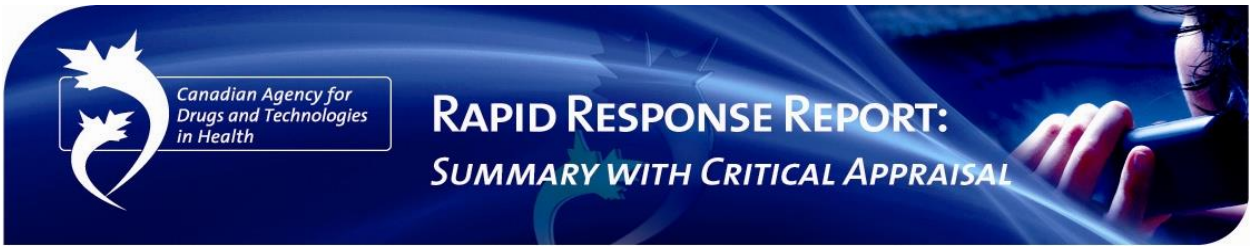

TITLE: Dry Needling and Injection for Musculoskeletal and Joint Disorders: A Review of the Clinical Effectiveness, Cost-Effectiveness, and Guidelines

DATE: 22 August 2016

CONTEXT AND POLICY ISSUES

Musculoskeletal pain is a common reason for primary healthcare visits.[1,2] Dry needling is a procedure that appears to be increasingly used to treat this type of pain.[3] Dry needling involves the insertion of needles to treat "myofascial pain" or "myofascial trigger point" pain. Trigger points are palpable, hypersensitive areas (nodules or bands) within muscle tissue that may cause local or referred pain.[3-5] Dry needling may also be used in other parts of the body, not involving trigger points, such as ligaments and tendons.[6]

WorkSafe BC defines dry needling as *"a technique that uses needles to treat myofascial pain in any body part, including low back pain. Dry needling involves the insertion of a needle (it can be an acupuncture needle or any other injection needle without injecting any liquid) at the myofascial trigger pain points (not toward meridian points as it is practiced in acupuncture). The needles are removed once the trigger point is inactivated. The activation of the trigger point should be followed by exercises, for example, with the purpose of re-establishing a painless, full range of motion and avoid recurrences. At present, the mechanisms, underlying the action of dry needling is [sic] still unclear."*[7]

There is no widely accepted, standard definition of myofascial trigger points, but they have been associated with musculoskeletal pain, including joint and spinal disorders, tendonitis, pelvic pain, and neuralgia.[8] The trigger points may be "active" or "latent".[5,9] Active trigger points are localized areas that are painful with or without palpation, and that may also cause radiated pain elsewhere in the body. Latent trigger points are only painful when palpated or activated through some kind of stimulus.[8]

It is important to note that the validity of myofascial trigger point pain theories have been questioned.[10,11] A 2007 review identified 19 different descriptions of diagnostic criteria for myofascial trigger points and associated pain, but found a lack consensus or standard definition.[2]

A 2009 systematic review found physical examination (palpation) was unreliable in identifying trigger points.[1] The authors concluded that "*the diagnosis and treatment of TPs [trigger points] does not have a firm clinical basis. Until a reliable diagnostic test for TPs has been demonstrated it is recommended that this diagnosis should not be considered as a primary, or exclusive diagnosis for patients presenting a report of pain. If a treatment or management plan is to be implemented on the basis of a diagnosis of TPs, then patients should be informed of the ambiguity of this diagnosis so that they may make an informed choice about their treatment options…. Reliable methods of identifying TPs should be demonstrated before the implementation of further studies investigating the prevalence or treatment of trigger points.*"[1]

Other studies have found poor inter-examiner reliability in identifying trigger points.[6,10,11] Some of the studies included in the systematic reviews noted the importance of achieving the local twitch response (LTR) to determine the precise area for needling, and included this as part of their study protocols, while other studies either did not require or report this aspect of the procedure.[6,12]

Dry needling may also be called dry needle fenestration, intramuscular manual stimulation, intramuscular needling, intramuscular manual therapy, intra-muscular stimulation (IMS), ultrasound-guided needling, needle release, needling therapy or trigger point dry needling.[5,6] When used as a treatment for disorders of the tendons, dry needling may be performed with ultrasound guidance and called tendon fenestration or tenotomy.[13] Whether dry needling is actually another form of acupuncture,[3,9,14] is also controversial and it is sometimes referred to as "western acupuncture".[4]

Various theories or schools of dry needling, have been put forward, including the radiculopathy model or intramuscular stimulation, proposed by Canadian physician, Dr. Chan Gunn.[3,4,12,15] The umbrella term of dry needling includes different techniques, such as:[9]

- Deep dry needling - insertion of the needle deep into the muscle tissue of the trigger point
- Superficial dry needling - insertion of the needle into the tissue overlying the trigger point
- Paraspinal dry needling – needling of both the myofascial trigger points and the corresponding paraspinal muscles[4]
- Ultrasound-guided tendon fenestration.[13]

As well as differences in the depth of needle insertion, other techniques used in dry needling vary.[8] These variations include the type, size and number of needles used, whether the needle is manipulated after insertion (moved in and out, rotated, or left static), and the period of time the needle remains inserted.[3,5]

Unlike trigger point injections ("wet needling"), for musculoskeletal pain, dry needling does not involve the injection of fluids (such as, corticosteroids, sclerosants or anesthetics).[6] However, dry needling is seldom offered in isolation, and injections and other procedures, such as massage and exercise therapies, are usually included as part of the patient's overall treatment.[5,9,10] Dry needling may also be combined with plasma-rich platelet (PRP) injections formulated from the patient's blood and usually injected with ultrasound guidance.[16,17]

Depending on professional scopes of practice within their jurisdictions, dry needling may be administered by different healthcare practitioners -- including physiotherapists, acupuncturists, occupational therapists, naturopaths, osteopaths, chiropractors, dentists, and physicians -- who have received training in the procedure.[18]

Although the use of dry needling appears to be increasing,[3,11] it is not clear whether there is good evidence that this procedure is clinically effective. The purpose of this review is to appraise the evidence on dry needling to inform decisions on whether this procedure should be funded through the public healthcare system.

RESEARCH QUESTIONS

1. What is the clinical effectiveness of dry needling for patients with musculoskeletal and joint disorders?

2. What is the clinical effectiveness of dry needling plus injection vs. injection alone for patients with musculoskeletal and joint disorders?

3. What is the cost-effectiveness of dry needling for patients with musculoskeletal and joint disorders?

4. What is the cost-effectiveness of dry needling plus injection vs. injection alone for patients with musculoskeletal and joint disorders?

5. What are the evidence-based guidelines on the use of dry needling and injection to treat patients with musculoskeletal and joint disorders?

KEY FINDINGS

Evidence on the effectiveness of dry needling is mixed. Limited evidence suggests that wet needling (injection) is more effective than dry needling in the treatment of musculoskeletal or joint pain.

Our literature search found no information on the cost-effectiveness of dry needling for patients with musculoskeletal or joint disorders, or on the cost-effectiveness of dry needling plus injection vs. injection alone for patients with these conditions.

No evidence-based guidelines were identified on the use dry needling in the treatment of musculoskeletal or joint disorders. While there are some statements on this treatment issued by physiotherapy and other healthcare professional associations, these are practitioner guides outlining competencies and safe practices for providing this procedure.

METHODS

Literature Search Methods

A limited literature search was conducted on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No methodological filters were applied to limit retrieval. Where possible, retrieval was limited to studies of the intervention in humans, and English language documents published between January 1, 2011 and July 19, 2016.

Rapid Response reports are organized so that the evidence for each research question is presented separately.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1. Systematic reviews and meta-analyses that included studies of dry needling (with or without injections) were included.

Table 1: Selection Criteria

Population	Adult patients with musculoskeletal pain, joint disorders, joint pain, derangement of joints, chronic tendinosis, tendinopathy, etc.
Intervention	Dry needling with or without injection, dry needling, ultrasound needling
Comparator	No comparator (or any treatment that is used to treat patients with above conditions)
Outcomes	Safety, effectiveness, cost-effectiveness, and clinical practice guidelines
Study Designs	Health technology assessment reports, systematic reviews, meta-analyses, economic evaluations or evidence-based guidelines

Exclusion Criteria

Publications were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, were not published in English, or were published prior to 2011. Guidelines that did not appear to be based on systematic reviews of the evidence were also excluded. Studies of dry needling in conditions other than those involving musculoskeletal or joint pain were also excluded (where possible). For example, the following conditions were not included: plantar fasciitis (heel pain), neuralgia, fibromyalgia, headache, and pelvic pain.

