Guideline summary review: An evidence-based clinical guideline for the diagnosis and treatment of low back pain

D. Scott Kreiner MD , Paul Matz MD , Christopher M. Bono MD , Charles H. Cho MD, MBA , John E. Easa MD, FIPP , Gary Ghiselli MD , Zoher Ghogawala MD, FACS , Charles A. Reitman MD , Daniel K. Resnick MD, MS , William C. Watters III MD, MS , Thiru M. Annaswamy MD , Jamie Baisden MD, FACS , Walter S. Bartynski MD , Shay Bess MD , Randall P. Brewer MD , R. Carter Cassidy MD , David S. Cheng MD , Sean D. Christie MD , Norman B. Chutkan MD, FACS , Bernard Allan Cohen PhD, FASNM, FACNS , Simon Dagenais PhD, MSc, DC , Dennis E. Enix DC, MBA , Paul Dougherty DC , S. Raymond Golish MD, PhD, MBA , Padma Gulur MD , Steven W. Hwang MD , Cumhur Kilincer MD, PhD , Jeffrey A. King DC, MS , Adam C. Lipson MD , Anthony J. Lisi DC , RJ Meagher MD , John E. O'Toole MD, MS , Paul Park MD , Murat Pekmezci MD , Daniel R. Perry MPT, MDT , Ravi Prasad PhD , David A. Provenzano MD , Kris E. Radcliff MD , Gazanfar Rahmathulla MD, MBBS , Tom E. Reinsel MD , Robert L. Rich Jr. MD, FAAFP , Daniel S. Robbins MD , Karie A. Rosoloski MPH , Jonathan N. Sembrano MD , Anil K. Sharma MD , Alison A. Stout DO , Christopher K. Taleghani MD , Ryan A. Tauzell PT, MA, MDT , Terry Trammell MD , Yakov Vorobeychik MD, PhD , Amy Yahiro MS, RD, LDN

PII: S1529-9430(20)30141-8
DOI: https://doi.org/10.1016/j.spinee.2020.04.006
Reference: SPINEE 58151

To appear in: *The Spine Journal*

Received date: 6 April 2020
Accepted date: 13 April 2020

Daniel R. Perry MPT, MDT , Ravi Prasad PhD , David A. Provenzano MD , Kris E. Radcliff MD , Gazanfar Rahmathulla MD, MBBS , Tom E. Reinsel MD , Robert L. Rich Jr. MD, FAAFP , Daniel S. Robbins MD , Karie A. Rosoloski MPH , Jonathan N. Sembrano MD , Anil K. Sharma MD , Alison A. Stout DO , Christopher K. Taleghani MD , Ryan A. Tauzell PT, MA, MDT , Terry Trammell MD , Yakov Vorobeychik MD, PhD , Amy Yahiro MS, RD, LDN , Guideline summary review: An evidence-based clinical guideline for the diagnosis and treatment of low back pain, *The Spine Journal* (2020), doi: https://doi.org/10.1016/j.spinee.2020.04.006

Guideline summary review: An evidence-based clinical guideline for the diagnosis and treatment of low back pain

Authors:

D. Scott Kreiner, MD*[a]

Paul Matz, MD[b]

Christopher M. Bono, MD[c]

Charles H. Cho, MD, MBA[d]

John E. Easa, MD, FIPP[e]

Gary Ghiselli, MD[f]

Zoher Ghogawala, MD, FACS[g]

Charles A. Reitman, MD[h]

Daniel K. Resnick, MD, MS[i]

William C. Watters III, MD, MS[j]

Thiru M. Annaswamy, MD[k]

Jamie Baisden, MD, FACS[l]

Walter S. Bartynski, MD[m]

Shay Bess, MD[n]

Randall P. Brewer, MD[o]

R. Carter Cassidy, MD[p]

David S. Cheng, MD[q]

Sean D. Christie, MD[r]

Norman B. Chutkan, MD, FACS[s]

Bernard Allan Cohen, PhD, FASNM, FACNS[t]

Simon Dagenais, PhD, MSc, DC[u]

Dennis E. Enix, DC, MBA[v]

Paul Dougherty, DC[w]

S. Raymond Golish, MD, PhD, MBA[x]

Padma Gulur, MD[y]

Steven W. Hwang, MD[z]

Cumhur Kilincer, MD, PhD[aa]

Jeffrey A. King, DC, MS[bb]

Adam C. Lipson, MD[cc]

Anthony J. Lisi, DC[dd]

RJ Meagher, MD[ee]

John E. O'Toole, MD, MS[ff]

Paul Park, MD[gg]

Murat Pekmezci, MD[hh]

Daniel R. Perry, MPT, MDT[ii]

Ravi Prasad, PhD[jj]

David A. Provenzano, MD[kk]

Kris E. Radcliff, MD[ll]

Gazanfar Rahmathulla, MD, MBBS[mm]

Tom E. Reinsel, MD[nn]

Robert L. Rich, Jr., MD, FAAFP[oo]

Daniel S. Robbins, MD[pp]

Karie A. Rosoloski, MPH[qq]

Jonathan N. Sembrano, MD[rr]

Anil K. Sharma, MD[ss]

Alison A. Stout, DO[tt]

Christopher K. Taleghani, MD[uu]

Ryan A. Tauzell, PT, MA, MDT[vv]

Terry Trammell, MD[ww]

Yakov Vorobeychik, MD, PhD[xx]

Amy Yahiro, MS, RD, LDN[yy]

*Corresponding Author:

D. Scott Kreiner, MD

4530 E. Muirwood Dr. Ste. 110

Phoenix, AZ 85048-7693

Phone: (623)562-5060

Email: scott.kreiner@barrowbrainandspine.com

a Barrow Neurological Institute, Phoenix, AZ, USA

b Advantage Orthopedics and Neurosurgery, Casper, WY, USA

c Massachusetts General Hospital, Boston, MA, USA

d Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

e Michigan State University, Holland, MI, USA

f Denver Spine Surgeons, Greenwood Village, CO, USA

g Lahey Hospital and Medical Center, Burlington, MA, USA, Tufts University School of Medicine, Boston, MA, USA

h Medical University of South Carolina, Charleston, SC, USA

i University of Wisconsin, Madison, WI, USA

j Institute of Academic Medicine Houston Methodist Hospital, Houston, TX, USA

k VA North Texas Health Care System, UT Southwestern Medical Center, Dallas, TX, USA

l Medical College of Wisconsin, Milwaukee, WI, USA

m Duke University, Durham, NC, USA

n Denver International Spine Center, Denver, CO, USA

o River Cities Interventional Pain Specialists, Shreveport, LA, USA

p University of Kentucky College of Medicine, Lexington, KY, USA

q University of Southern California, Los Angeles, CA, USA

r QE II Health Sciences Centre, Halifax NS B3H 3A7, Canada

s The CORE Institute, Phoenix, AZ, USA

t Neurological Monitoring Associates, LLC, Milwaukee, WI, USA

u Spine Research LLC, Winchester, MA, USA

v Ballwin, Missouri

w VA Finger Lakes Healthcare System, Canandaigua, NY, USA

x Jupiter Medical Center, Jupiter, FL, USA

y Duke University, Durham, NC, USA

z Shriners Hospital for Children, Philadelphia, PA, USA

aa Trakya University Faculty of Medicine, Edirne, Turkey

bb Medical College of Wisconsin, Milwaukee, WI, USA

cc IGEA Brain & Spine, Union, NJ, USA

dd VACT Healthcare System, West Haven, CT, USA

ee Princeton Brain, Spine & Sports Medicine, Mullica Hill, NJ, USA

ff Rush University, Chicago, IL, USA

gg University Of Michigan, Ann Arbor, MI, USA

hh University of California, San Francisco, CA, USA

ii Choice Physical Therapy, Christiansburg, VA

jj University of California, Davis, Sacramento, CA, USA

kk Pain Diagnostics and Interventional Care, Sewickley, PA, USA
ll Rothman Institute, Thomas Jefferson University, Egg Harbor Township, NJ, USA
mm University of Florida College of Medicine, Jacksonville, FL, USA
nn Huntington, WV, USA
oo Bladen Medical Associates, Elizabethtown, NC, USA
pp Synergy Surgicalists, Portland, ME, USA
qq North American Spine Society, Burr Ridge, IL, USA
rr University of Minnesota, Minneapolis, MN, USA
ss Spine and Pain Centers, Wall, NJ, USA
tt Evergreen Sport and Spine Center, Kirkland, WA, USA
uu Maui Brain and Spine, Wailuku, HI, USA
vv Choice Physical Therapy & Wellness, Christiansburg, VA, USA
ww Trammell Consulting LLC, Pittsboro, IN, USA
xx Penn State Health Milton S. Hershey Medical Center, Hershey, PA, USA
yy North American Spine Society, Burr Ridge, IL, USA

Funding disclosure(s) statement: Development of this guideline was funded in its entirety by the North American Spine Society (NASS) with the exception that stakeholder societies provided representatives and paid for the travel and accommodation of their representatives to recommendation meetings. The NASS Evidence-Based Guideline Development Committee developed this guideline.

Acknowledgements

All participating authors have disclosed potential conflicts of interest consistent with NASS' disclosure policy (http://www.spine.org/DisclosurePolicy). The Technical Report associated with this document includes the disclosures of all authors and contributors along with a description of participating and contributing societies. The following approach was applied for sequencing the

complete author list: Evidence-Based Guideline Committee Co-Chairs (alphabetically), Section Chairs (alphabetically), Work Group Members and NASS staff (alphabetically). With the exception of the Evidence-Based Guideline Development Committee Co-Chairs, who reviewed the entire document, each author affirmed authorship only for the section under which he or she is listed.

Authors

Evidence-Based Guideline Development Committee Co-Chairs: D. Scott Kreiner, MD; Paul Matz, MD

Diagnosis Section: Daniel K. Resnick, MD, MS (Section Chair); Norman B. Chutkan, MD, FACS; Adam C. Lipson, MD; Anthony J. Lisi, DC; Tom E. Reinsel, MD; Robert L. Rich, Jr., MD, FAAFP [Stakeholder Representative, American Academy of Family Physicians (AAFP)]

Imaging Section: Charles H. Cho, MD, MBA (Section Co-Chair); Gary Ghiselli, MD (Section Co-Chair); Walter S. Bartynski, MD [Stakeholder Representative, American Society of Spine Radiology (ASSR)]; Sean D. Christie, MD; Bernard A. Cohen, PhD, FASNM, FACNS; S. Raymond Golish, MD, PhD, MBA; Murat Pekmezci, MD

Medical & Psychological Treatment Section: Christopher M. Bono, MD (Section Chair); Randall P. Brewer, MD [Stakeholder Representative, American Academy of Pain Medicine (AAPM)]; Paul Dougherty, DC; Ravi Prasad, PhD [Stakeholder Representative, American Academy of Pain Medicine (AAPM)]; Gazanfar Rahmathulla, MD, MBBS; Christopher K. Taleghani, MD; Terry Trammell, MD

Physical Medicine & Rehabilitation Section: Charles A. Reitman, MD (Section Chair); R. Carter Cassidy, MD; Dennis E. Enix, DC, MBA; Daniel S. Robbins, MD; Alison A. Stout, DO; Ryan A. Tauzell, PT, MA, MDT

Interventional Treatment Section: John E. Easa, MD, FIPP (Section Chair); Jamie Baisden, MD, FACS; Shay Bess, MD; David S. Cheng, MD; David A. Provenzano, MD [Stakeholder Representative, American Society of Regional Anesthesia and Pain Medicine (ASRA)]; Yakov Vorobeychik, MD, PhD [Stakeholder Representative, Spine Intervention Society (SIS)]

Surgical Treatment Section: William C. Watters III, MD, MS (Section Chair); Thiru M. Annaswamy, MD; Steven W. Hwang, MD; Cumhur Kilincer, MD, PhD; RJ. Meagher, MD; Kris E. Radcliff, MD [Stakeholder Representative, American Academy of Orthopaedic Surgeons (AAOS)]; Anil K. Sharma, MD

Cost-Utility Section: Zoher Ghogawala, MD, FACS (Section Chair); Simon Dagenais, PhD, MSc, DC; Padma Gulur, MD [Stakeholder Representative, American Society of Anesthesiologists (ASA)]; Jeffrey A. King, DC, MS; Paul Park, MD; John E. O'Toole, MD, MS [Stakeholder Representative, American Association of Neurological Surgeons (AANS)/Congress of Neurological Surgeons (CNS)]; Daniel R. Perry, MPT, MDT; Jonathan N. Sembrano, MD

Contributors: John P. Birkedal, MD; Michael P. Dohm, MD; Thomas J. Gilbert, MD; Joseph Gjolaj, MD; Jordan Gliedt, DC; Darren R. Lebl, MD; Robert C. Nucci, MD; Alex Seldomridge, MD, MBA; Matthew Smuck, MD [Stakeholder Representative, American Academy of Physical Medicine and Rehabilitation (AAPM&R)]; William L. Tontz, Jr., MD

Participating Societies (does not necessarily imply endorsement): American Academy of Family Physicians (AAFP); American Academy of Orthopaedic Surgeons (AAOS); American Academy of Pain Medicine (AAPM); American Association of Neurological Surgeons (AANS)/Congress of Neurological Surgeons (CNS); American Society of Anesthesiologists

(ASA); American Society of Regional Anesthesia and Pain Medicine (ASRA); American Society of Spine Radiology (ASSR); Spine Intervention Society (SIS)

Contributing Societies (does not necessarily imply endorsement): American Academy of Physical Medicine and Rehabilitation (AAPM&R); American Physical Therapy Association (APTA)

North American Spine Society Staff: Karie A. Rosolowski, MPH; Amy M. Yahiro, MS

Introduction

To improve the knowledge base concerning the diagnosis and treatment of nonspecific low back pain in adult patients, the Low Back Pain Work Group of the North American Spine Society's (NASS) Evidence-Based Guideline Development Committee developed an evidence-based clinical guideline on this topic. When employing the principles of evidence-based medicine, the clinical literature is extensively searched to answer specific clinical questions about a disease state or medical condition. The literature, identified in the search, is rated according to its scientific merit using NASS evidence analysis criteria and the levels of evidence as determined by specific rule sets that apply to human, clinical investigations. The evidence with the highest possible levels of evidence obtained from the searches is utilized to answer the specific clinical questions. As a final step, the answers to clinical questions are reformulated as recommendations. Recommendations are then assigned a recommendation grade according to the level of evidence for the best clinical evidence available at the time of answering each question. The intent of the grade of recommendation is to indicate the strength of evidence used by the work group in answering the question asked.

Methods

The methods used to develop this guideline and guideline development disclosure policies are detailed in the complete guideline [1] and technical report. [2] In brief (Figure 1), a multidisciplinary work group of spine care specialists, including representatives from the fields of primary care, psychology, neurosurgery, orthopedic surgery, physical medicine and rehabilitation, chiropractic care, physical therapy, anesthesiology, research, and radiology, convened to identify clinical questions to address in the guideline. To ensure broad-based representation on this topic, NASS invited representatives from organizations whose members

are involved in the care of patients with low back pain to serve on guideline work groups. The patient population for this guideline encompasses adults (18 years or older) with low back pain defined as pain of musculoskeletal origin extending from the lowest rib to the gluteal fold that may at times extend as somatic referred pain into the thigh (above the knee). The following conditions were excluded: low back pain due to tumor, infection, metabolic disease, inflammatory arthritis, fracture; patients with a diagnosed deformity, including spondylolisthesis, spondylolysis and scoliosis; pain experienced below the knee; extra-spinal conditions (ie, visceral, vascular, genito-urinary); patients who have undergone prior lumbar surgery; presence of neurological deficit; back pain that is associated with widespread multi-site pain (>2 sites); or pregnancy. A full list of inclusion and exclusion criteria can be found in the complete guideline [1] and technical report. [2] The literature search strategy was developed in consultation with medical librarians. Upon completion of the systematic literature search, evidence relevant to the clinical questions posed in the guideline was reviewed. Work group members utilized NASS evidentiary table templates to summarize study conclusions, identify study strengths and weaknesses, and assign levels of evidence according to the NASS Levels of Evidence for Primary Research Question scale. [3] Work group members participated in webcasts and in-person recommendation meetings to update and formulate evidence-based recommendations and incorporate expert opinion when necessary. The draft guideline was submitted to an internal peer review process as well as an external review by participating stakeholder societies and was ultimately approved by the NASS Board of Directors. A full list of all authors as well as participating and contributing societies can be found in the complete clinical guideline. [1]

Results

Eighty-two clinical questions were addressed in this guideline. Work group members engaged in a two-step screening process to determine article eligibility, including title and abstract screening and evidentiary review. The total number of articles retrieved, eligible for critical appraisal, and meeting inclusion criteria for each individual clinical question can be accessed in the technical report. [2] A total of 119 recommendations and 2 work group consensus statements were issued.

