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published in

Musculoskeletal Science and Practice
2018

DOI (link to publisher)

[10.1016/j.msksp.2018.06.001](https://doi.org/10.1016/j.msksp.2018.06.001)

document version

Publisher's PDF, also known as Version of record

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citation for published version (APA)

Maissan, F., Pool, J., Stutterheim, E., Wittink, H., & Ostelo, R. (2018). Clinical reasoning in unimodal interventions in patients with non-specific neck pain in daily physiotherapy practice, a Delphi study. *Musculoskeletal Science and Practice*, 37, 8-16. <https://doi.org/10.1016/j.msksp.2018.06.001>

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Original article

Clinical reasoning in unimodal interventions in patients with non-specific neck pain in daily physiotherapy practice, a Delphi study

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ARTICLE INFO

Keywords:

Non-specific neck pain

Physiotherapy

Evidence based medicine

Delphi study

ABSTRACT

Background: Neck pain is the fourth major cause of disability worldwide but sufficient evidence regarding treatment is not available. This study is a first exploratory attempt to gain insight into and consensus on the clinical reasoning of experts in patients with non-specific neck pain.

Objective: First, we aimed to inventory expert opinions regarding the indication for physiotherapy when, other than neck pain, no positive signs and symptoms and no positive diagnostic tests are present. Secondly, we aimed to determine which measurement instruments are being used and when they are used to support and objectify the clinical reasoning process. Finally, we wanted to establish consensus among experts regarding the use of unimodal interventions in patients with non-specific neck pain, i.e. their sequential linear clinical reasoning.

Study design: A Delphi study.

Methods: A Web-based Delphi study was conducted. Fifteen experts (teachers and researchers) participated.

Results: Pain alone was deemed not be an indication for physiotherapy treatment. PROMs are mainly used for evaluative purposes and physical tests for diagnostic and evaluative purposes. Eighteen different variants of sequential linear clinical reasoning were investigated within our Delphi study. Only 6 out of 18 variants of sequential linear clinical reasoning reached more than 50% consensus.

Conclusion: Pain alone is not an indication for physiotherapy. Insight has been obtained into which measurement instruments are used and when they are used. Consensus about sequential linear lines of clinical reasoning was poor.

1. Introduction

Neck pain is the fourth major cause of disability worldwide (Vos et al., 2012). The prevalence for neck pain in the world was 4.9% in 2010. The total disability burden from musculoskeletal disorders (MSK) measured as Years Lived with Disability (YLDs), was 21.3% of which 20.1% as a result of neck pain (March et al., 2014). Moreover, from 1990 to 2010, the disability burden attributable to MSK disorders increased by 46%. It is further expected that this burden will increase in the coming years (March et al., 2014). Therefore, effective treatment methods are necessary. There is no conclusive evidence regarding specific pathology in the majority of cases of acute or chronic neck pain, therefore, most cases are labeled as nonspecific neck pain or neck pain of unknown origin, without further subdivision into subgroups (Bogduk N, 2000).

The most frequently used interventions for the treatment of neck

pain are exercises, manipulative therapies, mobilization, massage, and multidisciplinary biopsychosocial rehabilitation (Pool et al., 2010). The evidence regarding the effectiveness of physiotherapy for neck pain is emerging (Bertozzi et al., 2013; Cheng and Huang, 2014; Gross et al., 2015; Monticone et al., 2015). However, sufficient evidence for application of a specific physiotherapy modality or therapy aiming at a specific patient subgroup is not available (Damgaard et al., 2013). The main recommendation in a review of physiotherapy interventions for patients with chronic neck pain was to identify relevant subgroups with matching treatments among patients with non-specific neck pain (Damgaard et al., 2013).

This matches the need in clinical practice for forms of “targeted treatment”, or personalized treatment (Godman et al., 2013). Personalized treatment is tailoring therapy to specific subgroups in order to optimize effectiveness (Bates, 2010). There are indications in patients with non-specific lower back pain that subgrouping is effective and cost

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effective (Hill et al., 2011). There is a need to do the same for patients with non-specific neck pain.

In clinical practice, physiotherapists first determine if physiotherapy is indicated for a patient. If so, they then, as a part of the clinical reasoning process, subgroup their patients aiming to match their treatment to the signs and symptoms and results of the diagnostic tests. Another important part of the clinical reasoning process is the use of measurement instruments. Measurement instruments, such as Patient Reported Outcome Measures (PROMs) and physical tests are used to support and objectify the clinical reasoning process. Which measurement instruments are most appropriate when they are used and how they support the clinical reasoning process in patients with non-specific neck pain is unclear.