Critical Appraisal of Individual Studies

The systematic reviews were critically appraised using the AMSTAR checklist.[19] Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described narratively.

SUMMARY OF EVIDENCE

Quantity of Research Available

A total of 309 citations were identified in the literature search of bibliographic databases. Following screening of titles and abstracts, 292 citations were excluded, and 17 potentially relevant systematic reviews and meta-analyses identified by the electronic database search were retrieved for full-text review. No relevant publications were identified from the grey literature search. One additional systematic review (identified through the reference list of another study) met the inclusion criteria and was included in this report. Of the 18 articles selected for full-text screening, 15 met the selection criteria for this review. Appendix 1 describes the PRISMA flowchart of the study selection.

Summary of Study Characteristics

Details on study characteristics, critical appraisal and findings are shown in Appendices 2, 3, and 4.

Study Design
This rapid response report is based on 15 systematic reviews and meta-analyses that included primary studies (mainly randomized controlled trials of varying quality) with dry needling as either the main treatment intervention, or as the comparator or control. These reviews were published from 2012 to 2016. The literature searches covered the most recent few years to as far back as the databases covered. The end-search date of the most recent review was August 2015.

Country of Origin
None of the systematic reviews were from Canada, but they were from multiple countries: USA,[8,12,20,21] UK, Europe,[22-27] Australia,[17] New Zealand,[28] China,[29] and Korea.[30,31] Each of the systematic reviews included primary studies from multiple countries.

Patient Population
All of the systematic reviews included adult patients with various types of musculoskeletal pain and tendinopathies, in particular: upper and lower body myofascial pain,[8,21,24] neck,[12,21,24,26,28-30] shoulder,[12,17,20-24,27-29,31] elbow,[17,20,23,24] back,[12,21,24,31] thigh,[8] knee,[8,12,17,23,25] and Achilles heel.[8,12,17,20,25]

Interventions and Comparators
In most of the systematic reviews dry needling was the main intervention (or one of them),[8,12,20-22,24,26-31] but in some reviews it was used as the comparator or control treatment for interventions such as platelet-rich plasma injection (PRP).[17,23,25]

The techniques used in dry needling varied across the primary studies and it was often combined with other treatment interventions (such as exercise therapy or injections). Comparators to dry needling included: exercise or stretching,[8,12,21,24,26,28,30] physiotherapy,[29,30] compression,[26,29] injections (of saline, anesthetics (such as lidocaine),[12,21,24,26,28,29] corticosteroids,[24,27] botinulum toxin,[21] platelet-rich plasma (PRP)[17,23,25] or other types of autologous blood products),[20] various types of acupuncture,[8,21,25,26,29-31] extracorporeal shockwave therapy (ESWT),[17,27] transcutaneous electrical nerve stimulation (TENS),[8] percutaneous electrical nerve stimulation (PENS),[12] laser,[21,28,29] drug therapies,[12,30,31] sham or superficial needling,[8,21,26,29,30] placebo,[12,24,29] or "usual care".[30] One systematic review compared ultrasound-guided needling and extracorporeal shock wave therapy to arthroscopic surgery for rotator cuff tendinopathy.[22]

Outcomes
Reduction in pain (pain intensity) was the main outcome assessed in most of the systematic reviews.[8,12,17,20,21,23,24,26-31] Various pain scales were used, most commonly a Visual Analog Scale (VAS). Some reviews also included range of movement (ROM).[12,24,26,30] Information on other outcomes, such as quality-of-life[30] and function/disability[20,22,23,27,30] were included in some reviews – from a smaller sub-set of studies that included this information.

Summary of Critical Appraisal

The 15 systematic reviews and meta-analyses included in this rapid response were of variable quality. Most followed general principles for systematic reviews, but many had limitations that may have affected their conclusions. Using the AMSTAR checklist[19], the most common limitations identified in the reviews were:

- a limited literature search (for example, searching only a single database, poor search terms, or a brief date range for the search)[12,21,25,26]
- use of a single reviewer for data extraction and quality assessment of studies[8]
- no indication that the risk of publication bias had been assessed.[8,12,17,20,22,25-27]

Two studies did not report performing quality assessment of the included studies.[20,25] The PEDro scale and the Cochrane risk of bias were the most commonly tools for quality assessment, but some studies used others, including GRADE, the MacDermid Quality Checklist, and the Coleman Methodology Score.

Most of the systematic reviews noted the included studies were heterogeneous, particularly in terms of the different dry needling techniques used (both with and without other interventions), in some cases the conditions treated, the variety of comparators, and the length of patient follow-up.

With one exception (where the information was not reported),[24] none of the authors of the systematic reviews reported a conflict of interest. Several good quality systematic reviews were available.[23,24,27-31]

Summary of Findings

Clinical effectiveness of dry needling

The higher quality systematic reviews generally found that dry needling had similar or worse outcomes compared to comparator interventions.

One review found dry needling had a positive effect on pain relief for lower body (lower back, hip, and knee pain) in short-term follow-up (up to six months), compared to stretching, no intervention, or sham needling.[8] However, dry needling did not appear to have a positive effect on range of movement, function, or quality of life.[8]

Another review compared dry needling to numerous other interventions for all types of musculoskeletal pain (e.g., neck, upper body, back, and legs).[12] The authors considered most of studies in their review to be high quality and showed dry needling was more effective in reducing pain than stretching exercises or percutaneous electric nerve stimulation, and at least as effective as manual trigger point release or other types of needling (such as acupuncture).[12] However, a critique of this review found the conclusions were overstated, and that many of the included studies had one or more methodological flaws, including failure to demonstrate a statistically significant difference from sham treatments, failure to control for confounders (such as the natural history of the condition), and limited follow-up (immediate to short-term) of outcomes.[11]

An older review compared pain relief with intramuscular stimulation therapy, a form of dry needling, to sham acupuncture, intramuscular electrical stimulation, drug therapy, or trigger point dry needling, for various musculoskeletal conditions (e.g., shoulder, lower back).[31] The authors found the four included trials had positive findings, but their methodological flaws prevented drawing evidence-based conclusions on the effectiveness of intramuscular stimulation therapy.[31] In the one trial that used trigger point dry needling as the comparator, intramuscular stimulation provided greater neck pain relief than dry needling.[31]

One review of acupuncture (including dry needling) for whiplash found dry needling was no more effective for pain relief than sham dry needling or other interventions (such as physiotherapy, exercise, and sham acupuncture).[30]

Another review that assessed extracorporeal shockwave therapy, ultrasound-guided dry needling, and arthroscopic surgery for rotator cuff tendinopathy found significant improvement in functional outcomes with dry needling at one-year follow-up, but that similar results were achieved with all three treatments.[22]

Dry needling vs. wet needling

One systematic review, on platelet-rich plasma injection, that included four studies of dry needling as a control intervention in patients with various tendinopathies (shoulder, elbow, knee, heel) found no difference in pain reduction between the control interventions used - injections of either saline, local anesthetic, corticosteroids, or dry needling.[17]

For neck and shoulder pain relief, one review found that dry needling could be effective for short (immediate to three days) to medium term (nine to 28 days) pain relief, but that wet needling (with lidocaine injection) provided more effective pain relief than dry needling in the medium term.[29] However, a second review, also for neck and shoulder pain, found no difference between dry needling and lidocaine injection immediately after treatment or at up to six months follow-up.[28]

A third review of dry needling for upper body myofascial pain (neck, shoulder, back), concluded that for immediate post-treatment pain relief and at four weeks lidocaine injection was superior to dry needling.[21] Nevertheless, the results of their meta-analysis of three trials found that dry needling may be superior to sham or placebo treatment for immediate pain relief, but the difference at 4 weeks was not statistically significant.[21]

One review assessed ischemic compression (exercise therapy) and dry needling (with or without exercise or stretching) compared to several other interventions (including lidocaine injection) for patients with neck pain.[26] Although the authors concluded that there was good evidence that dry needling reduced pain, in the four studies that compared dry needling plus stretching exercises to lidocaine injection plus stretching exercises pain relief outcomes were similar.[26]

Another review found ultrasound-guided needling was not more effective than ultrasound-guided subacromial corticosteroid injection for rotator cuff injury.[27] However, this study found, based on one low quality study, that dry needling was better than no treatment at three month follow-up.