Summary of Recommendations

Recommendations were graded according to the NASS Grades of Recommendation. [4] In summary, these are Recommendation Grade A=Good evidence, Recommendation Grade B=Fair evidence, Recommendation Grade C=Poor quality evidence, and I=Insufficient or conflicting evidence. The recommendations are summarized below.

Diagnosis

Diagnosis Question 1: In patients with low back pain, are there specific history or physical examination findings that would indicate the structure causing pain and, therefore, guide treatment?

a. Vertebral body

b. Intervertebral disc

c. Zygapophyseal joint

d. Posterior elements

e. Sacroiliac joint

f. Muscle/tendon

g. Central sensitization

There is insufficient evidence to make a recommendation for or against the use of innominate kinematics for the assessment of sacroiliac joint pain. [5]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of pain localization in predicting response to a diagnostic injection. [6]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the assessment of centralization or peripheralization for the prediction of discography results. [7]

Grade of Recommendation: I

Diagnosis Question 2: In patients with low back pain, are there history or physical examination findings that would serve as predictors for the recurrence of low back pain?

There is insufficient evidence to indicate that body mass index (BMI) is a potential predictor of a recurrence of low back pain. [8]

Grade of Recommendation: I

It is suggested that history of low back pain is a potential predictor of a recurrence of low back pain. [8,9]

Grade of Recommendation: B

Diagnosis Question 3: In patients with acute low back pain, are there history or physical examination findings that would predict that an episode will resolve within one month?

Diagnosis Question 6: What are the patient characteristics that increase or decrease the risk of developing chronic low back pain after an acute episode?

Diagnosis Question 9: Does a psychological evaluation assist with identifying patients with low back pain who are at risk for developing chronic pain or disability?

The work group considered these questions together as the vast majority of the literature evaluating the conversion from acute to chronic pain combined various demographic, social, psychological, and physical examination findings in predictive models.

It is recommended that psychosocial factors and workplace factors be assessed when counseling patients regarding the risk of conversion from acute to chronic low back pain. [10-26]

Grade of Recommendation: A

It is recommended that psychosocial factors be used as prognostic factors for return to work following an episode of acute low back pain. [19,20,22,24,26]

Grade of Recommendation: A

It is recommended that pain severity and functional impairment be used to stratify risk of conversion from acute to chronic low back pain. [13, 16, 19, 20, 27-29]

Grade of Recommendation: A

It is suggested that prior episodes of low back pain be considered a prognostic factor for the conversion from acute to chronic low back pain. [13, 16, 17]

Grade of Recommendation: B

There is insufficient evidence to assess sleep quality as a prognostic variable to predict recovery from acute low back pain. [12]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of smoking and/or obesity as prognostic factors for the conversion from acute to chronic low back pain. [11, 18, 23]

Grade of Recommendation: I

Diagnosis Question 4: In patients with low back pain, what history and/or physical examination findings are useful in determining if the cause is nonstructural in nature and, therefore, guide treatment?

A nonstructural cause of low back pain may be considered in patients with diffuse low back pain and tenderness. [30,31]

Grade of Recommendation: C

There is insufficient evidence to make a recommendation for or against the use of fear avoidance behavior to determine the likelihood of a structural cause of low back pain. [32]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the presence of diffuse back tenderness for the prediction of the presence of disc degeneration on radiographs. [30]

Grade of Recommendation: I

Diagnosis Question 5: In patients with low back pain, what elements of the patient's history and findings from the physical examination would suggest the need for diagnostic laboratory studies?

There is insufficient evidence to make a recommendation for or against obtaining laboratory tests to assess for inflammatory disease in patients with sacroiliac joint pain. [33]

Grade of Recommendation: I

Diagnosis Question 7: In patients with low back pain, are there specific findings on a pain diagram that help differentiate the structure which is causing pain?

A systematic review of the literature yielded no studies to adequately address this question.

Diagnosis Question 8: Are there assessment tools or questionnaires that can help identify the cause of acute, subacute or chronic low back pain?

A systematic review of the literature yielded no studies to adequately address this question.

Diagnosis Question 10: Are there history and physical examination findings that would warrant obtaining advanced imaging studies?

A systematic review of the literature yielded no studies to adequately address this question.

Work Group Consensus Statement: In the absence of reliable evidence supporting an absolute indication for advanced imaging based upon history and physical examination in the specifically-defined patient population, it is the work group's opinion that, in patients with severe and intractable pain syndromes who have failed medical/interventional treatment, advanced imaging may be indicated. Subgroups of patients have been shown to have a higher or lower incidence of radiographic abnormalities based upon acuity of low back pain, tenderness to palpation, and provocation maneuvers; however, the utility of these findings in guiding treatment is not clear. [34-38]

Imaging

Imaging Question 1: What is the association between low back pain and spondylosis on routine radiography?

There is insufficient evidence to make a recommendation for or against an association between low back pain and spondylosis using routine radiography. [39,40]

Grade of Recommendation: I

Imaging Question 2: Is there evidence to support the use of computed tomography (CT) or magnetic resonance imaging (MRI) for the evaluation of low back pain in the absence of x-ray/radiographic abnormality?

A systematic review of the literature yielded no studies to adequately address this question.

Imaging Question 3: In patients with low back pain, does duration of symptoms correlate with abnormal findings on imaging?

A systematic review of the literature yielded no studies to adequately address this question.

Imaging Question 4: What is the optimal imaging protocol that should be used in the setting of low back pain? 4a. Are unique MRI sequences considered preferential or optimal?

There is insufficient evidence that unique magnetic resonance imaging (MRI) sequences can be considered preferential or optimal. [41]

Grade of Recommendation: I

4b. What is the history and clinical presentation that suggests the use of contrast enhanced imaging in patients with low back pain?

A systematic review of the literature yielded no studies to adequately address this question.

4c. Is there evidence to support imaging the lumbar spine in an oblique plane?

A systematic review of the literature yielded no studies to adequately address this question.

4d. What is the value of flexion/extension films in evaluating lower back pain?

A systematic review of the literature yielded no studies to adequately address this question.

Imaging Question 5: In the absence of red flags, what are the imaging (x-ray, CT or MRI) recommendations for patients with acute or chronic low back pain?

There is insufficient evidence to make a recommendation for or against obtaining imaging in the absence of red flags. [42]

Grade of Recommendation: I

Imaging Question 6: Are there imaging findings that correlate with the presence of low back pain?

There is insufficient evidence for or against imaging findings correlating with the presence of low back pain. [41, 43-49]

Grade of Recommendation: I

Imaging Question 7: Are there imaging findings that contribute to decision-making by healthcare providers to guide treatment?

There is insufficient evidence to determine whether imaging findings contribute to decision-making by healthcare providers to guide treatment. [50]

Grade of Recommendation: I

<u>Medical and Psychological Treatment (Med/Psych)</u>

Med/Psych Question 1: Is smoking cessation effective in decreasing the frequency of low back pain episodes?

A systematic review of the literature yielded no studies to adequately address this question.

Med/Psych Question 2: In patients with low back pain, is pharmacological treatment effective in decreasing duration of pain, decreasing intensity of pain, increasing functional outcomes of treatment and improving the return-to-work rate?

Versus:

a. No treatment

i. Risks

ii. Complications

b. Cognitive behavioral therapy (CBT) and/or psychosocial intervention alone

c. Patient education alone

There is insufficient evidence to make a recommendation for or against the use of anticonvulsants for the treatment of low back pain. [51]

Grade of Recommendation: I

Antidepressants are not recommended for the treatment of low back pain. [52-55]

Grade of Recommendation: A

There is insufficient evidence to make a recommendation for or against the use of Vitamin D for the treatment of low back pain. [56]

Grade of Recommendation: I

Non-selective NSAIDs are suggested for the treatment of low back pain. [57-59]

Grade of Recommendation: B

There is insufficient evidence to make a recommendation for or against the use of selective NSAIDs for the treatment of low back pain. [57-59]

Grade of Recommendation: I

It is suggested that the use of oral or IV steroids is not effective for the treatment of low back pain. [60, 61]

Grade of Recommendation: B

It is suggested that the use of opioid pain medications should be cautiously limited and restricted to short duration for the treatment of low back pain. [62-70]

Grade of Recommendation: B

Med/Psych Question 3: In patients with low back pain, is topical treatment (e.g., cream or gel) effective in decreasing duration of pain, decreasing intensity of pain, increasing functional outcomes of treatment and improving the return-to-work rate?

There is insufficient evidence to make a recommendation for or against the use of lidocaine patch for the treatment of low back pain. [71]

Grade of Recommendation: I

Topical capsicum is recommended as an effective treatment for low back pain on a short-term basis (3 months or less). [72, 73]

Grade of Recommendation: A

Med/Psych Question 4: Following treatment for low back pain, do patients with healthy sleep habits experience decreased duration of pain, decreased intensity of pain, increased functional outcomes and improved return-to-work rates compared to patients with poor sleeping habits?

A systematic review of the literature yielded no studies to adequately address this question.

Med/Psych Question 5: In patients with low back pain, is cognitive behavioral therapy (CBT) and/or psychosocial intervention and/or neuroscience education effective in decreasing duration of pain, decreasing intensity of pain, increasing functional outcomes, decreasing anxiety and/or depression and improving return-to-work rate? [74-84]

Cognitive behavioral therapy is recommended in combination with physical therapy, as compared with physical therapy alone, to improve pain levels in patients with low back pain over 12 months.

Grade of Recommendation: A

Cognitive behavioral therapy in combination with physical therapy, compared to physical therapy alone, is suggested to improve functional outcomes (disability) and return to work in patients with low back pain.

Grade of Recommendation: B

There is conflicting evidence to make a recommendation for or against cognitive behavioral therapy for improving depression or anxiety in patients with low back pain.

Grade of Recommendation: I

Med/Psych Question 6: In patients with low back pain, does the timing of cognitive behavioral therapy (CBT) and/ or psychosocial intervention and/or neuroscience education affect duration of pain, intensity of pain, functional outcomes, anxiety, depression and return-to-work status?

A systematic review of the literature yielded no studies to adequately address this question.

Med/Psych Question 7: In patients undergoing interventional or surgical treatment for low back pain, does the addition of cognitive behavioral therapy (CBT) and/or psychosocial intervention add incremental benefit?

There is insufficient evidence to make a recommendation for or against the addition of cognitive behavioral therapy or psychosocial intervention for patients undergoing interventional or surgical treatment for low back pain and whether it would provide incremental benefit. [85]

Grade of Recommendation: I

Med/Psych Question 8: Does educating a patient about low back pain improve treatment compliance and outcomes, including duration of pain, intensity of pain, functional outcomes, anxiety, depression and return-to-work status?

There is conflicting evidence to make a recommendation for or against the use of patient education to improve treatment compliance and outcomes, including duration of pain, intensity of pain, functional outcomes, anxiety, depression and return to work status. [86-116]

Grade of Recommendation: I

Med/Psych Question 9: In patients undergoing treatment for low back pain, what is the effectiveness of interventions that address fear-avoidance behaviors?

Treatments targeting fear avoidance combined with physical therapy are recommended compared to physical therapy alone to improve low back pain in the first six months. [117-120]

Grade of Recommendation: A

Med/Psych Question 10: Is active treatment (pharmacological or psychotherapeutic) of anxiety and depression effective in decreasing low back pain?

A systematic review of the literature yielded no studies to adequately address this question.

Med/Psych Question 11: What are the psychological factors influencing outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, of low back pain treatment?

It is suggested that kinesiophobia is a negative prognostic factor for predicting response to low back pain treatment. [121-123]

Grade of Recommendation: B

Med/Psych Question 12: In patients with low back pain, what psychosocial/cognitive/emotional or other assessments should be utilized to establish an accurate diagnosis?

A systematic review of the literature yielded no studies to adequately address this question.

Med/Psych Question 13: Does nutrition (other than weight reduction) influence the frequency of low back pain episodes?

A systematic review of the literature yielded no studies to adequately address this question.

Physical Medicine and Rehabilitation (PM&R)

PM&R Question 1: In patients undergoing treatment for low back pain, what is the effectiveness of the following in decreasing the duration of pain, decreasing intensity of pain, increasing functional outcomes and improving return to work status, as compared with natural history plus or minus medication:

a. Acute vs. subacute vs. chronic

i. Patient education and self- directed exercise program

Back school is recommended to provide improvements in pain and function when compared with general medical care, modality care or a simple handout at 6-12 months' follow-up for chronic low back pain. [101, 114, 124, 125]

Grade of Recommendation: A

There is insufficient evidence that outcomes from a home-based exercise program are different than no care. [126, 127]

Grade of Recommendation: I

There is insufficient evidence that a ***self-directed*** McKenzie exercise program for acute low back pain results in different outcomes compared to usual medical care. [128]

Grade of Recommendation: I

There is insufficient evidence that a monitored pedometer-based exercise program with web-based feedback provides any improvement over pedometer instruction alone. [129]

Grade of Recommendation: I

ii. Physical agents

a. (e.g., heat, cold)

It is suggested that the use of heat for acute low back pain results in short-term improvements in pain. [130-136]

Grade of Recommendation: B

b. *(e.g., ultrasound)*

In patients with chronic low back pain, ultrasound is not recommended to improve functional outcomes. [137, 138]

Grade of Recommendation: A

There is conflicting evidence that ultrasound provides immediate pain relief in patients with chronic low back pain. [137, 138]

Grade of Recommendation: I

c. *(e.g., TENS)*

There is conflicting evidence that transcutaneous electrical nerve stimulation (TENS) results in improvement in pain or function at short- to medium-term follow-up. [139-145]

Grade of Recommendation: I

d. *(e.g., laser- cutaneous stimulation for purpose of pain modulation)*

Laser acupuncture provides no short-term or medium-term benefit over sham treatment for patients with chronic low back pain. [146, 147]

Grade of Recommendation: A

It is suggested that the combination of laser therapy (low-level or high level) with exercise provides better short-term relief of ***pain*** than either exercise or laser therapy alone. [148, 149]

Grade of Recommendation: B

There is conflicting evidence that the combination of laser therapy with exercise provides better short-term improvement in ***function*** compared to exercise or laser therapy alone. [148, 149]

Grade of Recommendation: I

It is suggested that there is no short-term benefit of laser therapy (low-level or high level) when compared with exercise alone. [148, 149]

Grade of Recommendation: B

e. (e.g., traction)

In patients with subacute or chronic low back pain, traction is not recommended to provide clinically significant improvements in pain or function. [150-152]

Grade of Recommendation: A

f. (e.g., dry needling)

There is insufficient evidence for or against the use of dry needling as a treatment option for patients with chronic low back pain. [153]

Grade of Recommendation: I

g. (e.g., electrical stimulation)

A systematic review of the literature yielded no studies to adequately address this question.

iii. Acupuncture

In patients with low back pain, there is conflicting evidence that acupuncture provides improvements in pain and function as compared to sham acupuncture. [150-152]

Grade of Recommendation: I

In patients with ***chronic*** low back pain, addition of acupuncture to usual care is recommended for short-term improvement of pain and function compared to usual care alone. [159-162]

Grade of Recommendation: A

There is insufficient evidence to draw conclusions regarding the comparative effectiveness of acupuncture techniques. [162-165]

Grade of Recommendation: I

iv. Bracing

-- *Lumbosacral brace*

-- *Sacroiliac brace*

There is conflicting evidence that bracing results in improvements in pain and function in patients with subacute low back pain. [166-168]

Grade of Recommendation: I

v. SMT [86, 89, 168-182]

For patients with acute or chronic low back pain, spinal manipulative therapy (SMT) is an option to improve pain and function.

Grade of Recommendation: C

For patients with acute low back pain, spinal manipulative therapy (SMT) results in similar outcomes to no treatment, medication or modalities. Periodically, short-term improvement is statistically better, but clinical significance is uncertain.

Grade of Recommendation: A

For patients with chronic low back pain, there is conflicting evidence that outcomes for spinal manipulative therapy (SMT) are clinically different than no treatment, medication or modalities.

Grade of Recommendation: I

vi. Exercise/physical therapy versus or plus massage [183-187]

There is insufficient evidence to determine the efficacy of acupressure compared to a standardized multimodal physical therapy.