The Hypothesis-Oriented Algorithm for Clinicians II (HOAC II) (Rothstein et al., 2003) provides an algorithm to describe the clinical reasoning process, and it combines the diagnostic process (the ‘why’) with the therapeutic process (the ‘what’). This helps the physical therapist to decide “why” to do “what” as the “why” describes the specific diagnosed group within a population of patients with non-specific neck pain and the “what” describes the matched treatment. In addition, the HOAC II recommends matching outcome measures to the goals of treatment in order to evaluate the effectiveness of treatment. This way this linear clinical reasoning process consists of three sequential phases: the diagnostic, the therapeutic and, the evaluative phase. Following the HOAC II, sequential linear clinical reasoning in the present study is defined as the transition from signs and symptoms to diagnostic tests, from diagnostic tests to an intervention with matching treatment goal and evaluation based on outcome measurements related to the matched goals.

A recent review of the literature on the clinical reasoning process in research on patients with non-specific neck pain showed a lack of a complete clinical reasoning process with matching outcome measures. Only 11 (9%) out of 122 randomized controlled trials (RCT) described a complete clinical reasoning process whereby the diagnostic process (“the why”), i.e. other signs or symptoms or diagnostic tests in their inclusion criteria, could be linked to the therapeutic process (“the what”) (Maissan et al., 2018). A remarkable outcome was that 46% of the 122 included RCTs described no impairment or activity limitation at all, with inclusion criteria limited to age and (duration of) pain. It can be questioned whether subjects having pain without any other signs/symptoms or positive diagnostic tests have an indication for physiotherapy treatment.

In conclusion, there is insufficient scientific evidence to form subgroups with matching, uni- or multimodal, interventions within patients with non-specific neck pain. Campbell et al. (Campbell et al., 2000) indicated that we first must understand working mechanisms of unimodal interventions before combining them into multimodal interventions. Therefore, it is sensible to first reach consensus on the various aspects of the clinical reasoning process when using unimodal interventions in patients with non-specific neck pain.

In this study we aimed to 1. describe expert opinion on the indication for physiotherapy when a patient's only problem is pain without other signs or symptoms or positive diagnostic tests 2. explore which measurement instruments are being used by experts to support their clinical reasoning process; when they are being used and for which purpose, 3. to establish consensus regarding the use of unimodal interventions, i.e. sequential linear clinical reasoning.

2. Methods

A Web-based Delphi study was conducted. The first round included questions to achieve the first two goals. In the second and third round an attempt was made to reach consensus regarding the use of unimodal interventions (to achieve the third goal).

To get expert opinion on the indication for physiotherapy when patients' only problem is pain without other signs or symptoms or

positive diagnostic tests, we asked: “Suppose you have a patient with non-specific neck pain. Other than pain, there are no other signs or symptoms and no positive diagnostic test(s). There are no contra-indications for physiotherapy. Do you think there is an indication for physiotherapy?” Secondly, we wanted information on the type of measurement instruments being used for diagnostic and/or evaluative purposes. For this purpose, we offered a list with the most frequently used measurement instruments in patients with non-specific neck pain selected from the 122 RCTs included in the review of Maissan et al. (2018) We asked the experts which measurement instruments they use and whether they use additional measurement instruments. We also gathered information about the timing of the evaluative tests; i.e. only by start and finish of the treatment or also during the treatment. We made a distinction between patients with acute/sub-acute and chronic neck pain. In this way, we assessed whether the duration of the presence of pain influences the timing of measurements. Regarding the diagnostic process we assessed the extent to which physical impairments were pragmatically diagnosed (i.e. a test developed in their own practice without evidence of the psychometric properties) or with valid tests (with known psychometric properties). If a valid test was used, we asked them to specify the test.

The Delphi method is appropriate to reach consensus in a field where a lack of agreement or incomplete knowledge is evident (Giannarou and Zervas, 2014). The Delphi technique is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain areas of interest (Hsu and Sandford, 2007). Therefore, the Delphi method creates the opportunity to gather information from a group of international experts in treating patients with non-specific neck pain, without the need of a meeting (Murphy et al., 1998). In this method, experts independently and anonymously answer a range of questions. During several rounds these experts get insight into group opinions and have the possibility to reconsider their own opinion as the results of the earlier rounds are returned until they achieve consensus (Hasson et al., 2000). The Delphi study consisted of three rounds as described by Hsu et al. (Hsu and Sandford, 2007).