One review of dry needling for various types of myofascial pain (e.g., in the neck, upper back, shoulder, elbow) found dry needling was not more effective in decreasing pain in comparison to placebo but was less effective than other treatments (including injections [lidocaine, corticosteroids, botulinum toxin], ultrasound, laser, stretching exercises).[24] For improving range of movement, dry needling was more effective than placebo, but less effective than the other treatments.[24]

A review of platelet-rich plasma injection for patients with various tendinopathies included two studies that used dry needling as a control intervention.[23] The authors concluded that no difference in pain relief was seen between dry needling or placebo (saline or corticosteroid injections) and platelet-rich plasma. The only exception was a small clinical improvement with platelet-rich plasma in patients with rotator cuff tendinopathy.[23]

Another review of platelet-rich plasma injection for knee and heel tendinopathies included one study with dry needling as both the co-intervention and the comparator treatment for patients with knee tendinopathy.[25] Platelet-rich plasma injection plus dry needling achieved better clinical outcomes (not specified) than dry needling alone.[25]

One review of four studies that compared tendon needling (in one study needling with exercise) to needling plus injection of autologous blood products (including platelet-rich plasma) for tendinopathies (shoulder, elbow and heel), concluded that tendon needling reduced pain at six months.[20] However, two of the studies found a benefit to the addition of platelet-rich plasma injection, while two found no difference.[20]

Safety of dry needling

Most of the systematic reviews did not report on safety outcomes, Of the systematic reviews that did include information on adverse events, the following were noted:

- pain during and after dry needling[22]
- minor petechial hemorrhage (bleeding)[27]
- mild vagal reaction (fainting)[27]
- painful bursitis and frozen shoulder.[27]

Other details of adverse events associated with dry needling have been reported in the literature. A 2014 review of the literature on the safety of dry needling, by the Health Quality Council of Alberta, addressed this issue.[15] In addition, Physiotherapy Alberta further outlines the types of adverse events that may occur with dry needling. Serious adverse events from dry needling are rare, but include pneumothorax (collapsing the lung), puncturing other vital tissue, infection, and broken needles.[15,32] Less serious adverse events include bruising, bleeding, pain (during and after treatment), drowsiness, dizziness, nausea or vomiting, fainting, sweating, headache, and seizure.[32] The Physiotherapy Alberta association recommends that patients be informed of the possible risks associated with this procedure.[32] Mild, transient adverse events (bruising, bleeding and pain) are common with dry needling.[32] However, one commentary noted that the difference in frequency of adverse events between dry needling and the sham group found in one trial meant that one in three patients treated with dry needling would experience an adverse event.[11]

Cost-effectiveness of dry needling

No information on the cost-effectiveness of dry needling for patients with joint disorders was identified.

Cost-effectiveness of dry needling plus injection vs. injection alone

No information on the cost-effectiveness of dry needling plus injection vs. injection alone for patients with joint disorders was identified.

Evidence-based guidelines on the use of dry needling

We found no evidence-based guidelines on the use dry needling in the treatment of joint disorders.

Limitations

Because of the ambiguous terminology in this area, and the volume of literature on acupuncture, studies of dry needling that used some of the less common terms for the procedure, or did not refer to dry needling in the title or abstract may not have been captured by the literature search.

In studies of chronic pain treatments, measurement of multiple outcomes is recommended. The Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) group recommends that, in addition to the measurement of pain intensity, additional measures such as physical functioning and psychological well-being should also be assessed.[33] Many of the primary studies included in the systematic reviews focused on pain reduction, and there is insufficient evidence on the effects of dry needling on other outcomes, such as range of movement or quality of life.

Although there is an abundance of studies on dry needling for various conditions, the systematic reviews found that most of the primary studies were methodologically flawed. For example, blinding of participants and assessors was often inadequate,[26,31] many studies were underpowered to accurately indicate treatment effects, patient populations were heterogeneous, outcome measures and length of follow-up varied, and most studies included various non-standardized treatment and comparator interventions that may have affected the outcomes.

The minimum clinically important difference (MCID) or "smallest worthwhile effect" is important when examining studies on chronic pain.[34] MCID is a patient-derived measure to determine what patients see as a *clinically significant* improvement or meaningful change – rather than a change in pain level, but one that does not make a difference to the patient. The IMMPACT group recommends:

- a 10% to 20% reduction in pain be considered the minimal clinically important difference
- a reduction in pain of more than 30% would indicate a moderately important improvement, and
- a reduction in pain of over 50% would indicate a substantial clinically important change.[33,34]

These levels also depend on the baseline severity of pain of the individual patient, and only an average of the differences between patient groups post-treatment will indicate actual treatment

effects.[34] In most of the studies of dry needling the MCID was not defined, and the results focused only on statistically significant changes.[12]

Some systematic reviews[20,21,28] overstated their conclusions which can be common in study reports of pain treatments.[34,35] Actual results were down played, while more positive terms, such as "trending towards" and "potentially significant" were used in the abstracts and conclusions. For example, the results of one systematic review and meta-analysis of dry needling for neck and shoulder pain noted that the meta-analyses found no significant difference between DN and lidocaine at one or three to six month follow-up.[28] Nevertheless, the authors concluded that, *"Although not significant in the meta-analyses, there were interesting patterns favouring lidocaine immediately after treatment and dry needling at three to six months*."[28]

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Despite the number of systematic reviews on dry needling, evidence to show that it is an effective intervention is still lacking. Most of the systematic reviews, even those with conclusions that favoured dry needling, noted that current evidence is inadequate and better quality trials, with standardized interventions are needed to determine whether there is value in this procedure.

This finding is consistent with coverage policies of two US insurers, Blue Cross Blue Shield, and Aetna, both of which currently deem there is insufficient evidence on this procedure and consider dry needling is "experimental or investigational", and consequently not covered.[36,37]

No information on the cost-effectiveness of dry needling was identified. Similarly, no evidence-based guidelines on the use of dry needling were identified. However, there are recent statements on the practice of dry needling, by physiotherapy and other healthcare professional associations, but these are practitioner guides outlining competencies and safe practices for providing this procedure rather than systematic reviews of the evidence.[38-43]

Many further trials of dry needling are currently underway and evidence from these studies may affect these conclusions.[44,45]

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REFERENCES

1. Lucas N, Macaskill P, Irwig L, Moran R, Bogduk N. Reliability of physical examination for diagnosis of myofascial trigger points: a systematic review of the literature. Clin J Pain. 2009 Jan;25(1):80-9.

2. Tough EA, White AR, Richards S, Campbell J. Variability of criteria used to diagnose myofascial trigger point pain syndrome--evidence from a review of the literature. Clin J Pain. 2007 Mar;23(3):278-86.

3. Unverzagt C, Berglund K, Thomas JJ. Dry needling for myofascial trigger point pain: A clinical commentary. Int J Sports Phys Ther [Internet]. 2015 Jun [cited 2016 Aug 5];10(3):402-18. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4458928

4. Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. J Am Board Fam Med [Internet]. 2010 Sep [cited 2016 Aug 5];23(5):640-6. Available from: http://www.jabfm.org/content/23/5/640.full.pdf+html

5. Kietrys DM, Palombaro KM, Mannheimer JS. Dry needling for management of pain in the upper quarter and craniofacial region. Curr Pain Headache Rep. 2014;18(8):437.

6. Dunning J, Butts R, Mourad F, Young I, Flannagan S, Perreault T. Dry needling: a literature review with implications for clinical practice guidelines. Phys Ther Rev [Internet]. 2014 Aug [cited 2016 Aug 5];19(4):252-65. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4117383

7. WorkSafeBC Evidence-Based Practice Group. Alternative medicine: some definitions, evidence & references. For health care benefits guidelines. 12th.WorkSafeBC; 2009 Oct.

8. Morihisa R, Eskew J, McNamara A, Young J. Dry needling in subjects with muscular trigger points in the lower quarter: a systematic review. Int J Sports Phys Ther [Internet]. 2016 Feb [cited 2016 Jul 26];11(1):1-14. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4739038

9. Dommerholt J. Dry needling - peripheral and central considerations. J Manual Manipulative Ther [Internet]. 2011 Nov [cited 2016 Aug 5];19(4):223-7. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3201653

10. Quintner JL, Bove GM, Cohen ML. A critical evaluation of the trigger point phenomenon. Rheumatology (Oxford) [Internet]. 2015 Mar [cited 2016 Aug 5];54(3):392-9. Available from: http://rheumatology.oxfordjournals.org/content/54/3/392.full.pdf+html

11. Fitzpatrick J, Bulsara M, Zheng MH. The effectiveness of platelet-rich plasma in the treatment of tendinopathy: a meta-analysis of randomized controlled clinical trials. Am J Sports Med [supplementary material]. 2016 Jun 6.

