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International Framework for Examination of the Cervical Region for Potential of Vascular Pathologies of the Neck Prior to Musculoskeletal Intervention: International IFOMPT Cervical Framework

Vascular pathologies of the neck and the head are rare[31] but are an important consideration for clinicians managing people with neck and/or head pain. Identifying vascular pathologies of this region is a complex process. There are a range of potential vascular pathologies and dysfunctions relating to the arterial system, which supplies blood to the brain. Their relevance for clinicians who treat musculoskeletal conditions is two-fold. First, clinical and empirical history stemming from the early days of manual therapy linked neurovascular patient safety incidents with therapeutic interventions. Second, in recent years, it has become more evident that there are a range of arterial pathologies with the potential to present as musculoskeletal pain and dysfunction (the so-called vascular masqueraders), meaning patients present to the clinician with a vascular pathology of the neck/head region manifesting as neck pain and/or headache.[9] Headache and/or neck pain are features of a range of vascular pathologies of the neck and head, including dissection and nondissection events.[1,8,16,33,44] For ease, we use the term "vascular pathologies" to refer to the wide range of distinct pathological processes, as well as nondisease-based mechanical dysfunctions such as nonspecific mechanical neck pain.

Many clinicians erroneously believe that there are no distinguishing features between patients presenting with vascular pathologies of the neck and patients who present with features of a musculoskeletal disorder. This position statement, stemming from the international framework developed through the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT), was developed in response to a call for guidance from professional bodies to address decades of uncertainty and clinician anxiety due to inconsistent knowledge and practice. This position statement, based upon the best contemporary evidence and expert opinion, aims to summarize

SYNOPSIS: This position statement, stemming from the International IFOMPT (International Federation of Orthopaedic Manipulative Physical Therapists) Cervical Framework, was developed based upon the best contemporary evidence and expert opinion to assist clinicians during their clinical reasoning process when considering presentations involving the head and neck. Developed through rigorous consensus methods, the International IFOMPT Cervical Framework guides assessment of the cervical spine region for potential vascular pathologies of the neck in advance of planned interventions. Within the cervical spine, events and presentations of vascular pathologies of the neck are rare but are an important consideration as part of patient examination. Vascular pathologies may be recognizable if the appropriate questions are asked during the patient history–taking process, if interpretation of elicited data enables recognition of this potential, and if the physical examination can be adapted to explore any potential vasculogenic hypothesis. *J Orthop Sports Phys Ther 2023;53(1):7-22. Epub: 14 September 2022. doi:10.2519/jospt.2022.11147*

KEY WORDS: *cervical spine, differential diagnosis/primary care, expert clinical practice, manual therapy/spine*

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the IFOMPT 2020 framework and assist clinicians during their clinical-reasoning process when considering presentations involving the head and neck.

The IFOMPT framework can support health care professionals who are working with cervical musculoskeletal conditions by supporting early identification of vascular pathologies, ensuring the best possible outcome for patients. It is based upon the best contemporary evidence and expert opinion, to assist all clinicians during their clinical-reasoning process. This position statement has moved from the IFOMPT language of "OMT" (orthopaedic manual therapy) to musculoskeletal intervention, to ensure (1) clarity for all clinicians and (2) that the revised framework completes a planned update of the original (2012) framework to ensure access to the contemporary evidence for clinical reasoning.

Consensus Methodology

We present the IFOMPT cervical framework as a consensus document developed through rigorous methods. The framework is not intended as a compilation of systematic reviews designed to answer specific questions. The consensus process considered the breadth and complexity of evidence, clinical reasoning, and facilitated recommendations where there was a lack of published material and considerable uncertainty.

For each section of the framework, discrete substantive areas were identified, and relevant electronic databases, reference lists, key journals, existing networks, and relevant organizations and conferences were searched. Study selection and charting of data and information was undertaken within each section in line with its focus. There were 4 stages to developing the framework:

- **Stage 1:** A survey to evaluate the previous 2012 cervical framework was distributed to all member organizations and registered interest groups of IFOMPT in 2016. The survey explored the perceived value of the framework, its strengths and limitations, and examples of its clinical and legal use.
- **Stage 2:** The key issues identified in the survey were initially explored at the IFOMPT Conference in 2016 in Glasgow. Findings from the evaluation survey were presented to facilitate discussion and debate through platform presentations. We confirmed the need for an updated version of the framework. The session generated considerable discussion to inform the first revisions of the framework. Guidelines, systematic reviews, and individual studies were used to inform the draft. When no evidence was available, we used expert consensus. We adapted terminology (OMT to musculoskeletal) and included 6 new case studies to support knowledge translation.
- **Stage 3:** Through an iterative consultative process, drafts of the framework were developed and circulated for review and feedback to member organizations and registered interest groups of IFOMPT, international experts/authors, nominated experts within IFOMPT countries, and professional organizations across physical therapy, osteopathy, and chiropractic. Each stage included an email including previous feedback, changes made, and a rationale for changes made/not made based on feedback. The final version was reviewed and appraised by a medical practitioner specialist in stroke and interventional neurology.
- **Stage 4:** The framework was voted on and accepted unanimously at the IFOMPT General Meeting in November 2020 by 22 member organizations (countries) as an international position statement for musculoskeletal clinicians.