For the Delphi study “Formdesk” software was used and invitations to participate were sent by email.

3. Preparation phase

For this exploratory Delphi study a convenience sample of twenty-four experts from the expert network of the second author were invited to participate. The expert group consisted of teachers and researchers in the field of Orthopedic Manipulative Therapy (Table 1) and, were all experts in treatment of patients with non-specific neck pain. Most experts were members of the standard committee of wherein the second author (JP) also participated. Table 1 shows their current main job and other characteristics. Although it was not part of the inclusion, all participants also met the four criteria set by Jensen et al. for being an expert in physiotherapy. These criteria are: knowledge, clinical reasoning skills, examination and evaluation skills of movement and

Table 1
Participant characteristics (n = 15).

Gender	9 female
Age; mean (range)	49.9 (39–65)
Nationality	Canada 3, Australia 3, New Zealand 2, USA 1, the Netherlands 1, Belgium 1, Portugal 1, South Africa 1, Denmark 1, Spain 1
Highest level of education	Phd 10, Msc 5
Current main job functions	Private practice 6, education 10, research 11, consultant 1
Years of experience in physiotherapy practice; mean (range)	20.3 (6–40)
Present-day work time as a physical therapist in ours a week; mean (range)	9.9 (1–35)

Table 2
Use of patient reported outcome measures (n = 15).

Patient Reported Outcome Measure	Total use (n)	Diagnostic use (n)	Evaluative use (n)	Acute-sub acute neck pain		Chronic neck pain	
				finish (n) treatment (n)	Start and Regular during	Start and Regular during	finish (n) treatment (n)
Visual analogue pain scale	8	6	7	7	5	6	6
Numeric pain rating scale	10	5	9	9	8	9	3
Neck disability index	14	5	13	13	13	14	3
Short form 12	4	0	3	3	0	3	0
Short form 36	4	0	4	4	0	4	0
Patient perceived effect	2	1	3	1	1	2	3
Patient specific function scale	6	1	6	6	3	6	0
Neck pain and disability scale	1	0	1	1	0	1	0
Tampa scale of Kinesiophobia	6	4	4	4	0	4	0
Fear avoidance beliefs questionnaire	6	3	5	5	1	5	1
Borg scale	3	0	3	6	2	7	1
McGill pain questionnaire	7	2	5	8	4	9	4
Headache disability index	7	0	7	9	4	8	4
Impact of event scale (IES)	6	2	4	6	0	6	0
Pain catastrophizing scale (PCS)	11	2	9	9	0	9	1
Dizziness handicap inventory (DHI)	7	0	7	6	4	6	4
Illness perception questionnaire (IPQ)	8	2	6	7	0	7	1
Pain self-efficacy questionnaire (PSEQ)	9	3	6	10	0	10	1
Whiplash disability questionnaire (WDQ)	5	0	5	6	2	6	2
Leeds Assessment of Neuropathic Symptoms and Signs pain scale (SLANSS)	5	4	5	5	2	5	5

virtues(Jensen et al., 2000). We chose experts because we assumed that they were most likely to reach consensus based on their knowledge from scientific research and the ability to translate this knowledge into practice.

By completing the questionnaire of round 1, the participants confirmed their participation in this study.

4. Procedure

The workgroup of this Delphi study consisted of the first two authors (FM, JP) who designed the three rounds and summarized the returned data. We considered more than 50% consensus in responses as the consensus cut-off point(Giannarou and Zervas, 2014).

4.1. First round Delphi

The first round addressed a linear clinical reasoning in physiotherapy based on the HOAC II. It consisted of open-ended questions starting with questions about the use of measurement instruments. As a starting point, the most frequently used measurement instruments in patients with non-specific neck pain were presented to the experts. We asked the experts for which signs and/or symptoms they would use a specific diagnostic test to determine the hypothesized cause of the patient experienced problem. Then we asked about the relationship between the diagnostic test (cause) and a chosen intervention. In other words, which diagnostic tests lead to which specific intervention. Finally, we wanted to determine which outcome measures the experts use to evaluate the effect of a specific intervention. In this way, we aimed to get an overview of the match between history taking (signs and symptoms), physical examination (diagnostic test), intervention, and the use of evaluative outcome measures. According to HOAC II this sequence describes the entire linear clinical reasoning process of the physical therapist(Rothstein et al., 2003). In addition to the clinical reasoning process, we inventoried which interventions the experts use regularly. Interventions used by 3 or less experts were not considered “regular treatment” in patients with non-specific neck pain.