12. Boyles R, Fowler R, Ramsey D, Burrows E. Effectiveness of trigger point dry needling for multiple body regions: a systematic review. J Manual Manipulative Ther. 2015 Dec;23(5):276-93.

13. Chiavaras MM, Jacobson JA. Ultrasound-guided tendon fenestration. Semin Musculoskelet Radiol. 2013 Feb;17(1):85-90.

14. McPartland JM. Travell trigger points--molecular and osteopathic perspectives. J Am Osteopath Assoc. 2004 Jun;104(6):244-9.

15. The safe practice of dry needling in Alberta. Summary report [Internet]. Calgary: Health Quality Council of Alberta; 2014 Oct. [cited 2016 Aug 5]. Available from: https://www.physiotherapyalberta.ca/files/safe_practice_of_dry_needling_in_alberta.pdf

16. Moraes VY, Lenza M, Tamaoki MJ, Faloppa F, Belloti JC. Platelet-rich therapies for musculoskeletal soft tissue injuries. Cochrane Database Syst Rev. 2013;(12).

17. Fitzpatrick J, Bulsara M, Zheng MH. The effectiveness of platelet-rich plasma in the treatment of tendinopathy: a meta-analysis of randomized controlled clinical trials. Am J Sports Med. 2016 Jun 6.

18. Dommerholt J, Fernández-de-las-Peñas C, editors. Trigger point dry needling: an evidence and clinical-based approach. London: Churchill Livingstone; 2013 Jan 29.

19. Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol [Internet]. 2007 [cited 2016 Aug 19];7:10. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1810543/pdf/1471-2288-7-10.pdf

20. Krey D, Borchers J, McCamey K. Tendon needling for treatment of tendinopathy: A systematic review. Phys Sportsmed. 2015 Feb;43(1):80-6.

21. Kietrys DM, Palombaro KM, Azzaretto E, Hubler R, Schaller B, Schlussel JM, et al. Effectiveness of dry needling for upper-quarter myofascial pain: a systematic review and meta-analysis. J Orthop Sports Phys Ther. 2013 Sep;43(9):620-34.

22. Louwerens JK, Veltman ES, van Noort A, van den Bekerom MP. The effectiveness of high-energy extracorporeal shockwave therapy versus ultrasound-guided needling versus arthroscopic surgery in the management of chronic calcific rotator cuff tendinopathy: A systematic review. Arthroscopy. 2016 Jan;32(1):165-75.

23. Tsikopoulos K, Tsikopoulos I, Simeonidis E, Papathanasiou E, Haidich AB, Anastasopoulos N, et al. The clinical impact of platelet-rich plasma on tendinopathy compared to placebo or dry needling injections: a meta-analysis. Phys Ther Sport. 2016 Jan;17:87-94.

24. Rodríguez-Mansilla J, González-Sánchez B, De Toro GA, Valera-Donoso E, Garrido-Ardila EM, Jiménez-Palomares M, et al. Effectiveness of dry needling on reducing pain intensity in patients with myofascial pain syndrome: A meta-analysis. J Tradit Chin Med [Internet]. 2016 Feb [cited 2016 Jul 26];36(1):1-13. Available from: http://www.journaltcm.com/modules/Journal/contents/stories/161/1.pdf

25. Di Matteo B, Filardo G, Kon E, Marcacci M. Platelet-rich plasma: evidence for the treatment of patellar and achilles tendinopathy--a systematic review. Musculoskelet Surg. 2015 Apr;99(1):1-9.

26. Cagnie B, Castelein B, Pollie F, Steelant L, Verhoeyen H, Cools A. Evidence for the use of ischemic compression and dry needling in the management of trigger points of the upper trapezius in patients with neck pain: A systematic review. Am J Phys Med Rehabil. 2015 Jul;94(7):573-83.

27. Louwerens JK, Sierevelt IN, van Noort A, van den Bekerom MP. Evidence for minimally invasive therapies in the management of chronic calcific tendinopathy of the rotator cuff: a systematic review and meta-analysis. J Shoulder Elbow Surg. 2014 Aug;23(8):1240-9.

28. Ong J, Claydon LS. The effect of dry needling for myofascial trigger points in the neck and shoulders: a systematic review and meta-analysis. J Bodywork Mov Ther. 2014 Jul;18(3):390-8.

29. Liu L, Huang QM, Liu QG, Ye G, Bo CZ, Chen MJ, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2015 May;96(5):944-55.

30. Moon TW, Posadzki P, Choi TY, Park TY, Kim HJ, Lee MS, et al. Acupuncture for treating whiplash associated disorder: a systematic review of randomised clinical trials. Evid Based Complement Alternat Med [Internet]. 2014 [cited 2016 Jul 26];2014:870271. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4034516

31. Kim TH, Lee CR, Choi TY, Lee MS. Intramuscular stimulation therapy for healthcare: a systematic review of randomised controlled trials. Acupunct Med. 2012 Dec;30(4):286-90.

32. FAQ: dry needling adverse effects [Internet]. Edmonton: Physiotherapy Alberta; 2016. [cited 2016 Aug 5]. Available from: https://www.physiotherapyalberta.ca/physiotherapists/resources_to_help_you_meet_practice_standards/dry_needling_safety_resources/faq_dry_needling_adverse_events

33. Dworkin RH, Turk DC, Wyrwich KW, Beaton D, Cleeland CS, Farrar JT, et al. Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. J Pain. 2008 Feb;9(2):105-21.

34. O'Connell NE, Moseley GL, McAuley JH, Wand BM, Herbert RD. Interpreting effectiveness evidence in pain: short tour of contemporary issues. Phys Ther. 2015 Aug;95(8):1087-94.

35. Harvie DS, O'Connell N, Moseley L. Dry needling for myofascial pain. Does the evidence make the grade? [Internet]. Adelaide (Australia): University of South Australia; 2016 Jul 4. [cited 2016 Jul 29]. Available from: http://www.bodyinmind.org/dry-needling-myofascial-pain/ Discussion Blog.

36. Dry needling of myofascial trigger points [Internet]. Topeka (KS): Blue Cross Blue Shield of Kansas; 2016. [cited 2016 Aug 9]. Available from: http://www.bcbsks.com/CustomerService/Providers/MedicalPolicies/policies/policies/DryNeedling_MyofascialTriggerPoints_2016-06-08.pdf

37. Acupuncture [Internet]. Hartford (CT): Aetna; 2016. [cited 2016 Aug 9]. Available from: http://www.aetna.com/cpb/medical/data/100_199/0135.html

38. Physical therapists & the performance of dry needling: an educational resource paper [Internet]. Alexandria (VA): American Physical Therapy Association; 2012 Jan. [cited 2016 Aug 9]. Available from: http://www.apta.org/StateIssues/DryNeedling/ResourcePaper/

39. Guidelines for safe acupuncture and dry needling practice [Internet]. Australia: Australian Society of Acupuncture Physiotherapists; 2013 Apr. [cited 2016 Aug 9]. Available from: http://combinedhealth.com.au/webfiles/ASAP_Guidelines_2013.pdf

40. Practice guideline - Myofascial dry needling. Melbourne (AU): Australian Association of Massage Therapists Ltd; 2015 Aug.

41. Bachmann S, Colla F, Grobli C, Mungo G, Grobli L, Reilich P, et al. Swiss guidelines for safe dry needling [Internet]. Winterthur (CH): Dry Needling Verband Schweiz (DVS); 2014 Nov 21. [cited 2016 Aug 9]. Available from: http://www.dgs.eu.com/fileadmin/documents/Richtlinien_fu__r_sicheres_Dry_Needling_Engl_1.6.pdf