Clinical Reasoning and Shared Decision-making

The IFOMPT cervical framework is intended to be informative and not prescriptive supporting clinical reasoning during assessment and treatment.[23,42,51,61] The current framework builds on the previous 2012 framework[52] (first version) and addresses concerns of the earlier framework highlighted through the consensus methodology and empirical work.[13] The framework requires sound clinical reasoning to enable effective, efficient, and safe assessment and management of the cervical spine region. It is clear that some recorded

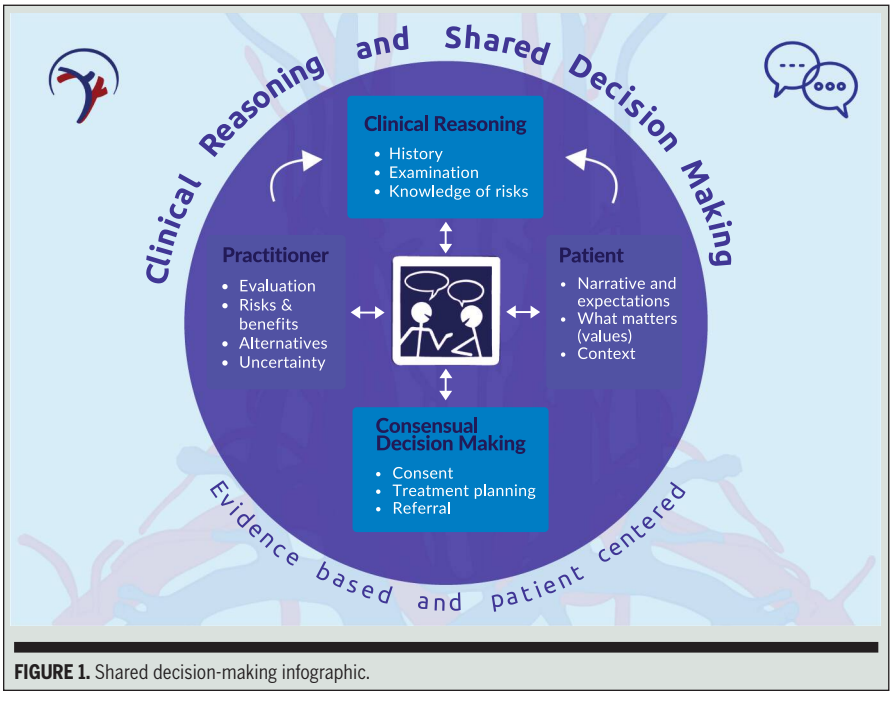


FIGURE 1. Shared decision-making infographic.

safety incidents could have been avoided if more thorough clinical reasoning had been exercised by the clinician.[47] The framework is designed to aid patient-centered clinical reasoning in a subject area where uncertainty is an important consideration.

Shared decision-making fosters patient-centered "care that is respectful of and responsive to individual patient preferences, needs, and values" and ensures "that patient values guide all clinical decisions."[26] The Informed Medical Decision-Making Foundation[11] describes shared decision-making as a dynamic two-way process. The clinician communicates personalized information about the options, outcomes, probabilities, and scientific uncertainties of available treatment options to the patient, whereas the patient communicates their values and the relative importance they place on benefits and harms. Shared decision-making is an effective means for reaching agreement on the best strategy for treatment. The framework adopts the Agency for Healthcare Research and Quality's 5-step SHARE approach: Seek your patient's participation, Help your patient explore and compare treatment options, Assess your patient's values and preferences, Reach a decision with your patient, and Evaluate your patient's decision, to achieve patient-centered practice (https://www.ahrq.gov/professionals/shareddecisionmaking/tools/tool-1/sharetool1.pdf). **FIGURE 1** summarizes the shared decision-making.

How an International Framework Can Help Clinicians

The priority for the clinician in this context is to first do no harm and, second, to excel in clinical reasoning and differential diagnosis. These 2 dimensions overlap and are important in the context of the known association between seeking care for neck pain and headache, and the natural history and progression of vascular pathologies of the neck.[9] Incidents that occur following musculoskeletal treatment are generally believed to manifest in people with vascular pathologies or who have a vascular predisposition (eg, elongated styloid process). There are also rare exceptions where the incident might seem unpredictable (eg, spontaneous cervical artery dissections).