4.2. Second round Delphi

In the second round each expert was asked to review and reflect on the items summarized by the investigators based on the information provided in round one(Hsu and Sandford, 2007). The experts were asked to rate the importance of the signs and symptoms in relation to the given diagnostic test, to rate the importance of the diagnostic test in relation to the given intervention and finally, rate the importance of the outcome measurement instruments in relation to the given intervention. The rating scale ranged from 1 (very important) to 5 (not important). This way preliminary priorities among items were established. In the second round the experts were also asked which physical or mental function or activity of the patient they wanted to improve (goal of the intervention) in relation to the chosen interventions.

4.3. Third round Delphi

The third round consisted of the summarized items and ratings of the importance of the previous round. In this final round, the complete sequence of a linear clinical reasoning process was presented in a table for each intervention. Each line in Table 5 represents such a sequence. For each included diagnostic test a different sequence of linear clinical reasoning was added to the questionnaire. The reason for this approach was that multiple diagnostic tests could lead to the same intervention, however, with possible different goals and evaluative measurement instruments. The signs and symptoms with more than 50% consensus on the score “very important” or “important” were combined because multiple signs and symptoms could lead to one diagnostic test. When there was no consensus after round two on “signs and symptoms” and “direct goal of intervention” and “evaluation test”, summarized results of round two were offered as final choice options in round three per sequence of linear clinical reasoning.

5. Results

Round 1 of the Delphi study began with 15 participants. There were 4 drop outs in round 2. The drop outs in round 2 were due to technical problems logging in the system. Data of these four experts were only

Table 3

Use of measurement instruments to measure physical constructs (n = 15).

Constructs	Total use (n)	Diagnostic use (n)	Evaluative use (n)	Acute-sub acute neck pain		Chronic neck pain	
				Start and Regular during	finish (n) treatment (n)	Start and Regular during	finish (n) treatment (n)
Range of motion	14	13	13	10	13	10	10
Muscle force	9	8	4	4	4	4	3
Pressure pain threshold	5	3	5	4	2	4	2
Electromyography	1	0	1	1	0	1	0
Pinch force	2	2	2	2	0	0	0
Joint play	10	10	7	5	7	4	5
Joint mobility	15	15	10	10	7	8	7
Endurance	15	5	4	4	4	3	3
Coordination	5	5	5	5	4	4	4
Active stability	8	7	7	7	4	7	3
Passive instability	10	10	4	4	2	4	1
Upper cervical instability	12	12	3	3	2	3	1
Reflexes	13	13	7	5	5	7	5
Sensibility	13	13	8	7	5	7	5
Neurodynamics	13	13	9	9	6	9	6

partly restored. In round 3 fourteen experts participated. There was only one drop out. Upon inquiry no reason could be determined.

Table 1 describes the characteristics of the participants. All experts considered physiotherapy treatment not indicated in patients with non-specific neck pain without any positive signs and/or symptoms or diagnostic tests. However, six out of fourteen (43%) experts named one possible treatment, namely pain education.

Tables 2 and 3 show which measurement instruments the experts use in daily practice. **Table 2** shows which PROMs the experts use in their daily practice and when the experts use the PROMs in their clinical reasoning process. The use is explicitly expressed as either diagnostic or evaluative use or both. **Table 3** shows the use of measurement instruments to measure physical constructs (physical tests). The timing “regular during treatment” of the use of these physical tests, to guide the intervention, was higher (81%) than the use of PROMs (39%) for patients with acute/sub-acute non-specific neck pain than in the group of patients with chronic non-specific neck pain namely, 73% and 30%. The PROMs were mainly used at the beginning and end of the treatment, except for pain measurements and the Neck Disability Index (NDI), which were also considered to be able to guide an intervention.

Table 4 shows whether a construct was measured in a pragmatic or

valid manner. Multiple valid measurement instruments were named, however, most experts measured physical constructs pragmatically.