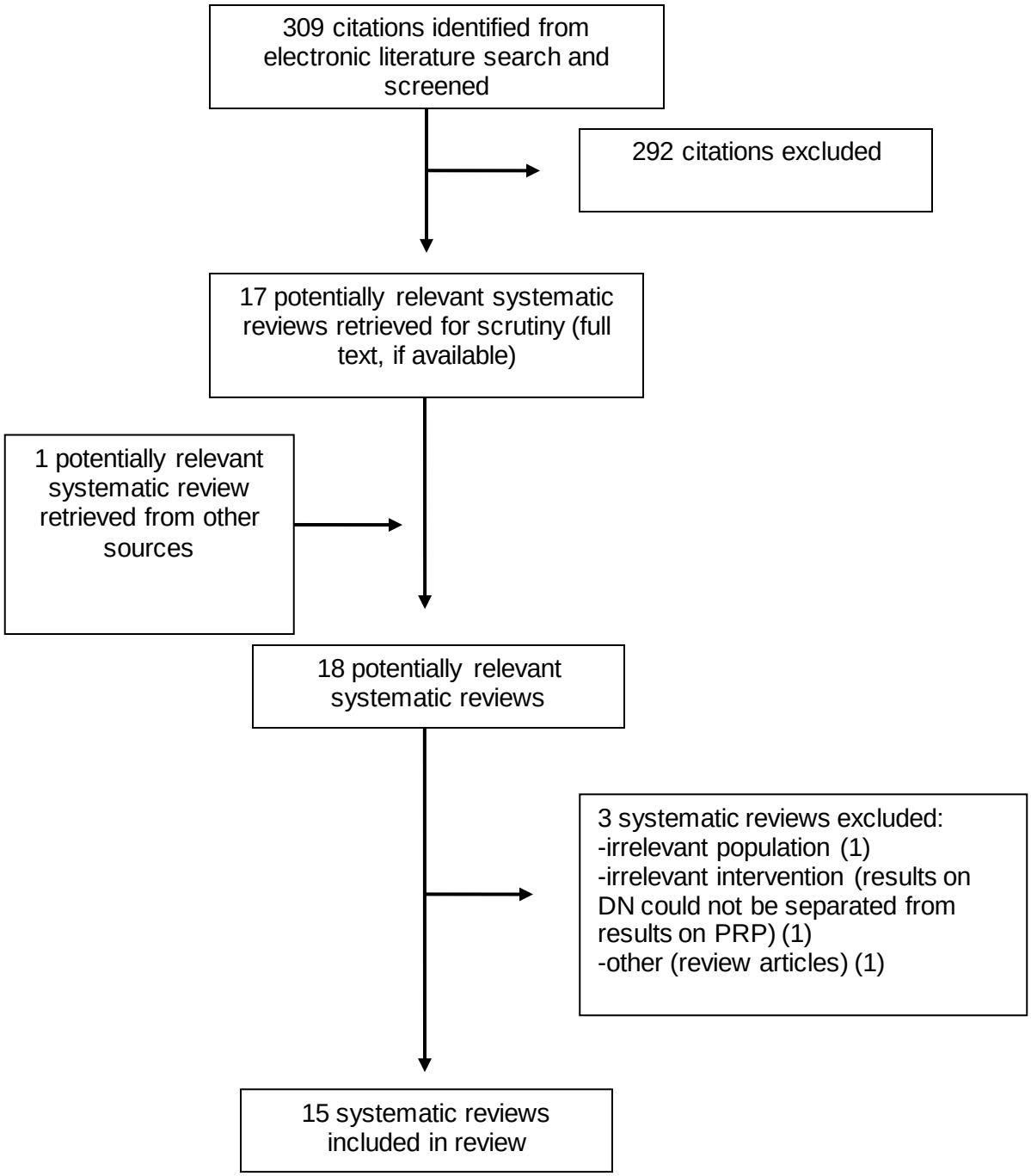
42. McEvoy J, Dommerholt J, Rice D, Holmes L, Grobli C, Fernandez-de-las-Penas C. Guidelines for dry needling practice [Internet]. Dublin (IE): Irish Society of Chartered Physiotherapists; 2012 Aug. [cited 2016 Aug 9]. Available from: http://www.colfisiocv.org/sites/default/files/Guidelines%20for%20Dry%20Needling%20Practice%20ISCP%202012.pdf

43. Dry needling in physical therapy [Internet]. Alexandria (VA): American Physical Therapy Association; 2016 Jul 14. [cited 2016 Aug 17]. Available from: http://www.apta.org/StateIssues/DryNeedling/

44. Painter K. 'Dry needling' for pain therapy is under scrutiny. USA Today [Internet]. 2016 Jul 17 [cited 2016 Aug 9]. Available from: http://www.usatoday.com/story/life/2016/07/17/dry-needling-acupuncture-pain/86940278/

45. ClinicalTrials.gov [Internet]. Bethesda (MD): U.S. National Library of Medicine; 2000 - [cited 2016 Aug 9]. Available from: www.clinicaltrials.gov

APPENDIX 1: Selection of Included Studies



Abbreviations: DN=dry needling; PRP=platelet-rich plasma injection

APPENDIX 2: Characteristics of Included Systematic Reviews

Table A: Characteristics of Included Systematic Reviews and Meta-Analyses

First Author, Publication Year, Country	Types and numbers of primary studies included	Population Characteristics	Intervention	Comparator(s)	Clinical Outcomes, Length of Follow-Up
Fitzpatrick et al.[17] (2016) Australia	- 18 RCTs (4 used DN as control)	- Tendinopathies (shoulder, elbow, knee, Achilles (heel) - Total 1,066 pts (136 in trials involving DN)	- PRP injections (various types)	- DN; eccentric exercise, injections (saline, local anesthetic, corticosteroid), shockwave treatment	- Outcome: pain - VAS & various pain & disability scales used - Follow-up to 6 months in DN studies
Morihisa et al.[8] (2016) USA	6 RCTs (one not relevant on plantar fasciitis (heel pain))	- Various types of lower body pain: upper & lower body, thigh, lower back, knee & heel - Total 301 pts (217 pts not including 84 pts in study of plantar fasciitis)	- Various forms of DN: needling duration, depth, repetition & # of treatments varied; administered with & without local anesthesia	- Sham DN (applying blunted needle to surface of skin), stretching only, no treatment, standard, superficial or deep acupuncture, TENS	- Outcomes: pain, # of follow-up treatments, hamstring tightness, stiffness, ROM, QoL - VAS and various pain & disability scales used Follow-up: short-term follow-up (from 3 days to 6 months)
Louwerens et al.[22] (2016) The Netherlands	22 studies (including 6 on DN (2 RCTs))	- Calcific rotator cuff tendinopathy (shoulder pain) - 1,258 shoulders (485 pts in DN studies)	- High-energy extracorporeal shockwave therapy versus ultrasound-guided needling (using single or double needle, lavage & aspiration used in double needle studies only)	- Arthroscopic surgery	- Outcomes: functioning and size of calcific deposit (measured by radiology) - Follow-up: ranged from 6 months to 10 years in DN studies
Tsikopoulos et al.[23] (2016) Greece	- 5 RCTs included in meta-analysis (2 used dry needling as the comparator)	- Tendinopathies (shoulder, elbow, knee) + diagnosis confirmed by MRI or US - Total of 190 pts	- Platelet-rich plasma injection	- Placebo (saline or corticosteroid injection) or dry needling	- Outcomes: pain,: functional disability - -Follow-up: at 2 or 3, and at 6 months post intervention for pain; follow-up at 3 months for functional disability

Table A: Characteristics of Included Systematic Reviews and Meta-Analyses					
First Author, Publication Year, Country	**Types and numbers of primary studies included**	**Population Characteristics**	**Intervention**	**Comparator(s)**	**Clinical Outcomes, Length of Follow-Up**
		(mostly men), data on 170 pts			
Rodriguez-Mansilla et al.[24] (2016) Spain	- 19 studies (10 included in meta-analysis)	- "Myofascial pain" (headache, neck, shoulder, back, gluteal, various muscles, jaw, elbow) - Total of 852 pts	- DN	- Stretching exercises, ultrasound therapy, injections with analgesics, lidocaine and corticosteroids, no intervention or placebo	- Outcomes: pain, ROM, PPT - Follow-up: ranged from before & after intervention to 8 months
Boyles et al.[12] (2015) USA	- 19 studies included (1 study retracted by publisher)	- multiple body regions (back, hamstring, neck, jaw, heel, shoulder, knee) - total of 1,102 pts (only 1,071 completed studies)	- DN	- Various: acupuncture, sham laser acupuncture, no treatment, placebo DN, lidocaine injection, stretching exercises, percutaneous electrical nerve stimulation; oral flurbiprofen (drug therapy)	- Outcomes: pain & ROM, various other outcomes assessed - Follow-up: ranged from immediate (10-30 min) to 6 months
Matteo et al.[25] (2015) Italy	- 22 studies (3 were RCTs; only 1 study included DN)	- Tendinopathies (knee & Achilles tendon (heel)) - DN was the comparator in 1 study of 23 pts (10 PRP & 13 DN)	- Platelet-rich plasma injections (PRP)	- ESWT, DN (1 study only), no comparator	- Outcomes: only described generally as positive clinical outcome or no difference - Follow-up: ranged from 6 months to 4 years; follow-up in DN study was 6 months
Krey et al.[20] (2015) USA	- 4 RCTs	- Tendinopathies (shoulder, elbow, Achilles tendon (heel)) - Total of 350 pts (complete follow-up on 333 pts)	- "Tendon needling" (DN, with/without exercise therapy)	DN + Autologous blood products (ACP/PRP/autologous blood)	- Outcomes: pain & function - Follow-up: to 6 months