Grade of Recommendation: I

In the long term, it is suggested that the addition of massage to an exercise program provides no benefit when compared to an exercise program alone.

Grade of Recommendation: B

There is insufficient evidence that the addition of massage to an exercise program provides short-term relief of pain.

Grade of Recommendation: I

vii. Active stabilization exercise

There is insufficient evidence to make a recommendation for or against lumbar stabilization in patients with chronic low back pain. [188-190]

Grade of Recommendation: I

viii. McKenzie exercise [includes directional preference, centralization, and mechanical diagnosis and therapy (MDT)] [191-193]

McKenzie method is an option for the treatment of chronic low back pain.

Grade of Recommendation: C

There is insufficient evidence that McKenzie method results in different outcomes when compared to a dynamic strengthening program for the treatment of chronic low back pain.

Grade of Recommendation: I

There is insufficient evidence that McKenzie method is better or worse than back school for the treatment of chronic low back pain.

Grade of Recommendation: I

ix. Yoga

It is suggested that, in patients with mild chronic low back pain, yoga may offer medium-term improvements in pain and function compared to usual care, although these improvements are not clinically meaningful due to low baseline pain/disability. [194-197]

Grade of Recommendation: B

x. Aerobic exercise [79-82]

Aerobic exercise is recommended to improve pain, disability and mental health in patients with non-specific low back pain at short-term follow-up.

Grade of Recommendation: A

There is insufficient evidence that aerobic exercise improves pain, disability and mental health in patients with non-specific low back pain at long-term follow-up.

Grade of Recommendation: I

xi. Work hardening or conditioning [202-209]

In patients with low back pain, work hardening may be considered to improve return to work.

Grade of Recommendation: C

There is insufficient evidence that work hardening is different than an active therapeutic exercise program or guideline-based physical therapy.

Grade of Recommendation: I

PM&R Question 2: In patients undergoing treatment for low back pain, what is the appropriate timing, frequency, and duration of treatment with:

Acute vs. subacute vs. chronic

i. Patient education and self- directed exercise program

ii. Physical agents

a. (e.g., heat, cold)

A systematic review of the literature yielded no studies to adequately address this question.

b. (e.g., ultrasound)

A systematic review of the literature yielded no studies to adequately address this question.

c. (e.g., TENS)

A systematic review of the literature yielded no studies to adequately address this question.

d. (e.g., laser- cutaneous stimulation for purpose of pain modulation)

A systematic review of the literature yielded no studies to adequately address this question.

e. *(e.g., traction)*

A systematic review of the literature yielded no studies to adequately address this question.

f. *(e.g., dry needling)*

A systematic review of the literature yielded no studies to adequately address this question.

g. *(e.g., electrical stimulation)*

A systematic review of the literature yielded no studies to adequately address this question.

iii. Acupuncture

A systematic review of the literature yielded no studies to adequately address this question.

iv. Bracing

-- *Lumbosacral brace*

-- *Sacroiliac brace*

A systematic review of the literature yielded no studies to adequately address this question.

v. SMT

There is insufficient evidence to determine whether 12 to 18 visits of spinal manipulative therapy (SMT) results in better outcomes than 6 visits for the treatment of low back pain. [170]

Grade of Recommendation: I

vi. Exercise/Physical Therapy versus or plus massage

A systematic review of the literature yielded no studies to adequately address this question.

vii. Active stabilization exercise

A systematic review of the literature yielded no studies to adequately address this question.

viii. McKenzie exercise [includes directional preference, centralization, and mechanical diagnosis and therapy (MDT)]

A systematic review of the literature yielded no studies to adequately address this question.

ix. Yoga

A systematic review of the literature yielded no studies to adequately address this question.

x. Aerobic exercise

A systematic review of the literature yielded no studies to adequately address this question.

xi. Work hardening or conditioning

A systematic review of the literature yielded no studies to adequately address this question.

PM&R Question 3: Are there specific patient or treatment characteristics that predict improved duration of pain, intensity of pain, functional outcomes and return-to-work status with SMT following an episode of low back pain?

There is conflicting evidence that symptoms above the knee, low fear avoidance questionnaire score, at least one hypo-mobile segment, and greater than 35 degrees of internal rotation of the hip are predictive of responding to spinal manipulative therapy (SMT) for patients with acute low back pain. [210-214]

Grade of Recommendation: I

There is insufficient evidence that hyper- or hypo-mobility, patient age, strains and sprains, instability, severe affective distress, relationship with healthcare provider, use of thrust vs. non-thrust techniques, pre-treatment psychological or socioeconomic status, or number of visits are predictive factors of response to spinal manipulative therapy (SMT). [215-223]

Grade of Recommendation: I

PM&R Question 4: In patients undergoing treatment for low back pain, what are outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, for exercise therapy alone versus exercise with cognitive behavioral therapy (CBT)?

There is conflicting evidence that addition of cognitive behavioral therapy (CBT) to an exercise program results in significant improvement in pain and function compared to exercise alone in patients with chronic low back pain. [81, 92, 104, 119, 224-227]

Grade of Recommendation: I

PM&R Question 5: In patients undergoing treatment for low back pain, what are outcomes, including duration of pain, intensity of pain, functional outcomes and return to work status, for a lumbar stabilization exercise program versus a general fitness program?

It is suggested that a specific stabilization exercise program is equivalent to a general exercise program. [228-232]

Grade of Recommendation: B

PM&R Question 6: In patients undergoing treatment for low back pain, what are outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, for SMT versus SMT plus active exercise?

It is suggested that the addition of exercise to spinal manipulative therapy (SMT) results in similar outcomes to SMT alone. [91, 233]

Grade of Recommendation: B

PM&R Question 7: In patients undergoing treatment for low back pain, what are the outcomes, including duration of pain, intensity of pain, functional outcomes and return to work status, for bed rest versus active exercise? [234-237]

It is suggested that, for patients with acute low back pain, those that exercise more at baseline and use exercise to facilitate recovery are predicted to have better functional outcomes over time than patients who do not exercise or use bed rest to help with recovery.

Grade of Recommendation: B

For patients with acute low back pain, it is suggested that advice to remain active within limits of pain compared to short periods of bed rest from 3 to 7 days all result in similar outcomes in pain and function at short- and medium-term follow-up.

Grade of Recommendation: B

Work Group Consensus Statement: In the absence of reliable evidence for patients with non-specific back pain, based on abundant data for other spinal disorders that result in back pain, it is the work group's opinion that remaining active is preferred and likely results in better short-term outcomes than does bed rest.

PM&R Question 8: In patients with low back pain, does a regular exercise program (or pre-surgical intervention with exercise, PT, education) prior to lumbar surgery decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate compared to those who don't exercise?

A systematic review of the literature yielded no studies to adequately address this question.

PM&R Question 9: In patients with low back pain, does exercise treatment after epidural steroid injections/spinal interventions decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate compared to injections alone?

A systematic review of the literature yielded no studies to adequately address this question.

PM&R Question 10: Following surgery for low back pain, are outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, improved with a formal exercise/rehabilitation program versus home instruction plus or minus self-directed exercise program alone?

A systematic review of the literature yielded no studies to adequately address this question.

PM&R Question 11: Can a clinical prediction rule determine appropriate indications and predict outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, for exercise for low back pain?

There is insufficient evidence to provide any reliable predictors of outcomes to an exercise program for the treatment of either acute or chronic low back pain. [238, 239]

Grade of Recommendation: I

Interventional Treatment

Interventional Question 1: In patients with low back pain, do fluoroscopically-guided epidural steroid injections decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

There is insufficient evidence to make a recommendation for or against the use of caudal epidural steroid injections in patients with low back pain. [240]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of interlaminar epidural steroid injections in patients with low back pain. [241]

Grade of Recommendation: I

Interventional Question 2: When evaluating fluoroscopically-guided intra-articular lumbar facet joint injections in patients with acute or chronic low back pain:

a. What is the diagnostic utility of this procedure?

b. From a therapeutic standpoint, does this procedure decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

There is insufficient evidence to make a recommendation for or against the use of patient-reported reproduction of pain during a zygapophyseal joint injection as a predictor of response to dual diagnostic blocks. [242]

Grade of Recommendation: I

In patients selected for facet joint procedures using diagnostic criteria of physical exam and a response to a single diagnostic intra-articular injection with 50% relief, it is suggested that intra-articular injection of steroids provides no clinically meaningful improvement at 6 months. [243, 244]

Grade of Recommendation: B

In patients selected for facet joint procedures using diagnostic criteria of physical exam and a response to a single diagnostic intra-articular injection with 50% relief, there is

insufficient evidence to make a recommendation for or against the use of radiofrequency neurotomy or periarticular phenol injections. [244, 245]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of steroid injections into the zygapophyseal joint in patients with chronic back pain and a physical exam suggestive of facet-mediated pain. [246]

Grade of Recommendation: I

Interventional Question 3: In patients with low back pain, do medial branch blocks have a role in defining treatment for low back pain?

a. Does duration of pain, intensity of pain, functional outcomes and return-to-work status vary when candidates for neurotomy are determined by single vs. comparative medial branch blocks?

b. Is there a threshold for the magnitude of relief from diagnostic facet nerve blocks that predict outcomes to neurotomy?

c. Does duration of pain, intensity of pain, functional outcomes and return-to-work status vary when candidates for neurotomy are determined by diagnostic facet nerve blocks vs. intra-articular facet joint injections?

d. Is there a therapeutic utility of medial branch blocks?

e. Does technical accuracy of medial branch blocks (e.g., contrast use) affects its validity and effectiveness of subsequent neurotomy?

There is insufficient evidence to make a recommendation for or against the use of SPECT imaging in the diagnosis of zygapophyseal joint pain. [247]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of uncontrolled medial branch blocks vs. pericapsular blocks for the diagnosis of zygapophyseal joint pain based on the outcomes of medial branch nerves cryoablation. [248]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of cryodenervation for the treatment of zygapophyseal joint pain. [248]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of a 50% reduction in pain following medial branch blockade for the diagnosis of zygapophyseal joint pain. [249, 250]

Grade of Recommendation: I

Thermal radiofrequency ablation is suggested as a treatment for patients with low back pain from the zygapophyseal joints. The outcomes of this procedure become more reliable when more stringent diagnostic criteria are used. The relief from these injections is durable for at least six months following the procedure. [244, 249, 251-257]

Grade of Recommendation: B

Interventional Question 4: In patients with low back pain due to lumbar facet joint arthropathy, does fluoroscopically-guided neurotomy decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

Thermal radiofrequency ablation is suggested as a treatment for patients with low back pain from the zygapophyseal joints. The outcomes of this procedure become more reliable when more stringent diagnostic criteria are used. The relief from these injections is durable for at least six months following the procedure. [244, 251-257]

Grade of Recommendation: B

Interventional Question 5: In patients with low back pain, do fluoroscopically-guided sacroiliac joint injections (SIJI) decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

a. Does duration of pain, intensity of pain, functional outcomes and return-to-work status vary when candidates for neurotomy are determined by single vs. comparative SIJI?

b. Is there a benefit to performing lateral branch blocks as compared with interarticular diagnostic injections as a predictor to response to lateral branch neurotomy?

c. Is there a threshold for the magnitude of relief from diagnostic SIJI that predict improvement in duration of pain, intensity of pain, functional outcomes and return-to-work status from SIJ neurotomy?

Intra-articular steroid joint injections may be considered in patients with suspected SI joint pain [258-260]

Grade of Recommendation: C

Interventional Question 6: In patients with pelvic posterior girdle pain relieved temporarily by image guided SIJ injections or lateral branch blocks, does lateral branch neurotomy decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

Cooled radiofrequency ablation of the sacral lateral branch nerves and dorsal ramus of L5 may be considered in patients with sacroiliac joint pain diagnosed with dual diagnostic blocks. [261, 262]

Grade of Recommendation: C

Interventional Question 7: In patients with low back pain, does spinal cord stimulation decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

There is insufficient evidence to make a recommendation for or against the use of spinal cord stimulation as a treatment for low back pain. [263]

Grade of Recommendation: I

Interventional Question 8: In patients with low back pain, does continuous delivery of intrathecal opioids decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate and are there risks associated with its use?

A systematic review of the literature yielded no studies to adequately address this question.

Interventional Question 9: In patients with low back pain, is provocative lumbar discography more accurate than other diagnostic modalities in identifying the disc as a source of pain?

There is high-level evidence that provocative discography without manometric measurements correlates with pain reproduction in the presence of moderate to severe disc degeneration on MRI/CT discography. [264-268]

Grade of Recommendation: A

There is high-level evidence that provocative discography without manometric pressure measurements correlates with the presence of endplate abnormalities on MRI imaging. [264, 265]

Grade of Recommendation: A

Bony vibration provocation may be considered to correlate with the presence of pain in patients who have pain on provocation discography without manometric pressure measurements. There is no correlation with the segmental level of pain. [269-271]

Grade of Recommendation: C

There is insufficient evidence to make a recommendation for or against the use of axial loaded magnetic resonance imaging (MRI) for the diagnosis of low back pain. [272]

Grade of Recommendation: I

There is conflicting evidence that pressure controlled provocative discography correlates with nuclear T2 signal intensity on magnetic resonance imaging (MRI) in patients with low back pain. [273, 274]

Grade of Recommendation: I

There is conflicting evidence that provocative discography without manometric pressure measurements correlates with the presence of a high-intensity zone (HIZ) on MRI imaging. [264, 265, 275]

Grade of Recommendation: I

Interventional Question 10: In patients with low back pain, is anesthetic lumbar discography more accurate than other diagnostic modalities in identifying the disc as a source of pain?

There is insufficient evidence to make a recommendation for or against the use of anesthetic discography. [276-279]

Grade of Recommendation: I

Interventional Question 11: In patients with low back pain, does intradiscal injection decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

Intradiscal steroids are suggested to provide short-term improvements in pain and function ***in patients with Modic changes***. [280, 281]

Grade of Recommendation: B

There is insufficient evidence that intradiscal steroids provide improvements in pain or function ***in patients with discogenic low back pain***. [282, 283]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of intradiscal bone marrow concentrate in patients with discogenic low back pain. [284]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of intradiscal platelet rich plasma in patients with discogenic low back pain. [285]

Grade of Recommendation: I

There is insufficient evidence to make a recommendation for or against the use of intradiscal Methylene Blue in patients with discogenic low back pain. [286]

Grade of Recommendation: I

Interventional Question 12: In patients with low back pain, does intradiscal electrothermal therapy or biacuplasty decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

Intradiscal electrothermal annuloplasty is suggested to provide improvements in pain and function at up to two years. This treatment is limited in its effectiveness with roughly 40-50% of patients receiving a 50% reduction in pain. [287-289]

Grade of Recommendation: B

Biacuplasty is an option to produce clinically and statistically significant improvements in pain at 6 months in patients with discogenic low back pain. [290-293]

Grade of Recommendation: C

There is insufficient evidence to make a recommendation for or against the use of percutaneous intradiscal radiofrequency thermocoagulation. [294]

Grade of Recommendation: I

Interventional Question 13: In patients with low back pain, do trigger point injections decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

There is insufficient evidence to make a recommendation for or against the use of trigger point injections in the treatment of low back pain. The type of injectate does not influence outcomes. [295, 296]

Grade of Recommendation: I

Surgical Treatment

Surgical Question 1: In patients with low back pain, does surgical treatment vs. medical/interventional treatment alone decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 2: In patients with low back pain, are there predictive factors which determine the benefit of initial treatment with surgical intervention versus initial medical/interventional treatment?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 3: In patients undergoing fusion surgery for low back pain, which fusion technique results in the best outcomes for the following: decreased duration of pain, decreased intensity of pain, increased functional outcomes of treatment and improved return-to-work rate?

a. Posterolateral fusion without internal fixation vs.

b. Posterolateral transverse fusion with internal fixation vs.

c. Stand-alone (anterior) interbody fusion vs.

d. Transforaminal lumbar interbody fusion (TLIF) or posterior lumbar interbody fusion (PLIF) vs.

e. Circumferential fusion (anterior interbody, lateral techniques)

There is insufficient evidence to make a recommendation for or against a particular fusion technique for the treatment of low back pain. [297, 298]

Grade of Recommendation: I

Surgical Question 4: In patients undergoing fusion surgery for low back pain, are clinical outcomes, including duration of pain, intensity of pain, functional outcomes and return-to-work status, different for multi-level fusions vs. single level fusions?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 5: In patients undergoing fusion surgery for low back pain, does radiographic evidence of fusion correlate with decreased duration of pain, decreased intensity of pain, increased functional outcomes of treatment and improved return-to-work rate?