The interventions used by less than 3 experts were: transcutaneous electrical nerve stimulation, electro thermal therapy, low level laser, Ultra Sound and taping. These interventions were excluded in this study. **Table 5** describes the degree of consensus among the participating experts concerning the remaining interventions. The sequential linear clinical reasoning process is divided into 5 steps: signs and/or symptoms, - diagnostic test, - intervention, - direct goal of the intervention and, - evaluation test. For example: “movement dysfunction/presence of stiffness” as sign and/or symptom leads to the diagnostic test for “range of movement” (ROM), which leads to the intervention “mobilization” which leads to the direct goal of “improve quality of movement”, which leads to the evaluation test “ROM”. The last column represents the degree of consensus of that specific sequential line of linear clinical reasoning. Only 6 out of 18 lines of sequential linear clinical reasoning reached more than 50% consensus. In addition to the consensus sequence as shown in **Table 5**, an overview of all other additional information given by the experts in round 3 is shown in [appendix 1](#).

Table 4

Measurement instruments to measure physical constructs (n = 15).

Constructs	Pragmatic test (n)	Valid test (n)	Do not use (n)	Name of valid test or measurement instrument
Range of motion	6	5		Cervical range of motion (CROM) device, Goniometer, Inclinator
Muscle force	5	3	3	Dynamometer; Medical Research Council (MRC) Scale for Muscle Strength
Pressure pain threshold	2	4	5	(digital) Pressure algometer
Pinch force	2	1	8	Jamar pinch force device
Joint play	11			
Joint mobility	10	1	1	Cervical range of motion (CROM) device
Endurance	5	4	2	Cranio-cervical flexion test (CCFT), Neck extensor test
Coordination	9	1	1	Joint position sense (JPS)
Active stability	7		4	
Passive stability	8		3	
Upper cervical instability	8	4		UC stability tests, sharp purser
Neurodynamics	6	5		ULTT, SLUMP, SLR
Tenderness	8	1	2	Quantitative sensory testing (QST)
Postural control	8		3	
Proprioception	5	3	3	Joint position sense (JPS)
Motor control	5	4	2	Cranio-cervical flexion test (CCFT)/stabilizer, the Fly
Movement pattern	8		3	
Muscle spasm	8		3	
Muscle length	9			
Muscle tension	8		3	

Table 5
Consensus in sequential linear clinical reasoning (n = 14).

sign and/or symptom = > = >	diagnostic test = > = >	intervention = > = >	Direct goal of intervention = > = >	Evaluation test	Consensus % (J/ N)
Muscle weakness in history	Strength test	Strength exercises	increase strength	Endurance test	50% (N)
Reduction of movement	ROM	Stretching	increase ROM	ROM	64% (J)
Pain, reduced ROM, presence of stiffness	Joint mobility assessment	Traction	reduce pain	Pain VAS/NPRS	29% (N)
Pain	Pain VAS/NPRS	Massage	reduce muscle tension	Palpation of tenderness	36% (N)
Muscle tension	Muscle tension/spasm test	Massage	Improve muscle tissue mobility	Palpation of tenderness	43% (N)
Pain	TP palpation	Dry needling	Reduce pain	TP palpation	43% (N)
Fear of movement	FABQ	Relaxation therapy	Reduce anxiety	Pain VAS/NPRS	50% (N)
Fear of movement	Coping test	Relaxation therapy	reduce anxiety	Pain VAS/NPRS	57% (J)
Fear of movement	Stress test	Relaxation therapy	reduce anxiety-	Pain VAS/NPRS	43% (N)
Decrease maladaptive cognitions and behaviors	Central sensitization test	Pain education	decrease maladaptive cognitions and behaviors	NDI (neck disability index)	62% (J)
Movement dysfunction, reduced ROM, presence of stiffness	ROM	Mobilization	improve quality of movement	ROM	36% (N)
Movement dysfunction, reduced ROM, presence of stiffness	Joint mobility assessment	Mobilization	Improve quality of movement	Joint mobility assessment	43% (N)
Movement dysfunction, reduced ROM, presence of stiffness	End feel	Mobilization	Improve quality of movement	Joint mobility assessment	43% (N)
Reduced control/ endurance, symptoms of motor control impairment	Motor control test	Endurance exercises	increase endurance	Neck endurance test	79% (J)
Postural dysfunction, symptoms of imbalance	Postural control test	Endurance exercises	increase postural control	Neck endurance test	50% (N)
Weakness, postural dysfunction, coordination difficulties	Active stability test	Stabilization exercises	Improve movement control	Active stability tests	36% (N)
Weakness, postural dysfunction, coordination difficulties	Proprioception test/ CCFT	Coordination exercises	- Improve motor control	Proprioceptive tests/ CCFT	79% (J)
Dizziness, Unsteadiness, coordination difficulties, symptoms of motor control impairment	Movement pattern assessment	Coordination exercises	improve motor control	Movement pattern assessment	79% (J)