Table A: Characteristics of Included Systematic Reviews and Meta-Analyses					
First Author, Publication Year, Country	**Types and numbers of primary studies included**	**Population Characteristics**	**Intervention**	**Comparator(s)**	**Clinical Outcomes, Length of Follow-Up**
Cagnie et al.[26] (2015) Belgium	- 15 RCTs (8 on DN)	- Neck pain - Total of 185 pts in the DN studies	- Ischemic compression or DN (with/without exercise/stretching	- Lidocaine injection+exercise/stretching; DN+paraspinal needling, non-TP DN; sham acupuncture, superficial DN	- Outcomes: pain, PPT, & ROM - Follow-up: to 12 weeks
Liu et al.[29] (2015) China	- 20 RCTs (not all included in meta-analyses)	- Neck & shoulder pain - Total of 839 pts	- DN	- Lidocaine or other injections; IMS; IMES; sham acupuncture; placebo; laser; sham laser; physiotherapy; sham DN; compression	- Outcome: pain - Follow-up: ranged from immediate to 24 weeks
Louwerens et al.[27] (2014) The Netherlands	- 20 studies (9 RCTs & 1 prospective non-RCT; 2 studies on needling)	- Rotator cuff (shoulder) tendinopathy - Total of 1,544 pts (# of pts for needling not known)	- Minimally invasive therapies: ESWT+ US-guided needling, US-guided needling, SWT, TENS, laser therapy	- Low ESWT, no treatment, steroid injection (in needling studies)	- Outcomes: pain, function, change in size of calcific deposit - Follow-up: short-mid term (minimum 3 months)
Moon et al.[30] (2014) Korea & UK	- 6 RCTs (only 1 study included DN)	- Whiplash-associated disorders (neck) - Total of 348 pts (34 pts in study of DN)	- Acupuncture, electroacupuncture or DN	- Usual care, physiotherapy, exercise & rest, relaxation, sham acupuncture, sham DN+physiotherapy, drug therapy	- Outcomes: pain intensity, QoL, ROM, function - Follow-up: ranged from 1 day to 6 months
Ong et al.[28] (2014) New Zealand & UK	- 5 RCTs	- MTrP (neck & shoulders) - Total of 266 pts	- DN (techniques varied)	- Lidocaine injection (with/without exercises/stretching); placebo laser	- Outcome: pain - Follow-up: ranged from immediately post-treatment to 6 months
Kietrys et al.[21] (2013) USA	- 12 RCTs	- Upper quarter myofascial pain (neck, shoulder, back) - Total of 696 pts	- DN (with/without stretch & exercise)	- Lidocaine injection; stretch & exercise; sham DN; acupuncture; sham acupuncture; sham laser acupuncture ;laser; sham laser; botulinum toxin injection; IMS;	- Outcome: pain - Follow-up: ranged from immediately post-treatment to 6 months

Table A: Characteristics of Included Systematic Reviews and Meta-Analyses					
First Author, Publication Year, Country	**Types and numbers of primary studies included**	**Population Characteristics**	**Intervention**	**Comparator(s)**	**Clinical Outcomes, Length of Follow-Up**
Kim et al.[31] (2012) Korea & UK	- 4 RCTs	- Headache (1 study), shoulder pain, low back pain - Total of 136 pts not including headache study pts	- IMS ("a DN technique"; needling techniques not clearly reported)	- Sham acupuncture; analgesic drug (Meloxicam); IMES, DN	- Outcome: pain - Follow-up: periods not clear (may have been immediately post-treatment)

ACP=autologous conditioned plasma; DN=dry needling; ESWT=extracorporeal shockwave therapy; IMES=intramuscular electrical stimulation; IMS=intramuscular stimulation; MCID=minimum clinically important difference; min=minutes; MRI=magnetic resonance imaging; MTrP=myofascial trigger point; PPT=pressure pain threshold; PRP=platelet-rich plasma injections; pts = patients; QoL = quality of life; RCTs = randomized controlled trials; ROM = range of movement; SWT=shockwave therapy; TENS = transcutaneous electric nerve stimulation; TP = trigger point; UK=United Kingdom; US=ultrasound; USA=United States of America; VAS = Visual Analog Scale

APPENDIX 3: Critical Appraisal of Included Publications

Table B: Strengths and Limitations of Systematic Reviews and Meta-Analyses [19]

Strengths	Limitations
Fitzpatrick (2016)[17]	
• Comprehensive literature search (5 year limit) • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed by 2 reviewers • Risk of bias assessed (Cochrane RoB tool) • Appropriate statistical methods used to combine study findings in network meta-analysis	• Unclear if grey literature included • English language studies only
Morihisa (2016)[8]	
• Comprehensive literature search • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed (PEDro scale)	• Grey literature not included • English language only • Risk of bias only assessed for one study
Louwerens (2016)[22]	
• Comprehensive literature search • Multiple languages included • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed (Coleman Methodology Score)	• Unclear if grey literature searched • Unclear if risk of publication bias assessed
Tsikopoulos (2016)[23]	
• Comprehensive literature search • Grey literature included • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Risk of bias assessed (Cochrane RoB tool) • Appropriate statistical methods used to combine study findings in meta-analysis	• Unclear if literature search limited to English language only
Rodriguez-Mansilla (2016)[24]	
• Comprehensive literature search • Duplicate study selection & data extraction • Grey literature included • Summary of study characteristics & list of included studies provided • Study quality assessed (PEDro scale) • Risk of bias assessed • Appropriate statistical methods used to combine study findings in meta-analysis	• None noted
Boyles (2015)[12]	
• Summary of study characteristics & list of included studies provided • Study quality assessed (PEDro scale)	• Unusual search strategy & limited date range (4 years) • Unclear if duplicate study selection and data extraction occurred

Table B: Strengths and Limitations of Systematic Reviews and Meta-Analyses [19]	
Strengths	**Limitations**
	• Unclear if risk of publication bias assessed
Di Matteo (2015)[25]	
• Duplicate study selection • Summary of study characteristics & list of included studies provided	• Limited literature search (1 database only) • Study quality not assessed; only a few included studies were RCTs • Risk of publication bias not assessed
Krey (2015)[20]	
• Comprehensive literature search • Grey literature included • Duplicate study selection & data abstraction • Summary of study characteristics & list of included studies provided	• English language only • Study quality assessed but not clear what criteria were used • Risk of publication bias not assessed
Cagnie (2015)[26]	
• Comprehensive literature search (2 databases but included handsearching) • Duplicate study selection & data abstraction • Summary of study characteristics & list of included studies provided • Study quality assessed (Dutch Cochrane Centre & Dutch Institute for Healthcare Improvement checklists) • Risk of bias assessed	• Unclear if grey literature included & date range of search unclear
Liu (2015)[29]	
• Comprehensive literature search • Grey literature included • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed (PEDro scale) • Risk of publication bias assessed • Appropriate statistical methods used to combine study findings in meta-analysis	• None noted
Louwerens (2014)[27]	
• Comprehensive literature search • Grey literature included • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided (in supplement) • Study quality assessed (Cochrane RoB tool, GRADE level of evidence) • Risk of publication bias assessed	• None noted
Moon (2014)[30]	
• Comprehensive literature search • Search included non-English language publications • Grey literature included • Duplicate study selection • Risk of bias assessed (Cochrane RoB tool) • Summary of study characteristics & list of	• None noted

Table B: Strengths and Limitations of Systematic Reviews and Meta-Analyses [19]	
Strengths	**Limitations**
included studies provided	
Ong (2014)[28]	
• Comprehensive literature search • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed (PEDro scale) • Risk of publication bias assessed (Cochrane RoB tool) • Appropriate statistical methods used to combine study findings in meta-analysis	• English language only • Grey literature not searched
Kietrys (2013)[21]	
• Study quality assessed & all studies assessed by at least 3 researchers (MacDermid Quality Checklist) • Risk of publication bias assessed (funnel plots) • Summary of study characteristics & list of included studies provided	• Limited search strategy (only one search term used) • Grey literature not searched • Two authors extracted data, but unclear if duplicate study selection & data extraction occurred
Kim (2012)[31]	
• Comprehensive literature search (including non-English language & grey literature sources) • Duplicate study selection & data extraction • Summary of study characteristics & list of included studies provided • Study quality assessed (Cochrane RoB tool) • Risk of publication bias assessed	• None noted