There is insufficient evidence to make a recommendation regarding whether radiographic evidence of fusion correlates with better clinical outcomes in patients with low back pain. [298]

Grade of Recommendation: I

Surgical Question 6: In patients undergoing fusion surgery for low back pain, does the use of bone growth stimulators (vs. fusion alone) decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 7: In patients undergoing fusion surgery for low back pain, does the use of BMP (vs. fusion alone) decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 8: In patients undergoing fusion surgery for low back pain, does the use of minimally invasive techniques decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate compared to open fusion techniques?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 9: In patients undergoing surgery for low back pain, do motion preserving systems (disc prosthesis and dynamic stabilization systems treatment) decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate compared to fusion surgery?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 10: In patients undergoing surgery for low back pain, do motion preserving systems (disc prosthesis and dynamic stabilization systems) result in lower incidence of symptomatic adjacent segment disease?

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 11: In patients with low back pain, does fusion treatment decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate compared to treatment with:

a. Discectomy

b. Discectomy plus rhizotomy

c. Decompression alone

A systematic review of the literature yielded no studies to adequately address this question.

Surgical Question 12: In patients with low back pain due to sacroiliac joint dysfunction, does sacroiliac joint fusion compared with medical/interventional treatment decrease the duration of pain, decrease the intensity of pain, increase the functional outcomes of treatment and improve the return-to-work rate?

A systematic review of the literature yielded no studies to adequately address this question.

<u>Cost Utility</u>

Cost Utility Question 1: Who is the most cost-effective spinal care provider for evaluating patients with low back pain:

a. Chiropractor vs.

b. Physical Therapist vs.

c. Primary Care Provider (including non-physician providers) vs.

d. Neurologist vs.

e. Physiatrist vs.

f. Spine Surgeon vs.

g. Anesthesiologists/Pain Medicine Physician vs.

i. Radiologist

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 2: What is the cost-utility of diagnostic imaging studies/workup in the evaluation of low back pain (acute, subacute, and chronic), in terms of influencing/altering treatment or in terms of leading to pain reduction and functional improvement?

a. X-rays (lumbar standing, lumbar flexion-extension, entire spine)

b. CT scan / CT myelogram

c. MRI (conventional or dynamic/upright/weight bearing)

There is insufficient evidence to make a recommendation for or against the cost effectiveness of the use of routine ordering of lumbar spine radiographs for low back pain lasting greater than 6 weeks in the absence of red flags. [299, 300]

Grade of Recommendation: I

Cost Utility Question 3: Does the use of ordering physician-owned diagnostic and treatment facilities affect the cost of low back pain related healthcare services?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 4: Are epidural steroid injections (including interlaminar, transforaminal, and caudal injections and selective nerve root blocks) more cost effective in the management of patients with low back pain than other medical/interventional treatments?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 5: Is spinal cord stimulation more cost effective in the management of patients with low back pain than other medical/interventional treatments?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 6: Is physical therapy in the management of patients with low back pain more cost effective than other medical/interventional treatments?

There is insufficient evidence to make a recommendation for or against the cost utility of physical therapy in the management of low back pain versus other medical/interventional treatments. [301]

Grade of Recommendation: I

Cost Utility Question 7: Is pharmacological management (over-the-counter + prescription medications) for patients with low back pain more or less cost-effective than interventional treatments including physical therapy and injection therapies?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 8: Is spinal manipulative therapy in the management of patients with low back pain more cost effective than other medical/interventional treatments?

There is insufficient evidence to make a recommendation for or against the cost utility of spinal manipulative therapy for the treatment of low back pain. [301]

Grade of Recommendation: I

Cost Utility Question 9: Is acupuncture-based therapy in the management of patients with low back pain more cost effective than other medical/interventional treatments?

Acupuncture-based therapy in the management of patients with low back pain is suggested to be cost effective when compared with other medical/interventional treatments. [302-304]

Grade of Recommendation: B

Cost Utility Question 10: Are over-the-counter medications only without other medical interventions more cost effective in the management of patients with low back pain than other medical/interventional treatments?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 11: Is cognitive or psychological-based therapy in the management of patients with low back pain more cost effective than other medical/interventional treatments?

There is conflicting evidence regarding the cost utility of cognitive or psychological-based therapy in the management of low back pain. [76, 305-308]

Grade of Recommendation: I

Cost Utility Question 12: In patients with low back pain, is a symptom guided treatment approach using directional preference/centralization matched exercise more cost effective than usual care (home care vs. medication vs. non-specific physical therapy exercise vs. non-specific physical therapy modalities) long-term at 12 months, 36 months?

There is insufficient evidence to make a recommendation for or against the cost utility of directional preference based therapy versus alternatives. [309]

Grade of Recommendation: I

Cost Utility Question 13: Is the surgical management (including fusion and lumbar disc replacement and spinal cord stimulators) of patients with low back pain more cost effective than medical/interventional treatments?

There is insufficient evidence to make a recommendation for or against the cost utility of surgical therapies versus medical/interventional therapies for low back pain. [310, 311]

Grade of Recommendation: I

Cost Utility Question 14: Is cognitive or psychological-based therapy in the management of patients with low back pain more cost effective than surgical therapies?

There is insufficient evidence to make a recommendation for or against the cost utility of cognitive or psychological-based therapies vs. surgical therapies in the treatment of low back pain. [311, 312]

Grade of Recommendation: I

Cost Utility Question 15: Are minimally invasive surgical procedures more cost effective in the management of patients with low back pain than conventional open surgical procedures?

A systematic review of the literature yielded no studies to adequately address this question.

Cost Utility Question 16: Is instrumented lumbar fusion more cost-effective compared to non-instrumented fusion for the treatment of patients with low back pain?

A systematic review of the literature yielded no studies to adequately address this question.

Discussion

This evidence-based clinical guideline for the diagnosis and treatment of low back pain has several functions. It is an educational tool for both clinicians and patients, and as such this particular guideline is intended to assist practitioners who treat adult patients with nonspecific low back pain. This guideline also serves to focus and rate the scientific data on this topic. An evidence-based guideline such as this allows a clinician access to the best and most current evidence and reduces the burden of "keeping up with the literature" that spans innumerable journals from a broad spectrum of disciplines. In addition, this evidence-based clinical guideline has the potential to improve the appropriateness and effectiveness of patient care by basing decisions on the best evidence available. Finally, this guideline serves to identify knowledge gaps in the clinical literature on nonspecific low back pain in adult patients. High-quality clinical guidelines ideally identify and suggest future research topics to improve guideline development

and thus patient care, as detailed in the current guideline. Recommendations were developed based on a specific definition, inclusion/exclusion criteria, and the resulting literature, which excluded conditions such as presence of a neurological deficit or leg pain experienced below the knee, among others. Given the exclusion criteria, these guideline recommendations address a subset of low back pain care as opposed to low back pain in its entirety. The complete clinical guideline summarized in this article, along with extensive descriptive narratives on each topic outlining the evidence and the work group rationale for the answers to each question, can be found on the NASS website at https://www.spine.org/Research-Clinical-Care/Quality-Improvement/Clinical-Guidelines. [1]

References

[1] North American Spine Society (NASS). Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and Treatment of Low Back Pain. https://www.spine.org/Portals/0/assets/downloads/ResearchClinicalCare/Guidelines/LowBackPain.pdf. Published January 29, 2020.

[2] North American Spine Society (NASS). Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and Treatment of Low Back Pain Technical Report. https://www.spine.org/Portals/0/assets/downloads/ResearchClinicalCare/Guidelines/LowBackPainTechReport.pdf. Published January 29, 2020.

[3] North American Spine Society. Levels of Evidence for Primary Research Question. Available at: https://www.spine.org/Portals/0/Assets/Downloads/ResearchClinicalCare/LevelsofEvidence.pdf.

[4] North American Spine Society. Grades of Recommendation. Available at: https://www.spine.org/Research-Clinical-Care/Research/Grades-of-Recommendation

[5] Adhia DB, Milosavljevic S, Tumilty S, Bussey MD. Innominate movement patterns, rotation trends and range of motion in individuals with low back pain of sacroiliac joint origin. Man Ther. 2016;21:100-108.

[6] Depalma MJ, Ketchum JM, Trussell BS, Saullo TR, Slipman CW. Does the location of low back pain predict its source? Pm R. 2011;3(1):33-39.

[7] Donelson R, Aprill C, Medcalf R, Grant W. A prospective study of centralization of lumbar and referred pain: a predictor of symptomatic discs and anular competence. Spine. 1997;22(10):1115-1122.

[8] Heuch I, Heuch I, Hagen K, Zwart JA. Body mass index as a risk factor for developing chronic low back pain: a follow-up in the Nord-Trondelag Health Study. Spine. 2013;38(2):133-139.

[9] Kääriä S, Kaila-Kangas L, Kirjonen J, Riihimäki H, Luukkonen R, Leino-Arjas P. Low back pain, work absenteeism, chronic back disorders and clinical findings in the low back as predictors of hospitalization due to low back disorders: a 28-year follow-up of industrial employees. Spine. 2005;30(10):1211-1218.

[10] Matsudaira K, Konishi H, Miyoshi K, Isomura T, Inuzuka K. Potential risk factors of persistent low back pain developing from mild low back pain in urban Japanese workers. PLoS ONE. 2014;9(4):e93924.

[11] Bakker EWP, Verhagen AP, Lucas C, Koning HJCMF, Koes BW. Spinal mechanical load: A predictor of persistent low back pain? A prospective cohort study. Eur Spine J. 2007;16(7):933-941.

[12] Alsaadi SM, McAuley JH, Hush JM, et al. Poor sleep quality is strongly associated with subsequent pain intensity in patients with acute low back pain. Arthritis Rheumatol. 2014;66(5):1388-1394.

[13] Coste J, Lefrancois G, Guillemin F, Pouchot J. Prognosis and Quality of life in patients with acute low back pain: insights from a comprehensive inception cohort study. Arthritis Care Res. 2004;51(2):168-176.

[14] Foster NE, Bishop A, Thomas E, et al. Illness perceptions of low back pain patients in primary care: what are they, do they change and are they associated with outcome? Pain. 2008;136(1-2):177-187.

[15] Fritz JM, Wainner RS, Hicks GE. The use of nonorganic signs and symptoms as a screening tool for returnto-work in patients with acute low back pain. Spine. 2000;25(15):1925-1931.

[16] Hancock MJ, Maher CG, Latimer J, Herbert RD, McAuley JH. Can rate of recovery be predicted in patients with acute low back pain? Development of a clinical prediction rule. Eur J Pain. 2009;13(1):51-55.

[17] Shaw WS, Pransky G, Patterson W, Winters T. Early disability risk factors for low back pain assessed at outpatient occupational health clinics. Spine. 2005;30(0):572-580.

[18] Shaw WS, Tveito TH, Woiszwillo MJ, Pransky G. The effect of body mass index on recovery and return to work after onset of work-related low back pain. J Occup Environ Med. 2012;54(2):192-197.

[19] Gatchel RJ, Polatin PB, Kinney RK. Predicting outcome of chronic back pain using clinical predictors of psychopathology: a prospective analysis. Health Psychol. 1995;14(5):415-420.

[20] Gatchel RJ, Polatin PB, Mayer TG. The dominant role of psychosocial risk factors in the development of chronic low back pain disability. Spine. 1995;20(24):2702-2709.

[21] Reme SE, Shaw WS, Steenstra IA, Woiszwillo MJ, Pransky G, Linton SJ. Distressed, immobilized, or lacking employer support? A sub-classification of acute work-related low back pain. J Occup Rehabil. 2012;22(4):541-552.

[22] Rolli Salathe C, Melloh M, Mannion AF, et al. Resources for preventing sickness absence due to low back pain. Occup Med. 2012;62(4):273-280.

[23] Shaw WS, Means-Christensen AJ, Slater MA, et al. Psychiatric disorders and risk of transition to chronicity in men with first onset low back pain. Pain Med. 2010;11(9):1391-1400.

[24] Turner JA, Franklin G, Fulton-Kehoe D, et al. Worker recovery expectations and fear-avoidance predict work disability in a population-based workers' compensation back pain sample. Spine. 2006;31(6):682-689.

[25] Melloh M, Elfering A, Egli Presland C, et al. Predicting the transition from acute to persistent low back pain. Occup Med. 2011;61(2):127-131.

[26] Sewitch MJ, Rossignol M, Bellavance F, et al. First lifetime back pain and psychiatry treatment: psychological factors and recovery in compensated workers. AAOHN J. 2000;48(5):234-242.

[27] Costa Lda C, Maher CG, McAuley JH, et al. Prognosis for patients with chronic low back pain: inception cohort study. BMJ. 2009;339:b3829.

[28] Friedman BW, Mulvey L, Davitt M, et al. Predicting 7-day and 3-month functional outcomes after an ED visit for acute nontraumatic low back pain. Am J Emerg Med. 2012;30(9):1852-1859 1858p.

[29] Neubauer E, Junge A, Pirron P, Seemann H, Schiltenwolf M. HKF-R 10 - screening for predicting chronicity in acute low back pain (LBP): a prospective clinical trial. Eur J Pain. 2006;10(6):559-566.

[30] Jensen OK, Nielsen CV, Stengaard-Pedersen K. Low back pain may be caused by disturbed pain regulation: a cross-sectional study in low back pain patients using tender point examination. Eur J Pain. 2010;14(5):514- 522 519p.

[31] Coste J, Paolaggi JB, Spira A. Classification of nonspecific low back pain. I. Psychological involvement in low back pain: A clinical, descriptive approach. Spine. 1992;17(9):1028-1037.

[32] Lundberg M, Fre\nnered K, Hagg O, Styf J. The impact of fear-avoidance model variables on disability in patients with specific or nonspecific chronic low back pain. Spine. 2011;36(19):1547-1553.

[33] Gupta AD. Sacroiliac joint pathologies in low back pain. Journ Back Musculoskel Rehabil. 2009;22(2):91-97.

[34] Berg L, Hellum C, Gjertsen O, et al. Do more MRI findings imply worse disability or more intense low back pain? A cross-sectional study of candidates for lumbar disc prosthesis. Skelet Radiol. 2013;42(11):1593-1602.

[35] Elgafy H, Semaan HB, Ebraheim NA, Coombs RJ. Computed tomography findings in patients with sacroiliac pain. Clin Orthop. 2001(382):112-118.

[36] Graves JM, Fulton-Kehoe D, Jarvik JG, Franklin GM. Early imaging for acute low back pain: one-year health and disability outcomes among Washington State workers. Spine. 2012;37(18):1617-1627.

[37] Kumar N, Wijerathne SI, Lim WWJ, Barry TWL, Nath C, Liang S. Resistive straight leg raise test, resistive forward bend test and heel compression test: Novel techniques in identifying secondary gain motives in low back pain cases. Eur Spine J. 2012;21(11):2280-2286.

[38] Mainka T, Lemburg SP, Heyer CM, Altenscheidt J, Nicolas V, Maier C. Association between clinical signs assessed by manual segmental examination and findings of the lumbar facet joints on magnetic resonance scans in subjects with and without current low back pain: a prospective, single-blind study. Pain. 2013;154(9):1886-1895.

[39] Nemoto O, Kitada A, Tsuda Y, Yokobe J, Matsukawa K, Ukegawa Y. A longitudinal study of radiological changes in the lumbar spine in asymptomatic Japanese military young adults. Eur Orthop Traumatol. 2012;3(2):135-139.

[40] Nemoto O, Kitada A, Naitou S, Tsuda Y, Matsukawa K, Ukegawa Y. A longitudinal study for incidence of low back pain and radiological changes of lumbar spine in asymptomatic Japanese military young adults. Eur Spine J. 2013;22(2):453-458.

[41] Lakadamyali H, Tarhan NC, Ergun T, Cakir B, Agildere AM. STIR sequence for depiction of degenerative changes in posterior stabilizing elements in patients with lower back pain. AJR Am J Roentgenol. 2008;191(4):973- 979.

[42] Kerry S, Hilton S, Dundas D, Rink E, Oakeshott P. Radiography for low back pain: a randomised controlled trial and observational study in primary care. Br J Gen Pract. 2002;52(479):469-474.

[43] Carragee E, Alamin T, Cheng I, Franklin T, van den Haak E, Hurwitz E. Are first-time episodes of serious LBP associated with new MRI findings? Spine J. 2006;6(6):624-635.

