Surgical rates after observation and bracing for adolescent idiopathic scoliosis: an evidence-based review. Spine 2007;32(19 Suppl):S91-S100.

102. Dobosiewicz K. Neurophysiological mechanism of the unloading reflex as a prognostic factor in the early stages of idiopathic adolescent scoliosis. Eur Spine J 1997;6(2):93-7.
103. Danner R, Leino E, Lindgren K. [Neurophysiological findings in the differential diagnosis of cervico-brachial syndromes]. Duodecim 1986;102(23-24):1752-9.
104. Dagfinrud H KTK, Hagen K B. Physiotherapy interventions for ankylosing spondylitis. In. Issue 1. Art. No.: CD002822. DOI: 10.1002/14651858.CD002822.pub3. ed: Cochrane Database of Systematic Reviews 2008; 2008.
105. Daffner R, Hackney D, Dalinka M, Davis P, Resnik C, Rubin D, et al. Suspected spine trauma. In: American College of Radiology (ACR) Expert Panel on Musculoskeletal and Neurologic Imaging; 2007.
106. Crosby C, Wehbe M. Conservative treatment for thoracic outlet syndrome. Hand Clin 2004;20(1):43-9, vi.
107. Cox S, Tornatore R, Marquina N. The Effect of Rib Adjusting on Tissue Oxygenation and Chest Expansion. The Journal of Chiropractic Education 2000;14(1):30-31.
108. Christensen H, Haghfelt T, Vach W, Johansen A, Hoilund-Carlsen P. Observer reproducibility and validity of systems for clinical classification of angina pectoris: comparison with radionuclide imaging and coronary angiography. Clin Physiol Funct Imaging 2006;26(1):26-31.
109. Christensen H. Musculoskeletal chest pain in patients with stable angina pectoralis - diagnosis and treatment. Odense: University of Southern Denmark; 2004.
110. Christensen MG, Delle Morgan DR, National Board of Chiropractic Examiners. Job analysis of chiropractic by state : a state-by-state statistical report on the nationwide NBCE survey of chiropractic practice and companion volume to "Job analysis of chiropractic". Greeley, Colo.: National Board of Chiropractic Examiners; 1994.
111. Cassidy J, Mierau D, Nykoliation J, Arthur B. Medical-Chiropractic Correspondence. J Can Chiropr Assoc 1985;29(1):29-31.
112. Bridwell K, Berven S, Edwards C, Glassman S, Hamill C, Schwab F. The problems and limitations of applying evidence-based medicine to primary surgical treatment of adult spinal deformity. Spine 2007;32(19 Suppl):S135-9.
113. Brantigan C, Roos D. Diagnosing thoracic outlet syndrome. Hand Clin 2004;20(1):27-36.
114. Boyle J, Singer K, Milne N. Pattern of intervertebral disc degeneration in the cervicothoracic junctional region. Manual Therapy 1998;3(2):72-7.
115. Blum C. Chiropractic and pilates therapy for the treatment of adult scoliosis. J Manipulative Physiol Ther 2002;25(4):E3.
116. Bilgili Y, Hizel S, Kara SA, Sanli C, Erdal HH, Altinok D. Accuracy of Skeletal Age Assessment in Children From Birth to 6 Years of Age With the Ultrasonographic Version of the Greulich-Pyle Atlas. J. Ultrasound Med. 2003;22(7):683-690.
117. Bertaina C, Stasiowska B, Benso A, Vannelli S. Is TW3 height prediction more accurate than TW2? Preliminary data. Horm Res 2007;67(5):220-3.
118. Bergman GJD, Winters JC, Groenier KH, Pool JJM, Jong BM-d, Postema K, et al. Manipulative Therapy in Addition to Usual Medical Care for Patients with Shoulder Dysfunction and Pain: A Randomized, Controlled Trial. Ann Intern Med 2004;141(6):432-439.
119. Basler H, Keller S, Herda C. Good postural habits: a pilot investigation using EMG scanning of the paraspinals. Appl Psychophysiol Biofeedback 1997;22(3):171-82.
120. Bagley L. Imaging of spinal trauma. Radiol Clin North Am 2006;44(1):1-12, vii.
121. Atasoy E. Recurrent thoracic outlet syndrome. Hand Clin 2004;20(1):99-105.
122. Atanasio S, Negrini A, Negrini A, Negrini A, Negrini G, Negrini S, et al. THE EVIDENCE BASED ISICO APPROACH TO SPINAL DEFORMITIES. Milano: ISICO - Italian Scientific Spine Institute
http://www.isico.it/approach/default.htm; 2007.
123. Amendt L, Ause-Ellias K, Eybers J, Wadsworth C, Nielsen D, Weinstein S. Validity and reliability testing of the Scoliometer. Physical Therapy 1990;70(2):108-117.
124. AGREE Collaboration [Appraisal of Guidelines R, and Evaluation in Europe (AGREE) Collaborative Group.]. AGREE Instrument Training Manual. January 2003.
125. AGREE Collaboration [Appraisal of Guidelines R, and Evaluation in Europe (AGREE) Collaborative Group.]. Appraisal of Guidelines for Research & Evaluation (AGREE) Instrument. 2001.