Abbreviations: RCTs=randomized controlled trials; RoB=risk of bias

APPENDIX 4: Main Study Findings and Author's Conclusions

Table C: Summary of Findings of Included Studies

Main Study Findings	Author's Conclusions
Fitzpatrick (2016)[17]	
18 RCTs of various types of platelet-rich plasma (PRP) injection for tendinopathies, including 4 that used DN as a control. This network meta-analysis found that injections (corticosteroid, local anesthetic, or saline) or DN for tendinopathies had similar, non-significant effects on pain (& therefore could appropriately be used as controls). For the control interventions, the meta-analyses reported the standardized mean difference (SMD) in pain from baseline for each: • DN SMD 25.22 (95% CI, 21.27-29.16) • saline injection SMD 14.62 (95% CI, 10.74-18.50) • local anesthetic injection SMD 15.00 (95% CI, 7.66-22.34) • corticosteroid injection SMD 23.82 (95% CI, 10.74-18.50)	• "In assessing the control groups, there was no clear difference between different types of control injections: saline... local anesthetic… corticosteroid… or dry needling…"[17] page 1
Morihisa (2016)[8]	
This systematic review included 6 RCTs on knee, thigh, low back, & plantar fasciitis (heel pain). 4 of the studies were considered high quality & 2 were fair quality. The individual studies reported statistically significant short-term improvement in pain with dry needling, but this improvement was not shown at longer follow-up. None of the studies reported statistically significant improvements in other aspects, including range of motion & functioning.	• "A review of current literature suggests that dry needling is effective in reducing pain associated with lower quarter trigger points in the short-term. However, the findings suggest that dry needling does not have a positive effect on function, quality of life, depression, range of motion, or strength. Further high quality research with long-term follow-up investigating the effect of dry needling in comparison to and in conjunction with other interventions is needed to determine the optimal use of dry needling in treating patients with lower quarter trigger points."[8] page 1
Louwerens (2016)[22]	
22 studies (11 RCTs, remainder were prospective & retrospective cohort studies, and one prospective non-RCT). Most studies involved high-energy extracorporeal shockwave therapy or arthroscopic surgery, but 6 (2 RCTs) involved ultrasound-guided needling, for rotator cuff tendinopathy. (Ultrasound used to visualize calcific deposits to puncture them.)Needling techniques differed between studies, some included aspiration & lavage, and all included corticosteroid injection post-needling with patients under local anesthesia. Based on 4 studies with 1 year follow-up, functional outcomes were improved. Costs (not reported) were said to be similar to that of extracorporeal shockwave therapy. Minor side effects reported,	• "Patients can achieve good to excellent clinical outcomes after high-energy ESWT, US-guided needling, and arthroscopy for calcific tendinopathy of the shoulder. Side effects and post-treatment complications should be taken into account when a decision is being made for each individual patient. Physicians should consider high-energy ESWT and US-guided needling as minimally invasive treatment options when primary conservative treatment fails. Arthroscopy can safely be used as a very effective but more invasive secondary option, although the extent of deposit removal and the additional benefit of subacromial decompression remain unclear."[22] page 165

Table C: Summary of Findings of Included Studies	
Main Study Findings	**Author's Conclusions**
mainly pain during & after treatment. Authors note clinical results may also be affected by natural course of healing.	
Tsikopoulos (2016)[23]	
5 RCTs were included in this meta-analysis which assessed platelet-rich plasma (PRP) injections for pain & function in patients with tendinopathies (shoulder, elbow, knee). Dry needling was used as the control group in 2 trials (others used saline or corticosteroid injections as the control). Although there was a statistically significant difference favouring PRP at the 2-3 month follow-up point, at 6-month follow-up, PRP injections did not show a significant clinical benefit in comparison to needling or injections, except a small clinical benefit in patients with rotator cuff tendinopathy. In PRP for pain relief, at 6 months the SMD was -0.48 (95%CI -0.86 to -0.10), in comparison to SMD -0.82 (CI 95%, -1.57 to -0.07) in the one DN study with 6-month outcomes.	• "…PRP injections did not provide significantly greater clinical relief compared to placebo or dry needling for the treatment of tendinopathy at a six-month follow-up. However, there was a marginal clinical advantage in patients who suffered from rotator cuff tendinopathy. The latter marginal clinical superiority should be further investigated in large-scale RCTs…"[23] page 93
Rodriguez-Mansilla (2016)[24]	
19 RCTs (10 included in the meta-analysis) assessed effectiveness of dry needling on reducing pain in patients with myofascial pain syndrome (jaw, neck, shoulder, back, elbow, gluteal, other muscles, headache pain). Dry needling resulted in some improvement in pain compared to placebo, but other treatments (laser, injections, stretching exercises, ultrasound) were more effective than dry needling for pain & range of movement. For pain reduction measured immediately before & after the intervention, DN was not statistically different from placebo: SMD -0.49 (95% CI, -3.21, 0.42), & superior to control: SMD -9.13 (95% CI, -14.70, -3.56). But, other treatments were more effective at reducing pain immediately after: SMD 2.54 (95% CI, -0.40, 5.48), and at 3-4 weeks post-treatment: SMD 4.23 (95% CI, 0.78, 7.68). Similarly, DN significantly increased range of movement (ROM) immediately after the intervention compared to placebo: SMD 2.00 (95% CI, 1.0, 2.41), but other treatments achieved better results: SMD -1.42 (95% CI, -1.84, -0,99).	• "…Despite clinical practice showing that DN is increasingly used nowadays and that this technique is being applied with positive effects in rehabilitation medicine, especially for the management of MPS, we can observe that the scientific evidence observed in the studies analysed do not have consistent results regarding its effectiveness. In some papers, no significant differences were seen in the improvement of MPS between the groups when DN was compared with a control group or a stimulated DN group. The comparison of DN with other experimental groups showed that the subjects treated with the alternative technique achieved better results than those treated with DN…. Further randomized controlled trials are needed in order to determine the effectiveness of this technique in the management of MPS and consequently, recommend or not its use in physical therapy…."[24] page 11
Boyles (2015)[12]	
19 RCTs (one since retracted) were included to assess the effectiveness of trigger point dry needling in various conditions. Authors considered included studies to be high quality &	• "The majority of the highest-quality studies of TDN [trigger point dry needling] in the literature to date seem to indicate that TDN is effective for reducing pain and tenderness in multiple body

Table C: Summary of Findings of Included Studies	
Main Study Findings	**Author's Conclusions**
support the use of dry needling, however the heterogeneity of studies did not allow a meta-analysis. A commentary on this review noted several issues, most importantly: "… only 47% of the included trials showed a statistically significant decrease in pain when compared to sham or alternative treatments, only 26% displayed a statistically significant decrease in disability and 42% did not include a sham or control intervention group…." (page 2).[11] Moreover, almost a third of the trials only assessed immediate treatment effects (up to 72 hours after needling).[11]	regions, including the head, trunk, upper extremity and lower extremity. Lack of consistency among the articles in this review in regards to patient recruitment, protocol, methodology and outcome measures precludes the formation of any strong conclusions from the available data. Nevertheless, an emerging body of evidence exists to suggest that multiple body regions may benefit from TDN for pain reduction, improved function and improved ROM. More high-quality studies and replication of current studies are needed to further substantiate this trend…"[12] page 292
Di Matteo (2015)[25]	
22 studies (3 RCTs) on platelet-rich plasma injections for knee and Achilles heel tendinopathies were included in this systematic review. One small (23 pts) RCT (knee) used DN as the comparator, and found a benefit with the use of PRP at 3 months, but similar results between the two treatments at 6 months.	• "The main finding of this study was the paucity of high-level literature regarding the application of PRP in the management of patellar and Achilles tendinopathy… "[25] page 1 • Re the small, single study (RCT) that compared PRP to dry needling for patellar tendinopathy (knee pain): "PRP administration contributed to accelerating recovery time at 3 months… even if at 6 months, results were comparable between groups…"[25] page 4
Krey (2015)[20]	
4 RCTs were used to assess dry needling (DN) (with/without autologous blood or platelet-rich plasma injection (PRP)) for tendinopathies (shoulder, elbow, heel). Needling techniques differed and some trials did not use ultrasound guidance. Two trials found no difference between groups - needling with and without autologous blood injections - at 6 months. Based on two trials authors found benefit ("a trend toward improvement") with PRP in addition to needling over needling alone at 6 months.	• "…Based on the results of our systematic review, there is benefit from tendon needling for tendinosis in regard to patient-reported outcomes. Despite these results, more high-quality evidence is needed to further evaluate the benefit of tendon needling for tendinopathy. Randomized controlled trials focusing on the timing of the intervention, ultrasound guidance, the needling technique, and how often to intervene would be beneficial. … the studies in this review demonstrated a trend toward improvement with the addition of blood products. Differences in regard to the blood products used, subjective assessments, and tendons that were studied make it hard to conclude which technique is superior. It is also not known if needling enhances the use of the injected blood products."[20] page 86
Cagnie (2015)[26]	
15 RCTs (8 on dry needling) were included in this assessment of ischemic compression and DN in reducing pain and range of movement (ROM) for patients with neck pain. Different needling techniques were used in the studies and the optimal method is unclear. Evidence was rated as moderate to strong that both ischemic compression and DN can	• "… there is strong evidence that DN has a positive effect on pain reduction. This decrease is greater compared with active ROM exercises as well as no or placebo intervention, but it is similar to other therapeutic approaches. There is moderate evidence that both IC and DN increase side-bending ROM, with similar effects compared with lidocaine injection. There is weak evidence