[44] Cho, N.H., Jung, Y.O., Lim, S.H., Chung, C.K., Kim, H.A. The prevalence and risk factors of low back pain in rural community residents of Korea. Spine. 2012;37:2001– 2010.

[45] Liu C, Cai HX, Zhang JF, Ma JJ, Lu YJ, Fan SW. Quantitative estimation of the high-intensity zone in the lumbar spine: comparison between the symptomatic and asymptomatic population. Spine J. 2014;14(3):391-396 396p.

[46] Maatta JH, Wadge S, MacGregor A, Karppinen J, Williams FMK. ISSLS prize winner: Vertebral endplate (Modic) change is an independent risk factor for episodes of severe and disabling low back pain. Spine. 2015;40(15):1187-1193.

[47] Riihimaki H, Wickstrom G, Hanninen K, Mattsson T, Waris P, Zitting A. Radiographically detectable lumbar degenerative changes as risk indicators of back pain. A cross-sectional epidemiologic study of concrete reinforcement workers and house painters. Scand J Work Environ Health. 1989;15:280–285.

[48] Teraguchi M, Yoshimura N, Hashizume H, et al. The association of combination of disc degeneration, end plate signal change, and Schmorl node with low back pain in a large population study: the Wakayama Spine Study. Spine J. 2015;15(4):622-628.

[49] Wiikeri, M., Nummi, J., Riihimaki, H., Wickstrom. Radiologically detectable lumbar disc degeneration in concrete reinforcement workers. Scand J Work Environ Health. 1978;4:47–53.

[50] Pneumaticos SG, Chatziioannou SN, Hipp JA, Moore WH, Esses SI. Low back pain: prediction of short-term outcome of facet joint injection with bone scintigraphy. Radiology. 2006 Feb;238(2):693-8.

[51] Muehlbacher M, Nickel MK, Kettler C, et al. Topiramate in treatment of patients with chronic low back pain: a randomized, double-blind, placebo-controlled study. Clin J Pain. 2006;22(6):526-531.

[52] Atkinson JH, Slater MA, Wahlgren DR, et al. Effects of noradrenergic and serotonergic antidepressants on chronic low back pain intensity. Pain. 1999;83(2):137-145.

[53] Dickens C, Jayson M, Sutton C, Creed F. The relationship between pain and depression in a trial using paroxetine in sufferers of chronic low back pain. Psychosomatics. 2000;41(6):490-499.

[54] Goodkin K, Gullion CM, Agras WS. A randomized, double-blind, placebo-controlled trial of trazodone hydrochloride in chronic low back pain syndrome. J Clin Psychopharmacol. 1990;10(4):269-278.

[55] Skljarevski V, Ossanna M, Liu-Seifert H, et al. A double-blind, randomized trial of duloxetine versus placebo in the management of chronic low back pain. Eur J Neurol. 2009;16(9):1041-1048.

[56] Sandoughi M, Zakeri Z, Mirhosainee Z, Mohammadi M, Shahbakhsh S. The effect of vitamin D on nonspecific low back pain. Int J Rheum Dis. 2015;18(8):854-858.

[57] Birbara CA, Puopolo AD, Munoz DR, et al. Treatment of chronic low back pain with etoricoxib, a new cyclo-oxygenase-2 selective inhibitor: improvement in pain and disability--a randomized, placebo-controlled, 3-month trial. J Pain. 2003;4(6):307-315.

[58] Pallay RM, Seger W, Adler JL, et al. Etoricoxib reduced pain and disability and improved quality of life in patients with chronic low back pain: a 3 month, randomized, controlled trial. Scand J Rheumatol. 2004;33(4):257- 266.

[59] Dreiser RL, Marty M, Ionescu E, Gold M, Liu JH. Relief of acute low back pain with diclofenac-K 12.5 mg tablets: a flexible dose, ibuprofen 200 mg and placebo-controlled clinical trial. Int J Clin Pharmacol Ther. 2003;41(9):375- 385.

[60] Eskin B, Shih RD, Fiesseler FW, et al. Prednisone for emergency department low back pain: A randomized controlled trial. J Emerg Med. 2014;47(1):65-70.

[61] Friedman BW, Holden L, Esses D, et al. Parenteral corticosteroids for Emergency Department patients with non-radicular low back pain. J Emerg Med. 2006;31(4):365-370.

[62] Buynak R, Shapiro DY, Okamoto A, et al. Efficacy and safety of tapentadol extended release for the management of chronic low back pain: results of a prospective, randomized, double-blind, placebo- and active-controlled Phase III study.[Erratum appears in Expert Opin Pharmacother. 2010 Nov;11(16):2773]. Expert Opin Pharmacother. 2010;11(11):1787-1804.

[63] Cloutier C, Taliano J, O'Mahony W, et al. Controlled-release oxycodone and naloxone in the treatment of chronic low back pain: A placebo-controlled, randomized study. Pain Res Manag. 2013;18(2):75-82.

[64] Hale M, Khan A, Kutch M, Li S. Once-daily OROS hydromorphone ER compared with placebo in opioid-tolerant patients with chronic low back pain.[Erratum appears in Curr Med Res Opin. 2010 Aug;26(8):1904]. Curr Med Res Opin. 2010;26(6):1505-1518.

[65] Lasko B, Levitt RJ, Rainsford KD, Bouchard S, Rozova A, Robertson S. Extended-release tramadol/paracetamol in moderate-to-severe pain: a randomized, placebo-controlled study in patients with acute low back pain. Curr Med Res Opin. 2012;28(5):847-857.

[66] Lee JH, Lee CS, Ultracet ERSG. A randomized, double-blind, placebo-controlled, parallel-group study to evaluate the efficacy and safety of the extended-release tramadol hydrochloride/acetaminophen fixed-dose combination tablet for the treatment of chronic low back pain. Clin Ther. 2013;35(11):1830-1840.

[67] Peloso PM, Fortin L, Beaulieu A, Kamin M, Rosenthal N, Protocol TRPCANSG. Analgesic efficacy and safety of tramadol/ acetaminophen combination tablets (Ultracet) in treatment of chronic low back pain: a multicenter, outpatient, randomized, double blind, placebo controlled trial. J Rheumatol. 2004;31(12):2454-2463.

[68] Ruoff GE, Rosenthal N, Jordan D, Karim R, Kamin M, Protocol C-SG. Tramadol/acetaminophen combination tablets for the treatment of chronic lower back pain: a multicenter, randomized, double-blind, placebo-controlled outpatient study. Clin Ther. 2003;25(4):1123- 1141.

[69] Schiphorst Preuper HR, Geertzen JHB, Van Wijhe M, et al. Do analgesics improve functioning in patients with chronic low back pain? An explorative triple-blinded RCT. Eur Spine J. 2014;23(4):800-806.

[70] Schnitzer TJ, Gray WL, Paster RZ, Kamin M. Efficacy of tramadol in treatment of chronic low back pain. J Rheumatol. 2000;27(3):772-778.

[71] Gimbel J, Linn R, Hale M, Nicholson B. Lidocaine patch treatment in patients with low back pain: results of an open-label, nonrandomized pilot study. Am J Ther. 2005;12(4):311-319.

[72] Frerick H, Keitel W, Kuhn U, Schmidt S, Bredehorst A, Kuhlmann M. Topical treatment of chronic low back pain with a capsicum plaster. Pain. 2003;106(1-2):59- 64.

[73] Keitel W, Frerick H, Kuhn U, Schmidt U, Kuhlmann M, Bredehorst A. Capsicum pain plaster in chronic non-specific low back pain. Arzneimittelforschung. 2001;51(11):896-903.

[74] Bendix AF, Bendix T, Ostenfeld S, Bush E, Andersen n. Active treatment programs for patients with chronic low back pain: a prospective, randomized, observer-blinded study. Eur Spine J. 1995;4(3):148-152.

[75] Dufour N, Thamsborg G, Oefeldt A, Lundsgaard C, Stender S. Treatment of chronic low back pain: A randomized, clinical trial comparing group-based multidisciplinary biopsychosocial rehabilitation and intensive individual therapist-assisted back muscle strengthening exercises. Spine. 2010;35(5):469-476.

[76] Lamb SE, Lall R, Hansen Z, et al. A multicentred randomised controlled trial of a primary care-based cognitive behavioural programme for low back pain. The Back Skills Training (BeST) trial. Health Technol Assess. 2010;14(41):1-253, iii-iv.

[77] Linden M, Scherbe S, Cicholas B. Randomized controlled trial on the effectiveness of cognitive behavior group therapy in chronic back pain patients. J Back Musculoskeletal Rehabil. 2014;27(4):563-568.

[78] Sullivan MJ, Adams H. Psychosocial treatment techniques to augment the impact of physiotherapy interventions for low back pain. Physiother Can. 2010;62(3):180-189.

[79] Turner JA, Jensen MP. Efficacy of cognitive therapy for chronic low back pain. Pain. 1993;52(2):169-177.

[80] Hampel P, Tlach L. Cognitive-behavioral management training of depressive symptoms among inpatient orthopedic patients with chronic low back pain and depressive symptoms: A 2-year longitudinal study. J Back Musculoskeletal Rehabil. 2015;28(1):49-60.

[81] Monticone M, Ambrosini E, Rocca B, Magni S, Brivio F, Ferrante S. A multidisciplinary rehabilitation programme improves disability, kinesiophobia and walking ability in subjects with chronic low back pain: results of a randomised controlled pilot study. Eur Spine J. 2014;23(10):2105-2113.

[82] Pincus T, Anwar S, McCracken LM, et al. Delivering an Optimised Behavioural Intervention (OBI) to people with low back pain with high psychological risk; results and lessons learnt from a feasibility randomised controlled trial of Contextual Cognitive Behavioural Therapy (CCBT) vs. Physiotherapy. BMC Musculoskelet Disord. 2015;16 (1) (no pagination)(147).

[83] Schiltenwolf M, Buchner M, Heindl B, Von Reumont J, Muller A, Eich W. Comparison of a biopsychosocial therapy (BT) with a conventional biomedical therapy (MT) of subacute low back pain in the first episode of sick leave: A randomized controlled trial. Eur Spine J. 2006;15(7):1083-1092.

[84] Smeets RJ, Vlaeyen JW, Hidding A, et al. Active rehabilitation for chronic low back pain: cognitive-behavioral, physical, or both? First direct post-treatment results from a randomized controlled trial [ISRCTN22714229]. BMC Musculoskelet Disord. 2006;7:5.

[85] Rolving N, Sogaard R, Nielsen CV, Christensen FB, Bunger C, Oestergaard LG. Preoperative cognitive-behavioral patient education versus standard care for lumbar spinal fusion patients: Economic evaluation alongside a randomized controlled trial. Spine. 2016;41(1):18-25.

[86] Cherkin DC, Deyo RA, Battié 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. N Engl J Med. 1998;339(15):1021-1029

[87] Basler HD, Bertalanffy H, Quint S, Wilke A, Wolf U. TTMbased counselling in physiotherapy does not contribute to an increase of adherence to activity recommendations in older adults with chronic low back pain - A randomised controlled trial. Eur J Pain. 2007;11(1):31-37.

[88] Berwick DM, Budman S, Feldstein M. No clinical effect of back schools in an HMO. A randomized prospective trial. Spine. 1989;14(3):338-344.

[89] Cecchi F, Molino-Lova R, Chiti M, et al. Spinal manipulation compared with back school and with individually delivered physiotherapy for the treatment of chronic low back pain: a randomized trial with one-year follow-up. Clin Rehabil. 2010;24(1):26-36 11p.

[90] Frost H, Lamb SE, Doll HA, Carver PT, Stewart-Brown S. Randomised controlled trial of physiotherapy compared with advice for low back pain. Bmj. 2004;329(7468):708.

[91] Hsieh CY, Adams AH, Tobis J, et al. Effectiveness of four conservative treatments for subacute low back pain: a randomized clinical trial. Spine. 2002;27(11):1142-1148.

[92] Johnson RE, Jones GT, Wiles NJ, et al. Active exercise, education, and cognitive behavioral therapy for persistent disabling low back pain: a randomized controlled trial. Spine. 2007;32(15):1578-1585.

[93] Karjalainen K, Malmivaara A, Mutanen P, Roine R, Hurri H, Pohjolainen T. Mini-intervention for subacute low back pain: two-year follow-up and modifiers of effectiveness. Spine. 2004;29(10):1069-1076.

[94] Leclaire R, Esdaile JM, Suissa S, Rossignol M, Proulx R, Dupuis M. Back school in a first episode of compensated acute low back pain: a clinical trial to assess efficacy and prevent relapse. Arch Phys Med Rehabil. 1996;77(7):673- 679.

[95] Magalhaes MO, Muzi LH, Comachio J, et al. The shortterm effects of graded activity versus physiotherapy in patients with chronic low back pain: A randomized controlled trial. Manual Therapy. 2015;20(4):603-609.

[96] Ribeiro LH, Jennings MF, Jones A, Furtado R, Natour J. Effectiveness of a back school program in low back pain. Clin Exp Rheumatol. 2008;26(1):81-88.

[97] Sparkes V, Chidwick N, Coales P. Effect of The Back Book on fear-avoidance beliefs, disability, and pain levels in subjects with low back pain. Int J Ther Rehabil. 2012;19(2):79-86 78p.

[98] Göhner W, Schlicht W. Preventing chronic back pain: evaluation of a theory-based cognitive-behavioural training programme for patients with subacute back pain. Patient Educ Couns. 2006;64(1-3):87-95.

[99] Cherkin DC, Deyo RA, Street JH, Hunt M, Barlow W. Pitfalls of patient education. Limited success of a program for back pain in primary care. Spine. 1996;21(3):345- 355.

[100] Du Bois M, Donceel P. Guiding low back claimants to work: a randomized controlled trial. Spine. 2012;37(17):142

[101] Durmus D, Unal M, Kuru O. How effective is a modified exercise program on its own or with back school in chronic low back pain? A randomized-controlled clinical trial. J Back Musculoskelet Rehabil. 2014;27(4):553- 561. 5-1431.

[102] Van Den Hout J, Vlaeyen J, Heuts P, Zijlema J, Wijen JA. Secondary prevention of work-related disability in nonspecific low back pain: does problem-solving therapy help? A randomized clinical trial. Clin J Pain. 2003;19(2):87-96.

[103] Albaladejo C, Kovacs FM, Royuela A, Pino R, Zamora J. The efficacy of a short education program and a short physiotherapy program for treating low back pain in primary care: a cluster randomized trial. Spine. 2010;35(5):483-496.

[104] Friedrich M, Gittler G, Arendasy M, Friedrich KM. Long-term effect of a combined exercise and motivational program on the level of disability of patients with chronic low back pain. Spine. 2005;30(9):995-1000 1006p.

[105] Heymans MW, de Vet HCW, Bongers PM, Knol DL, Koes BW, van Mechelen W. The effectiveness of high-intensity versus low-intensity back schools in an occupational setting: a pragmatic randomized controlled trial. Spine. 2006;31(10):1075-1082 1078p.

[106] Indahl A, Haldorsen EH, Holm S, Reikerås O, Ursin H. Five-year follow-up study of a controlled clinical trial using light mobilization and an informative approach to low back pain. Spine. 1998;23(23):2625-2630.

[107] Pengel LHM, Refshauge KM, Maher CG, Nicholas MK, Herbert RD, McNair P. Physiotherapist-directed exercise, advice, or both for subacute low back pain: a randomized trial. Ann Intern Med. 2007;146(11):787-756 710p.

[108] Tavafian SS, Jamshidi A, Mohammad K, Montazeri A. Low back pain education and short term quality of life: a randomized trial. BMC Musculoskelet Disord. 2007;8:21.

[109] Zhang Y, Wan L, Wang X. The effect of health education in patients with chronic low back pain. J Int Med Res. 2014;42(3):815-820.

[110] Basler HD, Jäkle C, Kröner-Herwig B. Incorporation of cognitive-behavioral treatment into the medical care of chronic low back patients: a controlled randomized study in German pain treatment centers. Patient Educ Couns. 1997;31(2):113-124.

[111] Castagnoli C, Cecchi F, Del Canto A, et al. Effects in Short and Long Term of Global Postural Reeducation (GPR) on Chronic Low Back Pain: A Controlled Study with One-Year Follow-Up. Scientific World Journal. 2015;2015:271436.

[112] Gremeaux V, Benaïm C, Poiraudeau S, Hérisson C, Dupeyron A, Coudeyre E. Evaluation of the benefits of low back pain patients' education workshops during spa therapy. Joint Bone Spine. 2013;80(1):82-87.