***The Following is a Summary of the Acute Musculoskeletal Pain Guidelines Group Key Messages on Acute Thoracic Spine Pain Management***

Group AAMPG. Acute Thoracic Spinal Pain: Evidence-Based Management. In: Evidence-Based Management of Acute Musculoskeletal Pain. Brisbane: Australian Academic Press; 2003. p. 63-92.

**Management Plan**

**Clinical Question: What is the best way to manage acute thoracic pain?**

It is recommended that the clinician and patient develop a management plan for acute musculoskeletal pain comprising the elements of assessment, management and review:

- Assessment — Conduct a history and physical examination to assess for the presence of serious conditions; ancillary investigations are not generally indicated unless features of serious conditions are identified.
- Management — Provide information, assurance and advice to resume normal activity and discuss other options for pain management as needed.
- Review — Reassess the pain and revise the management plan as required.

CONSENSUS: Steering Committee

**Non-Pharmacological Interventions**

Simple interventions (providing information, assurance and encouraging reasonable maintenance of activity) may be used alone or in combination with other interventions for the successful management of acute musculoskeletal pain. CONSENSUS: Steering Committee

**Pharmacological Interventions**

Specific pharmacological interventions may be required to relieve pain; such agents can be used in conjunction with non-pharmacological interventions. CONSENSUS: Steering Committee

Paracetamol or other simple analgesics, administered regularly, are recommended for relief of mild to moderate acute musculoskeletal pain. CONSENSUS: Steering Committee

Where paracetamol is insufficient for pain relief, a non-steroidal anti-inflammatory (NSAID) medication may be used, unless contraindicated. CONSENSUS: Steering Committee

Oral opioids may be necessary to relieve severe musculoskeletal pain. It is preferable to administer a short-acting agent at regular intervals, rather than on a pain-contingent basis. CONSENSUS: Steering Committee

Ongoing need for opioid analgesia is an indication for reassessment. CONSENSUS: Steering Committee

Adjuvant agents such as anticonvulsants and antidepressants are not recommended in the management of acute musculoskeletal pain. CONSENSUS: Steering Committee

Any benefits from muscle relaxants may be outweighed by their adverse effects, therefore, they cannot be routinely recommended. CONSENSUS: Steering Committee

**DIAGNOSIS**

**Aetiology and Prevalence**

Pain may be referred to the upper thoracic spine from visceral structures and cervical spinal structures or arise in the thoracic interspinous ligaments, paravertebral muscles and zygapophyseal joints. *LEVEL IV: Kelley 1997; Dwyer et al.. 1990; Aprill et al.. 1990; Fukui et al.. 1996; Feinstein et al.. 1954; Kellgren et al.. 1939; Hockaday and Whitty 1967;Cloward 1959; Kellgren 1939; Dreyfuss et al. 1994