Table C: Summary of Findings of Included Studies	
Main Study Findings	**Author's Conclusions**
decrease neck pain caused by trigger points in the upper trapezius muscle. 6 studies measured effect of DN on ROM. Most of these studies compared needling to lidocaine injection and found ROM improvements were similar for both interventions. Two studies (by same author) found that lidocaine injection and DN with paraspinal needling resulted in better ROM compared to needling only, but 2 other studies found no difference between groups.	regarding its effects on functionality and quality-of-life. Additional research with high-quality study design and appropriate comparative treatments are needed to develop more conclusive evidence."[26] pages 581-582
Liu (2015)[29]	
20 RCTs were included in this systematic review and meta-analysis of the effectiveness of DN on neck and shoulder pain. The meta-analysis found DN (compared to control or sham treatment) was effective in relieving pain in the short term (immediate to 3 days), SMD -1.91 (95% CI, -3.10 to -.73, P=.002) and medium term (9 to 28 days), SMD -1.07 (5% CI, -1.87 to -.27, P=.009). However, wet needling (injection of lidocaine) was more effective than DN for pain relief in the medium term, SMD 1.69 (95% CI, 0.40 to 2.98, P=.01). Other therapies, including physiotherapy, were also more effective in relieving pain than DN in the medium term, SMD 0.62 (95% CI, 0.02 to 1.21, P=0.04). All SMDs for DN were lower than the reported 1.3cm/1.4cm MCID.	• "… dry needling can be cautiously recommended for relieving MTrP pain in neck and shoulders in the short and medium term than control/sham, but wet needling is found to be more effective than dry needling in relieving MTrP pain in neck and shoulders in the medium term. On the basis of the results of 6 individual RCTs included in the meta-analysis of 7 studies, other treatments can be cautiously recommended for relieving MTrP pain in neck and shoulders in the medium term than dry needling. However, scientific evidence proving the effectiveness of dry needling for MTrPs associated with neck and shoulder pain compared with wet needling and other treatments in the short and long term is insufficient…"[29] page 954
Louwerens (2014)[27]	
This systematic review and meta-analysis included 20 studies for rotator cuff (shoulder) injury. Most of the RCTs were on extracorporeal shock wave treatment (ESWT), 2 RCTs included ultrasound-guided needling. Meta-analysis was conducted, where possible, given heterogeneity of studies. Based on one small moderate level of evidence study, corticosteroid injection was more effective (but not statistically significantly different) in improving function at 6 months than ultrasound-guided needling (mean difference 6.42 (95% CI, -2.56 to 15.40, P=0.16). Based on one other low quality study of needling versus no treatment for pain relief at 3 months, the mean difference was -4.0 (95% CI, -4.5 to -3.5, P <0.0001).	• "Ultrasound-guided needling is safe but has not been proven to be more effective than an ultrasound-guided subacromial corticosteroid injection in recent level I research, and further research will have to prove its effectiveness."[27] page 1240 • "Furthermore, there is no evidence about what the best US-guided needling technique is, because single-needling and double-needling techniques are both used in modern practice."[27] pages 1247-1248
Moon (2014)[30]	
6 RCTs of acupuncture, electroacupuncture or DN for the treatment of whiplash associated disorder (WAD) were included in this systematic review. Meta-analysis of the studies was not feasible. The evidence is limited and most RCTs	• Re the feasibility study (RCT) that compared DN+physiotherapy to sham DN+physiotherapy in 34 women with grade II whiplash associated disorder: "… After six weeks, the authors reported no between group differences … and

Table C: Summary of Findings of Included Studies	
Main Study Findings	**Author's Conclusions**
had methodological flaws. One RCT found DN+physio was no different than sham needling+physio for pain reduction. None of the RCTs found any of the interventions (including DN) to be more effective than the various control interventions for reducing disability/function.	concluded that a large RCT is both feasible and clinically relevant."[30] page 3 • Overall conclusions: "The evidence for the effectiveness of AT/EA/DN for the treatment of WAD is limited. Therefore, more research in this area is warranted.[30] page 1
Ong (2014)[28]	
Five small RCTs (4 rated high quality, 1 rated low quality) were included in this systematic review and meta-analysis on neck and shoulder pain. Where possible, outcomes at different times were assessed (immediately after treatment, and at 1, and 3 to 6 months). The meta-analysis of DN compared to lidocaine injection for pain relief (based on 4 studies) found no significant differences immediately after treatment: SMD 0.41 (95% CI, -0.15 to 0.97), at one month: SMD -1.46 (95% CI, -2.04 to 4.96), and at 3 to 6 months: SMD -0.28 (95% CI, -0.63 to 0.07).	• "The main conclusion of this systematic review with meta-analysis is there is no significant difference between dry needling and lidocaine in the management of MTrPs in the neck and shoulder region. However, it should be acknowledged that these analyses are based on a relatively small number of participants… Further conclusions of this review is that there is limited evidence of no significant difference between dry needling and placebo for pain intensity and activity outcomes immediately after treatment and at 6 month follow-up. There is also limited evidence of no significant difference between dry needling and lidocaine on activity levels immediately after treatment and at 1 month. As dry needling is as effective as lidocaine injection, dry needling may be more favorable and more feasible in the physiotherapy clinical setting due to it being minimally invasive, lower cost, and has less adverse effects than a local anesthetic injection…"[28] page 397
Kietrys (2013)[21]	
12 RCTs were used to assess the effectiveness of DN on various types of upper body myofascial pain. The Interventions and study populations were heterogeneous. A subset of trials was suitable for inclusion in the meta-analyses. Despite the results of the statistical analyses, the authors feel there is good quality evidence (based on 4 studies) that dry needling is more effective than sham or placebo treatment in reducing pain immediately after treatment compared to sham or placebo: SMD 1.06 (95% CI, 0.05, 2.06), but the difference was not statistically significant at 4 weeks (based on 3 studies): SMD 1.07 (95% CI, -0.21, 2.35). In comparing DN to other treatments for immediate pain relief, results of the meta-analysis of 2 studies favoured lidocaine injection or non-localized acupuncture over DN: SMD -0.64 (95% CI, -1.21, -0.06). Comparing DN to other treatments at 4 weeks, meta-analysis of 6 studies also favoured other treatments over DN, but the differences were not	• "… More evidence is needed to establish efficacy of dry needling compared to other interventions for upper-quarter MPS. However, it appears that injection with lidocaine may be superior to dry needling for pain reduction both immediately after treatment and at 4 weeks."[21] page 633

Table C: Summary of Findings of Included Studies	
Main Study Findings	**Author's Conclusions**
statistically significant: SMD -0.07 (95% CI, -1.39, 1.26).	
Kim (2012)[31]	
Four RCTs were included in this systematic review of intramuscular stimulation therapy (IMS) for various types of pain (headache, shoulder, upper body, lower back). Individual studies had positive results for IMS but were subject to high risk of bias. One study found no significant difference between IMS and meloxicam drug therapy for chronic shoulder pain. IMS was superior to DN for shoulder pain in one study. IMS+standard treatment was superior to standard treatment alone in patients with low back pain.	• "… the results of this systematic review do not provide conclusive evidence in support of IMS for several conditions. Although the trial data are positive …. Too many important caveats – including small sample size and only one RCT for each condition – exist to draw firm conclusions."[31] page 290

Abbreviations: AT=acupuncture; CI=confidence interval; EA=electroacpuncture; DN=dry needling; ESWT=extracorporeal shockwave therapy; IC=ischemic compression; MCID=minimum clinically important difference; MPS=myofascial pain; MTrP=myofascial trigger point; platelet-rich plasma injection; RCT=randomized controlled trial; SMD=standardized mean difference; TDN=trigger point dry needling; US=ultrasound; WAD=whiplash associated disorder