[113] Iles R, Taylor NF, Davidson M, O'Halloran P. Telephone coaching can increase activity levels for people with non-chronic low back pain: a randomised trial. J Physiother. 2011;57(4):231-238.

[114] Jaromi M, Nemeth A, Kranicz J, Laczko T, Betlehem J. Treatment and ergonomics training of work-related lower back pain and body posture problems for nurses. J Clin Nurs. 2012;21(11/12):1776-1784 1779p.

[115] Paolucci T, Morone G, Iosa M, et al. Psychological features and outcomes of the Back School treatment in patients with chronic non-specific low back pain. A randomized controlled study. Eur J Phys Rehabil Med. 2012;48(2):245-253.

[116] Burton AK, Waddell G, Tillotson KM, Summerton N. Information and advice to patients with back pain can have a positive effect. A randomized controlled trial of a novel educational booklet in primary care. Spine. 1999;24(23):2484-2491.

[117] George SZ, Fritz JM, Bialosky JE, Donald DA. The effect of a fear-avoidance-based physical therapy intervention for patients with acute low back pain: results of a randomized clinical trial. Spine. 2003;28(23):2551- 2560.

[118] George SZ, Zeppieri Jr G, Cere AL, et al. A randomized trial of behavioral physical therapy interventions for acute and sub-acute low back pain (NCT00373867). Pain. 2008;140(1):145-157.

[119] Monticone M, Ferrante S, Rocca B, Baiardi P, Farra FD, Foti C. Effect of a long-lasting multidisciplinary program on disability and fear-avoidance behaviors in patients with chronic low back pain: results of a randomized controlled trial. Clin J Pain. 2013;29(11):929-938.

[120] Woods MP, Asmundson GJG. Evaluating the efficacy of graded in vivo exposure for the treatment of fear in patients with chronic back pain: A randomized controlled clinical trial. Pain. 2008;136(3):271-280.

[121] Foster NE, Thomas E, Bishop A, Dunn KM, Main CJ. Distinctiveness of psychological obstacles to recovery in low back pain patients in primary care. Pain. 2010;148(3):398-406.

[122] Helmhout PH, Staal JB, Heymans MW, Harts CC, Hendriks EJ, Bie RA. Prognostic factors for perceived recovery or functional improvement in non-specific low back pain: secondary analyses of three randomized clinical trials. Eur Spine J. 2010;19(4):650-659.

[123] Keeley P, Creed F, Tomenson B, Todd C, Borglin G, Dickens C. Psychosocial predictors of health-related quality of life and health service utilisation in people with chronic low back pain. Pain. 2008;135(1-2):142-150.

[124] Hurri H. The Swedish back school in chronic low back pain. Part I. Benefits. Scand J Rehabil Med. 1989;21(1):33- 40.

[125] Morone G, Paolucci T, Alcuri MR, et al. Quality of life improved by multidisciplinary back school program in patients with chronic non-specific low back pain: a single blind randomized controlled trial. Eur J Phys Rehabil Med. 2011;47(4):533-541.

[126] Kuukkanen T, Mälkiä E, Kautiainen H, Pohjolainen T. Effectiveness of a home exercise programme in low back pain: a randomized five-year follow-up study. Physiother Res Int. 2007;12(4):213-224.

[127] Shirado O, Doi T, Akai M, et al. Multicenter randomized controlled trial to evaluate the effect of homebased exercise on patients with chronic low back pain: the Japan low back pain exercise therapy study. Spine. 2010;35(17):E811-819.

[128] Underwood MR, Morgan J. The use of a back class teaching extension exercises in the treatment of acute low back pain in primary care. Fam Pract. 1998;15(1):9-15.

[129] Krein SL, Kadri R, Hughes M, et al. Pedometer-based internet-mediated intervention for adults with chronic low back pain: randomized controlled trial. J Med Internet Res. 2013;15(8):e181-e181 181p.

[130] Dehghan M, Farahbod F. The efficacy of thermotherapy and cryotherapy on pain relief in patients with acute low back pain, a clinical trial study. J Clin Diag Res. 2014;8(9):LC01-LC04.

[131] Kettenmann B, Wille C, Lurie-Luke E, Walter D, Kobal G. Impact of continuous low level heatwrap therapy in acute low back pain patients: subjective and objective measurements. Clin J Pain. 2007;23(8):663-668.

[132] Mayer JM, Ralph L, Look M, et al. Treating acute low back pain with continuous low-level heat wrap therapy and/or exercise: a randomized controlled trial. Spine J. 2005;5(4):395-403.

[133] Nadler SF, Steiner DJ, Erasala GN, Hengehold DA, Abeln SB, Weingand KW. Continuous low-level heatwrap therapy for treating acute nonspecific low back pain. Arch Phys Med Rehabil. 2003;84(3):329-334 326p.

[134] Nadler SF, Steiner DJ, Petty SR, Erasala GN, Hengehold DA, Weingand KW. Overnight use of continuous low-level heatwrap therapy for relief of low back pain. Arch Phys Med Rehabil. 2003;84(3):335-342 338p

[135] Shakoor MA, Rahman MS, Moyeenuzzaman M. Effects of deep heat therapy on the patients with chronic low back pain. Mymensingh Med J. 2008;17(2 Suppl):S32-38.

[136] Tao X, Bernacki EJ. A randomized clinical trial of continuous low-level heat therapy for acute muscular low back pain in the workplace. J Occup Environ Med. 2005;47(12):1298-1306 1299p.

[137] Durmus D, Alayli G, Goktepe AS, Taskaynatan MA, Bilgici A, Kuru O. Is phonophoresis effective in the treatment of chronic low back pain? A single-blind randomized controlled trial. Rheumatol Int. 2013;33(7):1737-1744.

[138] Ebadi S, Ansari NN, Henschke N, Naghdi S, Tulder MW. The effect of continuous ultrasound on chronic low back pain: protocol of a randomized controlled trial. BMC Musculoskelet Disord. 2011;12:59.

[139] Herman E, Williams R, Stratford P, Fargas-Babjak A, Trott M. A randomized controlled trial of transcutaneous electrical nerve stimulation (CODETRON) to determine its benefits in a rehabilitation program for acute occupational low back pain. Spine. 1994;19(5):561-568.

[140] Weiner DK, Rudy TE, Glick RM, et al. Efficacy of percutaneous electrical nerve stimulation for the treatment of chronic low back pain in older adults. J Am Geriatr Soc. 2003;51(5):599-608.

[141] Weiner DK, Perera S, Rudy TE, Glick RM, Shenoy S, Delitto A. Efficacy of percutaneous electrical nerve stimulation and therapeutic exercise for older adults with chronic low back pain: a randomized controlled trial. Pain. 2008;140(2):344-357.

[142] Deyo RA, Walsh NE, Martin DC, Schoenfeld LS, Ramamurthy S. A controlled trial of transcutaneous electrical nerve stimulation (TENS) and exercise for chronic low back pain. N Engl J Med. 1990;322(23):1627-1634.

[143] Jarzem PF, Harvey EJ, Arcaro N, Kaczorowski J. Transcutaneous electrical nerve stimulation [TENS] for short-term treatment of low back pain - Randomized double blind crossover study of sham versus conventional TENS. J Musculoskel Pain. 2005;13(2):11-17.

[144] Marchand S, Charest J, Li J, Chenard JR, Lavignolle B, Laurencelle L. Is TENS purely a placebo effect? A controlled study on chronic low back pain. Pain. 1993;54(1):99-106.

[145] Thompson JW, Bower S, Tyrer SP. A double blind randomised controlled clinical trial on the effect of transcutaneous spinal electroanalgesia (TSE) on low back pain. Eur J Pain. 2008;12(3):371-377.

[146] Glazov G, Schattner P, Lopez D, Shandley K. Laser acupuncture for chronic non-specific low back pain: a controlled clinical trial. Acupunct Med. 2009;27(3):94-100.

[147] Glazov G, Yelland M, Emery J. Low-dose laser acupuncture for non-specific chronic low back pain: a double-blind randomised controlled trial. Acupunct Med. 2014;32(2):116-123.

[148] Alayat MS, Atya AM, Ali MM, Shosha TM. Long-term effect of high-intensity laser therapy in the treatment of patients with chronic low back pain: a randomized blinded placebo-controlled trial. Lasers Med Sci. 2014;29(3):1065-1073.

[149] Djavid GE, Mehrdad R, Ghasemi M, Hasan-Zadeh H, Sotoodeh-Manesh A, Pouryaghoub G. In chronic low back pain, low level laser therapy combined with exercise is more beneficial than exercise alone in the long term: A randomised trial. Aust J Physiother. 2007;53(3):155-160.

[150] Borman P, Keskin D, Bodur H. The efficacy of lumbar traction in the management of patients with low back pain. Rheumatol Int. 2003;23(2):82-86.

[151] Diab AA, Moustafa IM. The efficacy of lumbar extension traction for sagittal alignment in mechanical low back pain: a randomized trial. J Back Musculoskeletal Rehabil. 2013;26(2):213-220.

[152] Schimmel JJ, de Kleuver M, Horsting PP, Spruit M, Jacobs WC, van Limbeek J. No effect of traction in patients with low back pain: a single centre, single blind, randomized controlled trial of Intervertebral Differential Dynamics Therapy. Eur Spine J. 2009;18(12):1843-1850.

[153] Gunn CC, Milbrandt WE, Little AS, Mason KE. Dry needling of muscle motor points for chronic low-back pain: a randomized clinical trial with long-term follow-up. Spine. 1980;5(3):279-291.

[154] Carlsson CP, Sjolund BH. Acupuncture for chronic low back pain: a randomized placebo-controlled study with long-term follow-up. Clin J Pain. 2001;17(4):296-305.

[155] Kerr DP, Walsh DM, Baxter D. Acupuncture in the management of chronic low back pain: a blinded randomized controlled trial. Clin J Pain. 2003;19(6):364-370.

[156] Vas J, Aranda JM, Modesto M, et al. Acupuncture in patients with acute low back pain: a multicentre randomised controlled clinical trial. Pain. 2012;153(9):1883- 1889.

[157] Cho YJ, Song YK, Cha YY, et al. Acupuncture for chronic low back pain: a multicenter, randomized, patient-assessor blind, sham-controlled clinical trial. Spine. 2013;38(7):549-557 549p.

[158] Cherkin DC, Sherman KJ, Avins AL, et al. A randomized trial comparing acupuncture, simulated acupuncture, and usual care for chronic low back pain. Arch Intern Med. 2009;169(9):858-866 859p.

[159] Haake M, Muller HH, Schade-Brittinger C, et al. German Acupuncture Trials (GERAC) for chronic low back pain: randomized, multicenter, blinded, parallel-group trial with 3 groups.[Erratum appears in Arch Intern Med. 2007 Oct 22;167(19):2072]. Arch Intern Med. 2007;167(17):1892-1898.

[160] Witt CM, Jena S, Selim D, et al. Pragmatic randomized trial evaluating the clinical and economic effectiveness of acupuncture for chronic low back pain. Am J Epidemiol. 2006;164(5):487-496.

[161] Yeung CK, Leung MC, Chow DH. The use of electro-acupuncture in conjunction with exercise for the treatment of chronic low-back pain. J Altern Complement Med. 2003;9(4):479-490.

[162] Yun M, Shao Y, Zhang Y, et al. Hegu Acupuncture for Chronic Low-Back Pain: A Randomized Controlled Trial. J Altern Complement Med. 2012;18(2):130-136.

[163] Ceccherelli F, Rigoni MT, Gagliardi G, Ruzzante L. Comparison of superficial and deep acupuncture in the treatment of lumbar myofascial pain: A double-blind randomized controlled study. Clin J Pain. 2002;18(3):149-153.

[164] Pach D, Yang-Strobel X, Ludtke R, et al. Standardized versus individualized acupuncture for chronic low back pain: A randomized controlled trial. Evid Based Complement Altern Med. 2013;2013 (no pagination)(125937).

[165] Shin BC, Kong JC, Park TY, Yang CY, Kang KW, Choi SM. Bee venom acupuncture for chronic low back pain: A randomised, sham-controlled, triple-blind clinical trial. Eur J Integ Med. 2012;4(3):e271-e280.

[166] Calmels P, Queneau P, Hamonet C, et al. Effectiveness of a lumbar belt in subacute low back pain: an open, multicentric, and randomized clinical study. Spine. 2009;34(3):215-220.

[167] Oleske DM, Lavender SA, Andersson GB, Kwasny MM. Are back supports plus education more effective than education alone in promoting recovery from low back pain?: Results from a randomized clinical trial. Spine. 2007;32(19):2050-2057.

[168] Doran DM, Newell DJ. Manipulation in treatment of low back pain: a multicentre study. Br Med J. 1975;2(5964):161-164.

[169] Dougherty PE, Karuza J, Dunn AS, Savino D, Katz P. Spinal Manipulative Therapy for Chronic Lower Back Pain in Older Veterans: A Prospective, Randomized, Placebo-Controlled Trial. Geriatr Orthop Surg Rehabil. 2014;5(4):154-164.

[170] Haas M, Vavrek D, Peterson D, Polissar N, Neradilek MB. Dose-response and efficacy of spinal manipulation for care of chronic low back pain: a randomized controlled trial. Spine J. 2014;14(7):1106-1116.

[171] Hancock MJ, Maher CG, Latimer J, et al. Assessment of diclofenac or spinal manipulative therapy, or both, in addition to recommended first-line treatment for acute low back pain: a randomised controlled trial. Lancet. 2007;370(9599):1638-1643.

[172] Hoiriis KT, Pfleger B, McDuffie FC, et al. A randomized clinical trial comparing chiropractic adjustments to muscle relaxants for subacute low back pain. J Manip Physiol Therap. 2004;27(6):388-398.

[173] Juni P, Battaglia M, Nuesch E, et al. A randomised controlled trial of spinal manipulative therapy in acute low back pain. Ann Rheum Dis. 2009;68(9):1420-1427.

[174] Schneider M, Haas M, Glick R, Stevans J, Landsittel D. Comparison of spinal manipulation methods and usual medical care for acute and subacute low back pain: a randomized clinical trial. Spine. 2015;40(4):209-217.

[175] Senna MK, Machaly SA. Does maintained spinal manipulation therapy for chronic nonspecific low back pain result in better long-term outcome? Spine. 2011;36(18):1427-1437.

[176] von Heymann WJ, Schloemer P, Timm J, Muehlbauer B. Spinal high-velocity low amplitude manipulation in acute nonspecific low back pain: a double-blinded randomized controlled trial in comparison with diclofenac and placebo. Spine. 2013;38(7):540-548.

[177] Grunnesjo MI, Bogefeldt JP, Blomberg SI, Strender LE, Svardsudd KF. A randomized controlled trial of the effects of muscle stretching, manual therapy and steroid injections in addition to 'stay active' care on health-related quality of life in acute or subacute low back pain. Clin Rehabil. 2011;25(11):999-1010.

[178] Licciardone JC, Stoll ST, Fulda KG, et al. Osteopathic manipulative treatment for chronic low back pain: A randomized controlled trial. Spine. 2003;28(13):1355- 1362.

[179] Cambron JA, Gudavalli MR, Hedeker D, et al. Oneyear follow-up of a randomized clinical trial comparing flexion distraction with an exercise program for chronic low-back pain. J Altern Complement Med. 2006;12(7):659-668.

[180] Enix DE, Sudkamp K, Malmstrom TK, Flaherty JH. A randomized controlled trial of chiropractic compared to physical therapy for chronic low back pain in community swelling geriatric patients. Top Integr Health Care. 2015;6(1):1-17.

[181] Hemmila HM, Keinanen-Kiukaanniemi SM, Levoska S, Puska P. Long-term effectiveness of bone-setting, light exercise therapy, and physiotherapy for prolonged back pain: a randomized controlled trial. J Manipulative Physiol Ther. 2002;25(2):99-104.

[182] Hurwitz EL, Morgenstern H, Kominski GF, Yu F, Chiang LM. A randomized trial of chiropractic and medical care for patients with low back pain: Eighteen-month follow-up outcomes from the UCLA low back pain study. Spine. 2006;31(6):611-621.

[183] Hsieh LLC, Kuo CH, Yen MF, Chen THH. A randomized controlled clinical trial for low back pain treated by acupressure and physical therapy. Prevent Med. 2004;39(1):168-176.