Men and women aged over 60 are at risk for spontaneous osteoporotic fractures of the thoracic spine; extent of vertebral deformity and multiple fractures appear linked with pain intensity. *LEVEL IV: Ross et al.. 1994; Patel et al.. 1991; Huang et al.. 1994

Clinicians should be alert to the potential for rare, serious conditions presenting as acute thoracic spinal pain; however, most cases of thoracic spinal pain are of mechanical origin. *LEVEL IV: Deyo and Diehl. 1988

**History**

History serves to differentiate sources of acute thoracic spinal pain to identify features of potentially serious conditions; however, it carries little diagnostic weight. CONSENSUS: Flynn 1996; Kenna and Murtagh 1989; Corrigan and Maitland 1988

**Physical Examination**

The reliability of palpation for tenderness of the thoracic spine is good, but its validity is unknown. *LEVEL IV: Christensen et al.. 2002

The reliability of motion palpation of the thoracic spine is marginal. *LEVEL IV: Love et al.. 1987; Christensen et al.. 2002

Following blunt trauma, a negative clinical examination in the presence of a clear sensorium makes a thoracic spinal fracture unlikely. *LEVEL IV: Durham et al.. 1995; Samuels and Kerstein 1993

Despite the absence of supportive, scientific data on the utility of physical examination of the thoracic spine, such examination provides an important opportunity to identify features of serious conditions. *LEVEL IV: Deyo et al.. 1988; Malawaski et al.. 1991; Durham et al.. 1995; Samuels and Kerstein 1993

**Ancillary Investigations**

In the absence of trauma, plain radiography is of limited use in defining the cause of pain. *LEVEL IV: Wood et al.. 1995; Nathan 1962; Crawford and Singer 1995

Fractures are more likely to occur in people over age 60 with a history of blunt trauma; a lower threshold for investigation is warranted in this group. *LEVEL IV: Frankel et al.. 1994; Durham et al.. 1995; Meldon and Moettus. 1995; Samuels and Kerstein 1993

In the presence of trauma, x-ray of the thoracolumbar spine is not indicated in those who are awake, alert and have no clinical evidence of injury; however, those with equivocal or positive clinical findings or with an altered level of consciousness should undergo thoracolumbar spine evaluation. *LEVEL IV: Samuels and Kerstein 1993; Durham et al.. 1995

CT scanning is only indicated for the evaluation of the neural canal and posterior elements of the thoracic spine when fractures have been detected with plain films. *LEVEL IV: Keene et al.. 1982

There is no research to inform ancillary investigations for acute thoracic spinal pain; investigations should be selected on the basis of clinical features suggesting the presence of serious conditions. CONSENSUS: Steering Committee

**Terminology**

The appropriate labels for non-specific "mechanical" thoracic spinal pain are "thoracic spinal pain of unknown origin" or "somatic thoracic spinal pain". CONSENSUS: Merskey and Bogduk 1994

There is a lack of published data on the natural history and influence of prognostic risk factors for acute thoracic spinal pain. NO EVIDENCE

**INTERVENTION**

**Evidence of Benefit**

*Spinal Manipulation* — There is evidence from one small study that spinal manipulation is effective compared to placebo in thoracic spinal pain. LEVEL II: Schiller 2001

## *SOSORT Scoliosis Guidelines*

The SOSORT document recommendations were created by consensus, but strongly rely on the literature and findings reported in the Italian guidelines. SOSORT guidelines were based on Italian guidelines, which had high quality scores. While the quality of these guidelines is debatable, the work may have value and is summarized below for physician's consideration.

Weiss H, Negrini S, Rigo M, Kotwicki T, Hawes M, Grivas T, et al. Indications for conservative management of scoliosis (guidelines). Scoliosis 2006;1:5.