6. Discussion

The experts state that pain alone is not an indication for physiotherapy, and that there must be other signs/symptoms present and/or at least one or more positive diagnostic test to substantiate the indication for physiotherapy. However, the review of [Maissan et al. \(2018\)](#) reported that only 16% of the 122 randomized controlled trials (RCTs) had a diagnosed cause, i.e. at least one diagnostic test was used as an inclusion criterion. Therefore, one could argue that RCTs, to examine the effect of a physiotherapy intervention, were regularly conducted without first determining whether or not there was an indication for physiotherapy, and if this was done, then this was not explicitly described in those RCTs. This discrepancy between what experts deemed to be important and the absence, or lack of a clear description, of an indication for physiotherapy underlines the need to apply recognisable clinical reasoning within the methodology of RCTs to enhance transferability to daily practice, especially the translation of the diagnostic process into the in/exclusion criteria for subject recruitment.

Our Delphi illustrates that experts used a wide range of measurement instruments. The most used PROMs were pain questionnaires (Visual Analogue Scale pain and Numeric Pain Rating Scale) and a questionnaire for physical functioning (NDI). Also PROMs regarding psychosocial topics, like catastrophizing or illness perceptions, were used. This indicates that the experts measure physical functions as well as mental functions. However, it is notable how rarely questionnaires about mental functioning are used for diagnostic purposes. For example, the Tampa scale of Kinesiophobia is used by 4 experts, Fear avoidance beliefs questionnaire by 3 and Impact of event scale (IES) by 2. On the other hand, the Visual analogue pain scale is used by 6 experts and the NDI by 5. This finding corresponds with other scientific research ([Emilson et al., 2016](#); [Synnott et al., 2015](#)). Indeed, for diagnostic

purposes the experts use measurement instruments for constructs representing physical functioning 4 times more than PROMs.

We acknowledge that physiotherapists use multiple interventions within one treatment session i.e. complex or multimodal interventions ([Campbell et al., 2000](#)) and that focusing on unimodal interventions is a simplification of clinical practice. To illustrate, one expert commented: “clinical practice is fluid and an intervention is not delivered in isolation” thereby underlining the fact that daily practice is more complex. However, this study shows that achieving consensus on unimodal clinical reasoning proved to be difficult enough. Despite the lenient boundary of consensus at > 50%, only 6 out of 18 linear lines of clinical reasoning reached consensus of > 50%. After round 1 the most frequently used interventions were further explored. After round two and three inconsistency was mainly on the items “Direct goal of the intervention” and “Evaluation test”. In hindsight, this was to be expected as interventions can pursue different goals with different evaluative outcome measures. An explanation for the inconsistency among expert regarding the item “Evaluation test” could be that different experts may have different preferences for certain outcome measures.

In addition to the aforementioned items “Direct goal of the intervention” and “Evaluation test”, there was also inconsistency on the other two items “sign and/or symptom” and “diagnostic test”. A last explanation for overall inconsistency could be the lack of translatability of the results from scientific research ([Maher et al., 2004](#)). We hypothesized that if scientific research includes a clear clinical reasoning process, it should be easier to translate this reasoning into daily practice, especially by experts. In our study we found that in interventions to improve motor control or endurance consensus was reached. This can be explained when we look in more detail at a review of [Maissan et al. \(2018\)](#). This review showed that 4 RCTs to improve motor control ([Beinert and Taube, 2013](#); [G. Jull, et al., 2007](#)) or endurance ([Beer](#)

et al., 2012; G. A. Jull, et al., 2009) were part of the 11 out of 122 RCTs with a complete clinical reasoning process. In other words, these RCTs included a diagnostic criterion like potential impairments, limitations in activities or restrictions in participation, to get a sub-group that matched with the unimodal intervention. Hence, it looks as if these research findings were easy to translate to clinical practice. Therefore, this seems to confirm the need to perform future research with a more clinically relevant focus.