[184] Hsieh LLC, Kuo CH, Lee LH, Yen AMF, Chien KL, Chen THH. Treatment of low back pain by acupressure and physical therapy: Randomised controlled trial. Br Med J. 2006;332(7543):696-698.

[185] Kankaanpaa M, Taimela S, Airaksinen O, Hanninen O. The efficacy of active rehabilitation in chronic low back pain. Effect on pain intensity, self-experienced disability and lumbar fatigability. Spine. 1999;24(10):1034- 1042.

[186] Little P, Lewith G, Webley F, et al. Randomised controlled trial of Alexander technique lessons, exercise, and massage (ATEAM) for chronic and recurrent back pain. Br Med J. 2008;337:a884.

[187] Zhang Y, Tang S, Chen G, Liu Y. Chinese massage combined with core stability exercises for nonspecific low back pain: a randomized controlled trial. Complement Ther Med. 2015;23(1):1-6.

[188] Moussouli M, Vlachopoulos SP, Kofotolis ND, Theodorakis Y, Malliou P, Kellis E. Effects of stabilization exercises on health-related quality of life in women with chronic low back pain. J Phys Act Health. 2014;11(7):1295- 1303.

[189] Lomond KV, Henry SM, Hitt JR, DeSarno MJ, Bunn JY. Altered postural responses persist following physical therapy of general versus specific trunk exercises in people with low back pain. Manual Ther. 2014;19(5):425- 432.

[190] Ganesh GS, Chhabra D, Pattnaik M, Mohanty P, Patel R, Mrityunjay K. Effect of trunk muscles training using a star excursion balance test grid on strength, endurance and

disability in persons with chronic low back pain. J Back Musculoskel Rehabil. 2015;28(3):521-530.

[191] Petersen T, Kryger P, Ekdahl C, Olsen S, Jacobsen S. The effect of McKenzie therapy as compared with that of intensive strengthening training for the treatment of patients with subacute or chronic low back pain: A randomized controlled trial. Spine. 2002;27(16):1702-1708.

[192] Petersen T, Larsen K, Jacobsen S. One-year follow-up comparison of the effectiveness of McKenzie treatment and strengthening training for patients with chronic low back pain: outcome and prognostic factors. Spine. 2007;32(26):2948-2956.

[193] Garcia AN, Costa Lda C, da Silva TM, et al. Effectiveness of back school versus McKenzie exercises in patients with chronic nonspecific low back pain: a randomized controlled trial. Phys Ther. 2013;93(6):729-747.

[194] Aboagye E, Karlsson ML, Hagberg J, Jensen I. Cost-effectiveness of early interventions for non-specific low back pain: a randomized controlled study investigating medical yoga, exercise therapy and self-care advice. J Rehabil Med. 2015;47(2):167-173.

[195] Tilbrook HE, Cox H, Hewitt CE, et al. Yoga for chronic low back pain: a randomized trial. Ann Intern Med. 2011;155(9):569-578.

[196] Williams KA, Petronis J, Smith D, et al. Effect of Iyengar yoga therapy for chronic low back pain. Pain. 2005;115(1- 2):107-117.

[197] Williams K, Abildso C, Steinberg L, et al. Evaluation of the effectiveness and efficacy of Iyengar yoga therapy on chronic low back pain. Spine. 2009;34(19):2066-2076.

[198] Murtezani A, Hundozi H, Orovcanec N, Sllamniku S, Osmani T. A comparison of high intensity aerobic exercise and passive modalities for the treatment of workers with chronic low back pain: a randomized, controlled trial. Eur J Phys Rehabil Med. 2011;47(3):359-366.

[199] Cuesta-Vargas AI, Adams N, Salazar JA, Belles A, Hazanas S, Arroyo-Morales M. Deep water running and general practice in primary care for non-specific low back pain versus general practice alone: randomized controlled trial. Clin Rheumatol. 2012;31(7):1073-1078.

[200] Chatzitheodorou D, Kabitsis C, Malliou P, Mougios V. A pilot study of the effects of high-intensity aerobic exercise versus passive interventions on pain, disability, psychological strain, and serum cortisol concentrations in people with chronic low back pain. Phys Ther. 2007;87(3):304-312.

[201] Tritilanunt T, Wajanavisit W. The efficacy of an aerobic exercise and health education program for treatment of chronic low back pain. Chotmaihet Thangphaet. 2001;84 Suppl 2:S528-533.

[202] Bendix T, Bendix A, Labriola M, Haestrup C, Ebbehoj N. Functional restoration versus outpatient physical training in chronic low back pain: a randomized comparative study. Spine. 2000;25(19):2494-2500.

[203] Sang LS, Eria LPY. Outcome evaluation of work hardening program for manual workers with work-related back injury. Work. 2005;25(4):297-305.

[204] Casso G, Cachin C, Van Melle G, Gerster JC. Return-towork status 1 year after muscle reconditioning in chronic low back pain patients. Joint Bone Spine. 2004;71(2):136- 139.

[205] Beaudreuil J, Kone H, Lasbleiz S, et al. Efficacy of a functional restoration program for chronic low back pain: Prospective 1-year study. Joint Bone Spine. 2010;77(5):435-439.

[206] Luk KD, Wan TW, Wong YW, et al. A multidisciplinary rehabilitation programme for patients with chronic low back pain: a prospective study. J Orthop Surg. 2010;18(2):131-138.

[207] Roche G, Ponthieux A, Parot-Shinkel E, et al. Comparison of a functional restoration program with active individual physical therapy for patients with chronic low back pain: a randomized controlled trial. Arch Phys Med Rehabil. 2007;88(10):1229-1235.

[208] Sivan M, Sell B, Sell P. The outcome of a functional restoration programme for chronic low back pain. Ir J Med Sci. 2009;178(4):461-467.

[209] van der Roer N, van Tulder M, Barendse J, Knol D, van Mechelen W, de Vet H. Intensive group training protocol versus guideline physiotherapy for patients with chronic low back pain: a randomised controlled trial. Eur Spine J. 2008;17(9):1193-1200.

[210] Flynn T, Fritz J, Whitman J, et al. A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with spinal manipulation. Spine. 2002;27(24):2835-2843.

[211] Childs JD, Fritz JM, Flynn TW, et al. A clinical prediction rule to identify patients with low back pain most likely to benefit from spinal manipulation: a validation study.[Summary for patients in Ann Intern Med. 2004 Dec 21;141(12):I39; PMID: 15611484]. Ann Intern Med. 2004;141(12):920-928.

[212] Dougherty PE, Karuza J, Savino D, Katz P. Evaluation of a modified clinical prediction rule for use with spinal manipulative therapy in patients with chronic low back pain: A randomized clinical trial. Chiro Man Therap. 2014;22 (1) (no pagination).

[213] Hancock MJ, Maher CG, Latimer J, Herbert RD, McAuley JH. Independent evaluation of a clinical prediction rule for spinal manipulative therapy: a randomised controlled trial. Eur Spine J. 2008;17(7):936-943 938p.

[214] Hallegraeff JM, de Greef M, Winters JC, Lucas C. Manipulative therapy and clinical prediction criteria in treatment of acute nonspecific low back pain. Percept Mot Skills. 2009;108(1): 196-208.

[215] Cook CE, Learman KE, O'Halloran BJ, et al. Which prognostic factors for low back pain are generic predictors of outcome across a range of recovery domains? Phys Ther. 2013;93(1): 32-40.

[216] Cecchi F, Negrini S, Pasquini G, et al. Predictors of functional outcome in patients with chronic low back pain undergoing back school, individual physiotherapy or spinal manipulation. Eur J Phys Rehabil Med. 2012;48(3):371-378.

[217] Cook CE, Showalter C, Kabbaz V, O'Halloran B. Can a within/between-session change in pain during reassessment predict outcome using a manual therapy intervention in patients with mechanical low back pain? Man Ther. 2012;17(4):325-329.

[218] Donaldson M, Learman K, O'Halloran B, Showalter C, Cook C. The role of patients' expectation of appropriate initial manual therapy treatment in outcomes for patients with low back pain. J Manipulative Physiol Ther. 2013;36(5):276-283.

[219] Fritz JM, Whitman JM, Childs JD. Lumbar spine segmental mobility assessment: an examination of validity for determining intervention strategies in patients with low back pain. Arch Phys Med Rehabil. 2005;86(9):1745- 1752.

[220] Haas M, Kraemer DF. Dose-response for chiropractic care of chronic low back pain. Spine J. 2004;4(5):574- 583.

[221] Hoehler FK, Tobis JS. Psychological factors in the treatment of back pain by spinal manipulation. Br J Rheumatol. 1983;22(4):206-212.

[222] Niemisto L, Sarna S, Lahtinen-Suopanki T, Lindgren KA, Hurri H. Predictive factors for 1-year outcome of chronic low back pain following manipulation, stabilizing exercises, and physician consultation or physician consultation alone. J Rehabil Med. 2004;36(3):104-109.

[223] Underwood MR, Morton V, Farrin A, Team UBT. Do baseline characteristics predict response to treatment for low back pain? Secondary analysis of the UK BEAM dataset [ISRCTN32683578]. Rheumatology. 2007;46(8):1297-1302.

[224] Steenstra IA, Anema JR, Bongers PM, de Vet HCW, Knol DL, van Mechelen W. The effectiveness of graded activity for low back pain in occupational healthcare. Occup Environ Med. 2006;63(11):718-725.

[225] Lindstrom I, Ohlund C, Eek C, et al. The effect of graded activity on patients with subacute low back pain: a randomized prospective clinical study with an operant-conditioning behavioral approach. Phys Ther. 1992;72(4):279-290; discussion 291-273.

[226] Vibe Fersum K, O'Sullivan P, Skouen JS, Smith A, Kvale A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: A randomized controlled trial. Eur J Pain. 2013;17(6):916-928.

[227] Sahin N, Albayrak I, Durmus B, Ugurlu H. Effectiveness of back school for treatment of pain and functional disability in patients with chronic low back pain: a randomized controlled trial. J Rehabil Med. 2011;43(3):224- 229.

[228] Aluko A, DeSouza L, Peacock J. The effect of core stability exercises on variations in acceleration of trunk movement, pain, and disability during an episode of acute nonspecific low back pain: a pilot clinical trial. J Manip Physiol Ther. 2013;36(8):497-504.e491-493.

[229] Koumantakis GA, Watson PJ, Oldham JA. Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain. Phys Ther. 2005;85(3):209-225.

[230] Unsgaard-Tondel M, Fladmark AM, Salvesen O, Vasseljen O. Motor control exercises, sling exercises, and general exercises for patients with chronic low back pain: a randomized controlled trial with 1-year follow-up. Phys Ther. 2010;90(10):1426-1440.

[231] Mostagi FQRC, Dias JM, Pereira LM, et al. Pilates versus general exercise effectiveness on pain and functionality in non-specific chronic low back pain subjects. J Bodywork Move Ther. 2015;19(4):636-645.

[232] Rasmussen-Barr E, Nilsson-Wikma L, Arvidsson I. Stabilizing training compared with manual treatment in sub-acute and chronic low-back pain. Man Ther. 2003;8(4):233-241.

[233] Team UBT. United Kingdom back pain exercise and manipulation (UK BEAM) randomised trial: effectiveness of physical treatments for back pain in primary care. Br Med J. 2004;329(7479):1377.

[234] Oleske DM, Neelakantan J, Andersson GB, et al. Factors affecting recovery from work-related, low back disorders in autoworkers. Arch Phys Med Rehabil. 2004;85(8):1362-1364.

[235] Hagen EM, Eriksen HR, Ursin H. Does early intervention with a light mobilization program reduce long-term sick leave for low back pain. Spine. 2000;25(15):1973- 1976.

[236] Rozenberg S, Delval C, Rezvani Y, et al. Bed rest or normal activity for patients with acute low back pain. Spine. 2002;27(14):1487-1493.

[237] Wiesel SW, Cuckler JM, Deluca F, Jones F, Zeide MS, Rothman RH. Acute low-back pain an objective analysis of conservative therapy. Spine. 1980;5(4):324-330.

[238] Underwood MR, UK BEAM Trial Team. (2007). Do baseline characteristics predict response to treatment for low back pain? Secondary analysis of the UK BEAM dataset [ISRCTN32683578]. Rheumatology. 46(8):1297-302. Epub 2007 May 23.

[239] Cecchi F, Pasquini G, Paperini A, et al. Predictors of response to exercise therapy for chronic low back pain: result of a prospective study with one year follow-up. Eur J Phys Rehabil Med. 2014;50(2):143-151.

[240] Southern D, Lutz GE, Cooper G, Barre L. Are fluoroscopic caudal epidural steroid injections effective for managing chronic low back pain? Pain Phys. 2003;6(2):167- 172.

[241] Lee JW, Shin HI, Park SY, Lee GY, Kang HS. Therapeutic trial of fluoroscopic interlaminar epidural steroid injection for axial low back pain: effectiveness and outcome predictors. AJNR Am J Neuroradiol. 2010 Nov;31(10):1817- 23.

[242] Schwarzer AC, Derby R, Aprill CN, Fortin J, Kine G, Bogduk N. The value of the provocation response in lumbar zygapophyseal joint injections. Clin J Pain. 1994;10(4):309-313.

[243] Carette S, Marcoux S, Truchon R, et al. A controlled trial of corticosteroid injections into facet joints for chronic low back pain. N Engl J Med. 1991;325(14):1002-1007.

[244] Lakemeier S, Lind M, Schultz W, et al. A comparison of intraarticular lumbar facet joint steroid injections and lumbar facet joint radiofrequency denervation in the treatment of low back pain: a randomized, controlled, double-blind trial. Anesth Analg. 2013;117(1):228-235.

[245] Schulte TL, Pietila TA, Heidenreich J, Brock M, Stendel R. Injection therapy of lumbar facet syndrome: a prospective study. Acta Neurochir (Wien). 2006;148(11):1165-1172; discussion 1172.

[246] Chaturvedi A, Chaturvedi S, Sivasankar R. Image-guided lumbar facet joint infiltration in nonradicular low back pain. Indian J Radiol Imaging. 2009;19(1):29-34.

[247] Ackerman WE, 3rd, Ahmad M. Pain relief with intraarticular or medial branch nerve blocks in patients with positive lumbar facet joint SPECT imaging: a 12-week outcome study. South Med J. 2008;101(9):931-934.

[248] Birkenmaier C, Veihelmann A, Trouillier H, Hausdorf J, von Schulze Pellengahr C. Medial branch blocks versus pericapsular blocks in selecting patients for percutaneous cryodenervation of lumbar facet joints. Reg Anesth Pain Med. 2007;32(1):27-33 27p.

[249] Kaplan M, Dreyfuss P, Halbrook B, Bogduk N. The ability of lumbar medial branch blocks to anesthetize the zygapophysial joint. A physiologic challenge. Spine. 1998;23(17):1847-1852.

[250] Rocha ID, Cristante AF, Marcon RM, Oliveira RP, Letaif OB, Barros Filho TE. Controlled medial branch anesthetic block in the diagnosis of chronic lumbar facet joint pain: the value of a three-month follow-up. Clinics. 2014;69(8):529-534.

[251] Nath S, Nath CA, Pettersson K. Percutaneous lumbar zygapophysial (Facet) joint neurotomy using radiofrequency current, in the management of chronic low back pain: a randomized double-blind trial. Spine. 2008;33(12):1291-1297; discussion 1298.

[252] Van Kleef M, Barendse GA, Kessels A, Voets HM, Weber WE, de Lange S. Randomized trial of radiofrequency lumbar facet denervation for chronic low back pain. Spine (Phila Pa 1976). 1999;24(18):1937-1942.

[253] Civelek E, Cansever T, Kabatas S, et al. Comparison of effectiveness of facet joint injection and radiofrequency denervation in chronic low back pain. Turk Neurosurg. 2012;22(2):200-206.

[254] Kroll HR, Kim D, Danic MJ, Sankey SS, Gariwala M, Brown M. A randomized double blind prospective study comparing the efficacy of continuous versus pulsed radiofrequency in the treatment of lumbar facet syndrome. J Clin Anesth. 2008;20(7):534-537.

[255] Tekin I, Mirzai H, Ok G, Erbuyun K, Vatansever D. A comparison of conventional and pulsed radiofrequency denervation in the treatment of chronic facet joint pain. Clin J Pain. 2007;23(6):524-529.

[256] Leclaire R, Fortin L, Lambert R, Bergeron YM, Rossignol M. Radiofrequency facet joint denervation in the treatment of low back pain: a placebo-controlled clinical trial to assess efficacy. Spine. 2001;26(13):1411-1416; discussion 1417.