The SOSORT guidelines establish the goals of conservative management as:

1. Stopping progression of the curve
2. Improving pulmonary function/vital capacity
3. Pain management.

Three modes of conservative management are recommended:

1. Physical therapy methods such as Methode Lyonaise, Side-Shift, Dobosiewicz and others.
2. Scoliosis intensive rehabilitation (SIR)
3. Bracing

The authors are clear in their recommendations that the physical therapy methods to be employed, and referred to below, are not general physical therapy, but a type specifically developed for scoliosis management. Recognized methods should be employed by appropriately trained practitioners.

SOSORT guidelines employ Lonstein and Carlson's prognostic risk calculations to estimate the risk of progression.

In children with no sign of maturity SOSORT recommends:

a) Cobb angle <15° - Observation at 6-12 month intervals.
b) Cob angle 15-20° - Outpatient physical therapy with treatment free intervals.
c) Cobb angle 20-25° - Outpatient physical therapy. Scoliosis Intensive Rehabilitation (SIR) program - where available

In children with Risser 0-3, showing first signs of maturation, less than 98% of mature height management is based on Lonstein and Carlson's prognostic risk calculations.

a) With progression risk of < 40% - Observation at 3 month intervals.
b) With progression risk of > 40% - Outpatient physiotherapy.
c) With progression risk of 50% - Outpatient physiotherapy, SIR where available.
d) With progression risk of 60% - Outpatient physiotherapy, SIR where available and part-time brace.
e) With progression risk of 80% - Outpatient physiotherapy, SIR where available and full-time brace.

In children with Risser 4

a) Cobb angle < 20° - Observation at 6-12 month intervals.
b) Cobb angle < 20 - 25° - Outpatient physiotherapy.
c) Cobb angle > 25° - Outpatient physiotherapy, SIR where available.
d) Cobb angle > 35° - Outpatient physiotherapy, SIR where available and part-time brace.
e) Brace weaning procedures: Outpatient physiotherapy, SIR where available and staged reduction in brace.

In children with Risser 4-5

a) Cobb angle > 25° - Outpatient physical therapy
b) Cobb angle > 30° - Outpatient physiotherapy, SIR where available.

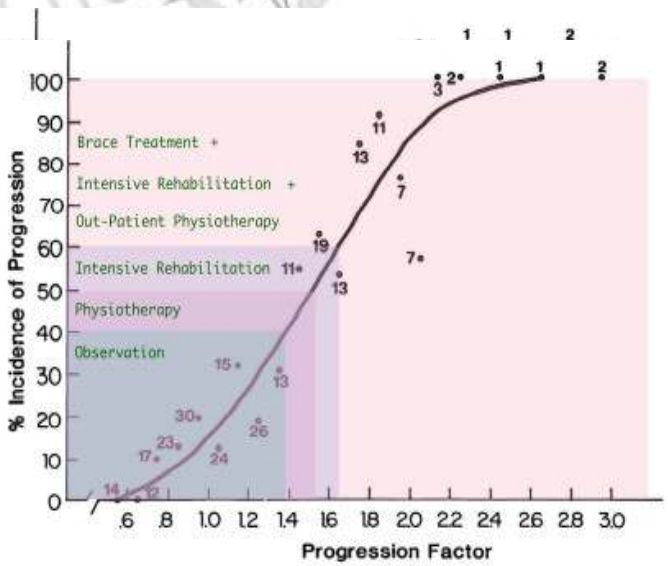
Adults with Cobb angle > 30°

b) Outpatient physiotherapy, SIR where available.

Adolescents and adults with any scoliosis and chronic pain

a) Outpatient physiotherapy, SIR where available, with a special pain program, bracing is optional if a therapeutic trial proves beneficial

**Scoliosis Graph**




Gra

Graph showing the incidence of progression according to the progression factor, which is calculated by the formula:

$$\frac{\text{Cobb Angle} - (3 \times \text{Risser sign})}{\text{Chonological age}}$$