A limitation of the study was the technical problems in round two; because of this technical problem some data have been missed. However, because in round three all the experts of round one had the opportunity to participate and the opportunity for additional suggestions, the loss of information was minimal. A second possible limitation is the relatively small number of experts. However, they were consistent in their answers. Still, this was an exploratory study and further research is needed to confirm our findings.

A strength of our study was the diversity of nationalities (Table 1) which ensured that the results of clinical reasoning are transboundary and not biased by habits of a single country. We also consider a strength the use of a transparent framework for clinical reasoning, namely the HOAC.

We already stated that future research must organize itself in a more clinically relevant manner, thus include a diagnostic process prior to or part of inclusion in a RCT. Per intervention, experts appointed signs/symptoms and diagnostic tests (Table 5) which can be the basis of a diagnostic process leading to a matching intervention which then can be incorporated into daily practice or into clinical trials. We do want to

emphasize the importance of evaluating the direct effect of the intervention in addition to patient experienced effects in order to determine if there is a (causal) relation between them, both in scientific research and in daily practice. To do so, measurement instruments to “diagnose” physical or mental constructs should also be used in the evaluative process to determine if the physical or mental construct under treatment has improved. However, appendix 1 shows, in addition to a wide variety of measurement instruments or diagnostic tests, also an inconsistency in the use of the same measurement instruments before and after the intervention. Only by using the same measurement instrument before and after the intervention more clarity can be obtained if the perceived effect by the patient is due because, or in spite of the intervention.

In conclusion: Pain alone, without other signs/symptoms present and/or at least one or more positive diagnostic test does not substantiate the indication for physiotherapy. Insight has been obtained into which measurement instruments are used and when they are used. Consensus about sequential linear lines of clinical reasoning was poor.

Acknowledgement

The authors wish to thank (in alphabetical order); Annalie Basson, Barbara Cagnie, Lisa Carlesso, Eduardo Cruz, Timothy Flynn, Anita Gross, Jan Hartvigsen, Elly Hengeveld, Wayne Hing, Gwen Jull, Roger Kerry, Andrew Leaver, Lorrie Maffey, Silvia Pérez and Darren Rivett for their participation in the Delphi study.

Appendix 1. Additional information besides the highest consensus in clinical reasoning (in bolt letters)

sign and/or symptom = > = >	diagnostic test = > = >	intervention = > = >	Direct goal of intervention = > = >	Evaluation test	Consensus % (J/N)
Muscle weakness in history - Chronic pain	Strength test - Plus a functional test - Muscle control test	Strength exercises - Muscle control task	increase strength - Control pain	Endurance test 10x - Functional test that integrates strength - Reassess test movement, in combination with subjective findings and activity levels of patient - Strength test - Strength test or endurance test depending on patient	50% (N)
Reduction of movement - Reduction in movement means what? Quality of ROM; Pain at end of range ...	ROM	Stretching - Combined intervention: muscle length, pain inhibition, specific joint motion, willingness to move - Mobilization with Movement; PNF	increase ROM - Reduce pain - Increase muscle length - Achieve meaningful functional task	ROM - Meaningful immediate task if applicable followed by meaningful larger functional task - Main parameter out of physical and subjective examinations	64% (J)
Pain, reduced ROM, presence of stiffness - Extremity Symptoms Centralized with Traction - Neuropathic pain, paresthesia or numbness	Joint mobility assessment - Plus meaningful functional task - Test Item Cluster for Cervical Radiculopathy - NPRS	Traction - Mobilization/manipulation	reduce pain - Reduce neuropathic pain - Increase strength - Is pain dominant or not? If dominant: first short term goal will be pain reduction	Pain VAS/NPRS	29% (N)