[257] MacVicar J, Borowczyk JM, MacVicar AM, Loughnan BM, Bogduk N. Lumbar medial branch radiofrequency neurotomy in New Zealand. Pain Med. 2013;14(5): 639-645.

[258] Chakraverty R, Dias R. Audit of conservative management of chronic low back pain in a secondary care setting -- part I: facet joint and sacroiliac joint interventions. Acupunct Med. 2004;22(4):207-213.

[259] Cusi M, Saunders J, Hungerford B, Wisbey-Roth T, Lucas P, Wilson S. The use of prolotherapy in the sacroiliac joint. Br J Sports Med. 2010;44(2):100-104.

[260] Slipman CW, Lipetz JS, Plastaras CT, et al. Fluoroscopically guided therapeutic sacroiliac joint injections for sacroiliac joint syndrome. Am J Phys Med Rehabil. 2001;80(6):425-432.

[261] Kapural L, Nageeb F, Kapural M, Cata JP, Narouze S, Mekhail N. Cooled radiofrequency system for the treatment of chronic pain from sacroiliitis: the first case-series. Pain Practice. 2008;8(5):348-354 347p.

[262] Karaman H, Kavak GO, Tufek A, et al. Cooled radiofrequency application for treatment of sacroiliac joint pain. Acta Neurochir (Wien). 2011;153(7):1461-1468.

[263] Vallejo R, Manuel Zevallos L, Lowe J, Benyamin R. Is Spinal Cord Stimulation an Effective Treatment Option for Discogenic Pain? Pain Pract. 2012;12(3):194-201.

[264] Chen JY, Ding Y, Lv RY, et al. Correlation between MR imaging and discography with provocative concordant pain in patients with low back pain. Clinical Journal of Pain. 2011;27(2):125-130.

[265] Weishaupt D, Zanetti M, Hodler J, et al. Painful lumbar disk derangement: Relevance of endplate abnormalities at MR imaging. Radiology. 2001;218(2):420-427.

[266] Vanharanta H, Sachs BL, Spivey MA, et al. The relationship of pain provocation to lumbar disc deterioration as seen by CT/discography. Spine. 1987;12:295-298.

[267] Collins CD, Stack JP, O'Connell DJ, et al. The role of discography in lumbar disc disease: a comparative study of magnetic resonance imaging and discography. Clin Radiol. 1990;42(4):252-257.

[268] Lim CH, Jee WH, Son BC, Kim DH, Ha KY, Park CK. Discogenic lumbar pain: association with MR imaging and CT discography. Eur J Radiol. 2005;54(3):431-437.

[269] Yrjama M, Vanharanta H. Bony vibration stimulation: A new, non-invasive method for examining intradiscal pain. Eur Spine J. 1994;3(4):233-235.

[270] Yrjama M, Tervonen O, Vanharanta H. Ultrasonic imaging of lumbar discs combined with vibration pain provocation compared with discography in the diagnosis of internal anular fissures of the lumbar spine. Spine. 1996;21(5):571-575.

[271] Yrjama M, Tervonen O, Kurunlahti M, Vanharanta H. Bony vibration stimulation test combined with magnetic resonance imaging: Can discography be replaced? Spine. 1997;22(7):808-813.

[272] Hanna H, Tommy H. HIZ's relation to axial load and low back pain: Investigated with axial loaded MRI and pressure controlled discography. Eur Spine J. 2013;22(4):734-739.

[273] O'Neill, C., et al. Accuracy of MRI for diagnosis of discogenic pain. Pain Phys. 2008;11(3): 311-326.

[274] Scuderi GJ, Brusovanik GV, Golish SR, et al. A critical evaluation of discography in patients with lumbar intervertebral disc disease. Spine J. 2008;8(4):624-629.

[275] Saifuddin A, Braithwaite I, White J, Taylor BA, Renton P. The value of lumbar spine magnetic resonance imaging in the demonstration of anular tears. Spine. 1998;23(4):453-457.

[276] Alamin TF, Kim MJ, Agarwal V. Provocative lumbar discography versus functional anesthetic discography: a comparison of the results of two different diagnostic techniques in 52 patients with chronic low back pain. Spine J. 2011;11(8):756-765.

[277] Putzier M, Streitparth F, Hartwig T, Perka CF, Hoff EK, Strube P. Can discoblock replace discography for identifying painful degenerated discs? Eur J Radiol. 2013; 82(9): 1463-1470.

[278] Derby R, Lee JE, Lee SH. Analgesic discography: Effect of adding a local anesthetic to routine lumbar provocation discography. Pain Med. 2010; 11:1335- 1342.

[279] Ohtori S, Kinoshita T, Yamashita M, et al. Results of surgery for discogenic low back pain: a randomized study using discography versus discoblock for diagnosis. Spine. 2009;34(13): 1345-1348.

[280] Cao P, Jiang L, Zhuang C, et al. Intradiscal injection therapy for degenerative chronic discogenic low back pain with end plate Modic changes. Spine J. 2011;11(2):100- 106.

[281] Fayad F, Lefevre-Colau MM, Rannou F, et al. Relation of inflammatory modic changes to intradiscal steroid injection outcome in chronic low back pain. Eur Spine J. 2007;16(7):925-931.

[282] Khot A, Bowditch M, Powell J, Sharp D. The use of intradiscal steroid therapy for lumbar spinal discogenic pain: a randomized controlled trial. Spine. 2004;29(8):833- 836; discussion 837.

[283] Yavuz F, Taskaynatan MA, Aydemir K, Ozgul A, Tan AK. The efficacy of intradiscal steroid injections in degenerative lumbar disc disease. Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi. 2012;58(2):88-92.

[284] Pettine K, Suzuki R, Sand T, Murphy M. Treatment of discogenic back pain with autologous bone marrow concentrate injection with minimum two year follow-up. Int Orthop. 2016;40(1):135-140.

[285] Tuakli-Wosornu YA, Terry A, Boachie-Adjei K, et al. Lumbar Intradiskal Platelet-Rich Plasma (PRP) Injections: A Prospective, Double-Blind, Randomized Controlled Study. PM and R. 2016;8(1):1-10.

[286] Peng B, Pang X, Wu Y, Zhao C, Song X. A randomized placebo-controlled trial of intradiscal methylene blue injection for the treatment of chronic discogenic low back pain. Pain. 2010;149(1):124-129.

[287] Pauza KJ, Howell S, Dreyfuss P, Peloza JH, Dawson K, Bogduk N. A randomized, placebo-controlled trial of intradiscal electrothermal therapy for the treatment of discogenic low back pain. Spine J. 2004;4(1):27-35.

[288] Bogduk N, Karasek M. Two-year follow-up of a controlled trial of intradiscal electrothermal anuloplasty for chronic low back pain resulting from internal disc disruption. Spine J. 2002 Sep-Oct;2(5):343-50.

[289] Freeman BJ, Fraser RD, Cain CM, Hall DJ, Chapple DC. A randomized, double-blind, controlled trial: intradiscal electrothermal therapy versus placebo for the treatment of chronic discogenic low back pain. Spine. 2005;30(21):2369-2377; discussion 2378.

[290] Desai MJ, Kapural L, Petersohn JD, Vallejo R, Menzies R, Creamer M, Gofeld M. A Prospective, Randomized, Multicenter, Open-label Clinical Trial Comparing Intradiscal Biacuplasty to Conventional Medical Management for Discogenic Lumbar Back Pain. Spine. 2016 Jul 1;41(13):1065-74.

[291] Kapural L, Ng A, Dalton J, Mascha E, Kapural M, de la Garza M, Mekhail N. Intervertebral disc biacuplasty for the treatment of lumbar discogenic pain: results of a six-month follow-up. Pain Med. 2008 Jan Feb;9(1):60- 7.

[292] Fukui S, Rohof O. Results of pulsed radiofrequency technique with two laterally placed electrodes in the annulus in patients with chronic lumbar discogenic Pain J. 2012;26(4):606-609.

[293] Karaman H, Tufek A, Kavak GO, et al. 6-month results of TransDiscal Biacuplasty on patients with discogenic low back pain: Preliminary findings. Int J Med Sci. 2011;8(1):1-8.

[294] Kvarstein G, Måwe L, Indahl A, Hol PK, Tennøe B, Digernes R, Stubhaug A, Tønnessen TI, Beivik H. A randomized double-blind controlled trial of intra-annular radiofrequency thermal disc therapy--a 12-month follow-up. Pain. 2009 Oct;145(3):279-86.

[295] Garvey TA, Marks MR, Wiesel SW. A prospective, randomized, double-blind evaluation of trigger-point injection therapy for low-back pain. Spine. 1989;14(9):962-964.

[296] De Andres J, Adsuara VM, Palmisani S, Villanueva V, Lopez-Alarcon MD. A double-blind, controlled, randomized trial to evaluate the efficacy of botulinum toxin for the treatment of lumbar myofascial pain in humans. Reg Anesth Pain Med. 2010;35(3):255-260.

[297] Madan SS, Boeree NR. Comparison of instrumented anterior interbody fusion with instrumented circumferential lumbar fusion. Eur Spine J. Dec 2003;12(6):567- 575.

[298] Vamvanij V, Fredrickson BE, Thorpe JM, Stadnick ME, Yuan HA. Surgical treatment of internal disc disruption: an outcome study of four fusion techniques. J Spinal Disord. Oct 1998;11(5):375-382.

[299] Kendrick D, Fielding K, Bentley E, Miller P, Kerslake R, Pringle M. The role of radiography in primary care patients with low back pain of at least 6 weeks duration: a randomised (unblinded) controlled trial. Health Technol Assess. 2001;5(30):1-69.

[300] Miller P, Kendrick D, Bentley E, Fielding K. Cost-effectiveness of lumbar spine radiography in primary care patients with low back pain. Spine. 2002;27(20):2291- 2297.

[301] UK BEAM Trial Team. United Kingdom back pain exercise and manipulation (UK Beam) randomised trial: cost effectiveness of physical treatments for back pain in primary care. BMJ. 2004 Dec 11: 329(7479): 1381. Epub 2004 Nov 19.

[302] Witt CM, Jena S, Selim D, et al. Pragmatic randomized trial evaluating the clinical and economic effectiveness of acupuncture for chronic low back pain. Am J Epidemiol. 2006;164(5):487-496.

[303] Ratcliffe J, Thomas KJ, MacPherson H, Brazier J. A randomised controlled trial of acupuncture care for persistent low back pain: Cost effectiveness analysis. BMJ. 2006;333(7569):626-628.

[304] Thomas KJ, MacPherson H, Ratcliffe J, et al. Longer term clinical and economic benefits of offering acupuncture care to patients with chronic low back pain. Health Technol Assess. 2005;9(32):68.

[305] Jellema P, van der Roer N, van der Windt DA, et al. Low back pain in general practice: Cost-effectiveness of a minimal psychosocial intervention versus usual care. Eur Spine J. 2007;16(11):1812-1821.

[306] Lamb SE, Hansen Z, Lall R, et al. Group cognitive behavioural treatment for low-back pain in primary care: a randomised controlled trial and cost-effectiveness analysis. Lancet. 2010;375(9718):916-923.

[307] Norton G, McDonough CM, Cabral H, Shwartz M, Burgess JF. Cost-utility of cognitive behavioral therapy for low back pain from the commercial payer perspective. Spine. 2015;40(10):726-733.

[308] Whitehurst DG, Lewis M, Yao GL, et al. A brief pain management program compared with physical therapy for low back pain: Results from an economic analysis alongside a randomized clinical trial. Arthritis Rheum. 2007;57(3):466-473.

[309] Apeldoorn AT, Bosmans JE, Ostelo RW, de Vet HC, van Tulder MW. Cost-effectiveness of a classification-based system for subacute and chronic low back pain. Eur Spine J. 2012;21(7):1290-1300

[310] Johnsen LG, Hellum C, Storheim K, et al. Cost-effectiveness of total disc replacement versus multidisciplinary rehabilitation in patients with chronic low back pain: A Norwegian multicenter RCT. Spine. 2014;39(1):23-32.

[311] Rivero-Arias O, Campbell H, Gray A, Fairbank J, Frost H, Wilson-MacDonald J. Surgical stabilisation of the spine compared with a programme of intensive rehabilitation for the management of patients with chronic low back pain: Cost utility analysis based on a randomised controlled trial. BMJ. 2005;330(7502):1239-1243.

[312] Fairbank J, Frost H, Wilson-MacDonald J, Yu LM, Barker K, Collins R. Spine Stabilisation Trial Group. BMJ. 2005 May 28;330(7502): 1233. Epub 2005. Eratum in: BMJ (2005 Jun 25;330(7506): 1485.

Figure Captions

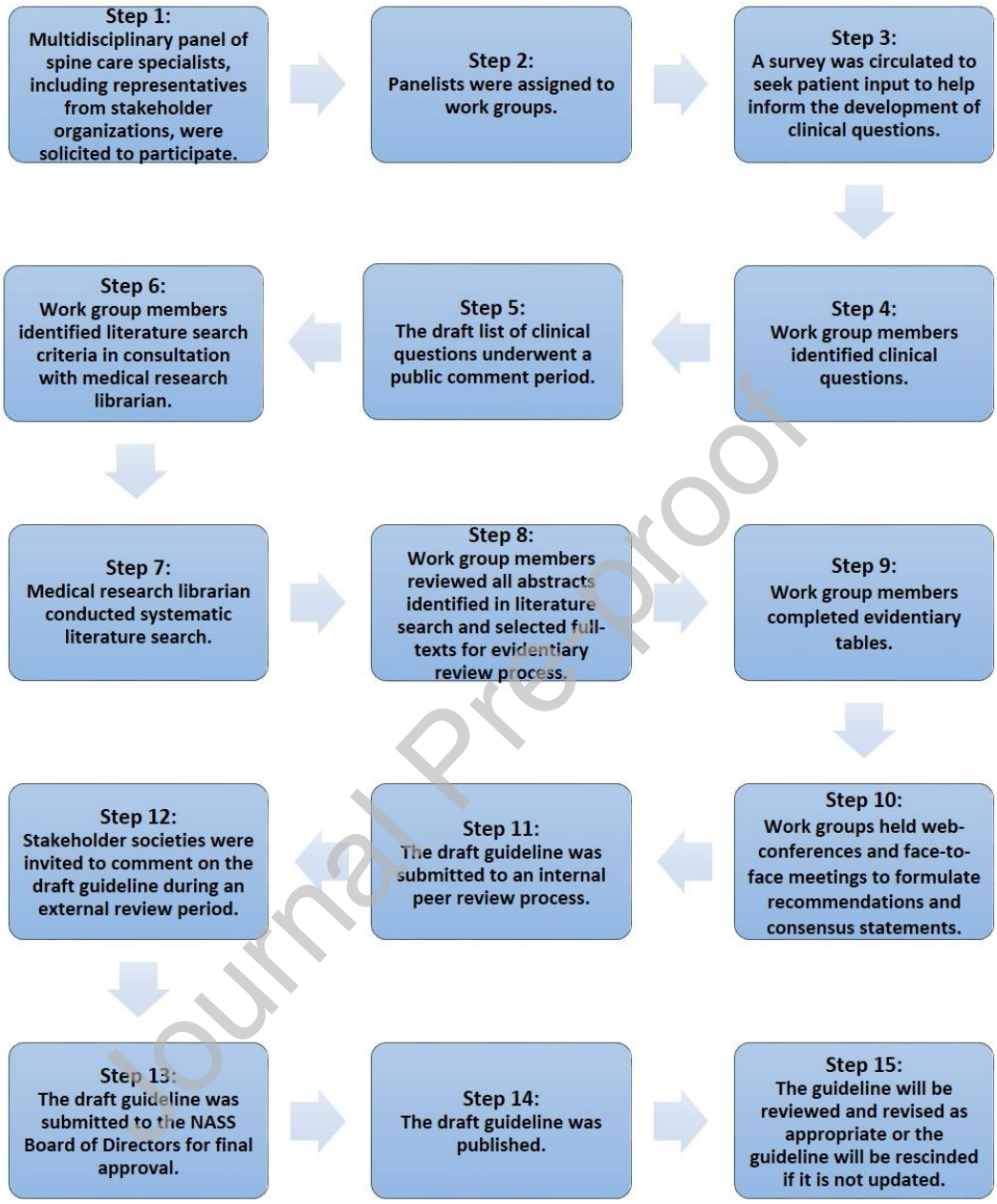

Figure 1. Summary of the North American Spine Society's guideline development process