Pain - Pain on palpation	Pain VAS/NPRS - Movement quality with pain - NPRS-surrogate measure in absence of reliable measure of tension - Pain provoking movement	Massage	reduce muscle tension - Improve muscle tissue mobility - Initiation of movement - pain relief	Palpation of tenderness - Movement quality with pain - Pain provoking movement - NPRS	36% (N)
Muscle tension - Pain - Limited ROM - Pale skin - Loss of specific functional movement	Muscle tension/spasm test	Massage	Improve muscle tissue mobility - Initialization of movement - Reduce muscle tension - Improved quality of movement including initialization of movement	Palpation of tenderness - Motor control task	43% (N)
Pain - Muscle tension - Decreased ROM - Pain at rest and with movement - Local and referred pain changes in skin color, texture and mobility - Reduce muscle mobility pain linked to movement restriction and movement incoordination - It is a combination of interacting symptoms and signs.	TP palpation - Reduces ROM - NPRS	Dry needling	Reduce pain - Relieve Triggerpoint - Reduce myofascial tightness	TP palpation - NPRS	43% (N)
Fear of movement - Poor symptom management - Muscle tension	FABQ - Self efficacy questionnaire - Checklist of non-verbal pain indicator (CNPI)	Relaxation therapy - Graded exercises - Why relaxation therapy if someone is afraid to move? Graded exposure ...	Reduce anxiety - Reduce pain - Reduce muscle tone - Reduce fear of re-injury - Improve self-efficacy	Pain VAS/NPRS - Self efficacy questionnaire - Brief Pain Inventory and CNPI - Ability to perform fearful movements	50% (N)
Fear of movement - Anxiety, inability to relax - Poor symptom management	Coping test - NPRS - Depends on combination of symptoms	Relaxation therapy	reduce anxiety - Reduce pain - Reduce muscle tone - Self management of symptoms	Pain VAS/NPRS - Brief Pain Inventory - Coping test, ability to relax - FABQ - Movement Test	57% (J)
Fear of movement - Anxiety - Inability to relax	Stress test - Coping test - DASS - Functional movement test	Relaxation therapy - Plus movement retraining - Relaxation-Interdisciplinary care with psychologist	reduce anxiety - Reduce pain - Reduce muscle tone - Response to stress via movement	Pain VAS/NPRS - Self-evaluation of identification of environmental stressors - DASS-monitored by psychologist - Coping test, ability to relax - FABQ - Functional movement tests	43% (N)

Decrease maladaptive cognitions and behaviors - Decrease fear avoidance and wrong beliefs - Decreased self-efficacy	Central sensitization test - Central sensitization inventory - Not always formally tested. Depends entirely on the construct	Pain education - Plus graded exposure	decrease maladaptive cognitions and behaviors - Decrease fear avoidance and wrong beliefs - Decreased self-efficacy - and increase function and decrease pain - Reframe belief or behavior into something positive	NDI (neck disability index) - Questionnaires on knowledge and beliefs - CSI - FABQ - Pain catastrophizing test	62% (J)
Movement dysfunction, reduced ROM, presence of stiffness	ROM	Mobilization	improve quality of movement - Increase ROM - Relaxation - Reduce pain	ROM - and pain response	36% (N)
Movement dysfunction, reduced ROM, presence of stiffness - Pain	Joint mobility assessment - NPRS	Mobilization	Improve quality of movement - Increase ROM - Reduce pain - Relaxation	Joint mobility assessment	43% (N)
Movement dysfunction, reduced ROM, presence of stiffness	End feel	Mobilization	Improve quality of movement - Increase ROM - Reduce pain - Relaxation	Joint mobility assessment 6x - ROM - End feel - VAS/NPRS - Movement coordination test and functional tasks	43% (N)
Reduced control/ endurance, symptoms of motor control impairment	Motor control test - Endurance test	Endurance exercises	increase endurance - Increase postural control	Neck endurance test	79% (J)
Postural dysfunction, symptoms of imbalance - Imbalance in posture, muscular imbalance - Pain with sustained activities	Postural control test - NPRS	Endurance exercises	increase postural control - Increase endurance - Control pain	Neck endurance test NPRS	50% (N)
Weakness, postural dysfunction, coordination difficulties	Active stability test	Stabilization exercises	Improve movement control - Improve active stability - Reduce pain - Decrease the incidence of recurrence	Active stability tests	36% (N)
Weakness, postural dysfunction, coordination difficulties	Proprioception test/CCFT	Coordination exercises	- Improve motor control - Reduce pain	Proprioceptive tests/CCFT	79% (J)
Dizziness, Unsteadiness, coordination difficulties, symptoms of motor control impairment - Reasons for dizziness, unsteadiness? Cervical, general proprioceptive, vascular? - Neurological weakness	Movement pattern assessment - Tests of motor control, movement coordination - Dizziness Handicap Inventory or Balance Test	Coordination exercises	improve motor control 1 - Reduce pain	Movement pattern assessment - Dizziness Handicap Inventory or Balance Test	79% (J)

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