The IFOMPT cervical framework guides assessment of the cervical spine region for potential vascular pathologies of the neck

TABLE 1 Range of Vascular Pathologies of the Neck

Structure/Site	Pathology	Symptoms/Presentation
Carotid artery	Atherosclerosis Stenotic Thrombotic Aneurysmal	Carotidynia, neck pain, facial pain, headache, cranial nerve dysfunction, Horner's syndrome, transient ischaemic attack (TIA), stroke
Carotid artery	Hypoplasia	Commonly silent, rare cerebral ischaemia
Carotid artery	Dissection	Neck pain, facial pain, headache, TIA, cranial nerve palsies, Horner's syndrome
Vertebral artery	Atherosclerosis	Neck pain, occipital headache, possible TIA, stroke
Vertebral artery	Hypoplasia	Commonly silent, rare cerebral ischaemia
Vertebral artery	Dissection	Neck pain, occipital headache, TIA, cranial nerve palsy
Temporal/vertebral/occipital/carotid arteries	Giant cell arteritis	Temporal pain (headache), scalp tenderness, jaw and tongue claudication, visual symptoms (diplopia or vision loss—may be permanent)
Cerebral vessels	Reversible cerebral vasoconstriction syndrome (RCVS)	Severe "thunderclap" headaches
Subarachnoid	Hemorrhage	Sudden severe headache, stiff neck, visual disturbance, photophobia, slurred speech, sickness, unilateral weakness
Jugular vein	Thrombosis	Neck pain, headaches, fever, swelling around neck/angle of jaw
Any other cervicocranial vessel	Vascular anomaly or malformation	Possible headache/neck pain, ie, unruptured carotid aneurysm (inclusive of anomaly arising from vascular vessel interface, eg, vessel entrapment)

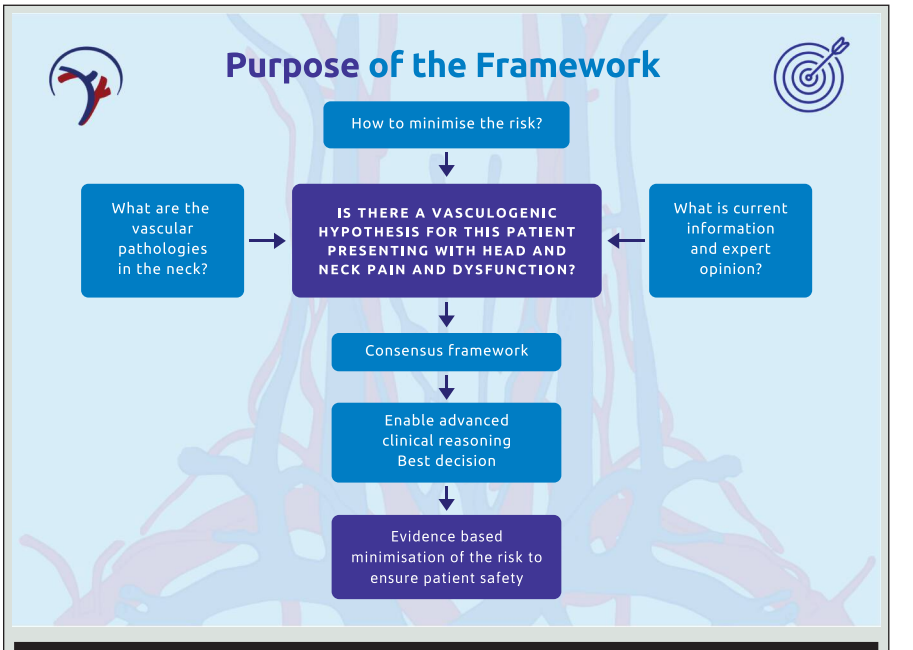


FIGURE 2. Purpose of the framework infographic.

in advance of planned interventions inclusive of mobilization, manipulation, and exercise. Within the cervical spine, events and presentations of vascular pathologies of the neck are rare[32] but are an important consideration as part of patient examination. **TABLE 1** details the range of vascular pathologies of the neck. Vascular pathologies may be recognizable if the appropriate questions are asked during the patient history–taking process, if interpretation of elicited data enables recognition of this potential and if the physical examination can be adapted to explore any potential vasculogenic hypothesis. The framework reflects best practice and aims to place risk in an appropriate context informed by the evidence. In this context, the framework considers ischaemic and nonischaemic presentations to identify risk in a patient presenting for cervical examination and management. **FIGURE 2** summarizes the purpose of the framework.

Risk and Context

One of the goals of the IFOMPT cervical framework is to ensure that clinicians understand risk in both its epidemiological and individual contexts. Epidemiologically, the risk of a vascular incident related to therapeutic interventions is extremely small. Despite this, clinicians must do everything in their power to mitigate and limit that risk. Individual patients differ with regard to risk (chance, high or low, that any hazard will actually cause somebody harm), hazard (something that can cause harm), profile (predisposition to arterial pathology), or existence of vascular pathology (masquerading as a musculoskeletal dysfunction).

Important Underlying Principle of the Framework

Clinicians cannot rely on the results of a single test to draw conclusions. Understanding the patient's presentation following an informed, planned, and individualized assessment is essential. There are multiple sources of information available from the process of patient assessment to improve the confidence of estimating the probability of vascular pathologies of the neck. Data available to inform clinical reasoning will improve and change with ongoing research. The framework provides a starting point, while encouraging clinicians to stay current in the topic area, to enable support for their clinical decisions. The following sections summarize the key issues for each stage of the clinical reasoning process: taking a patient's history, planning the physical examination, conducting the physical examination, planning the intervention, and evaluating the intervention. Case histories illustrate the clinical reasoning required for safe and effective practice.

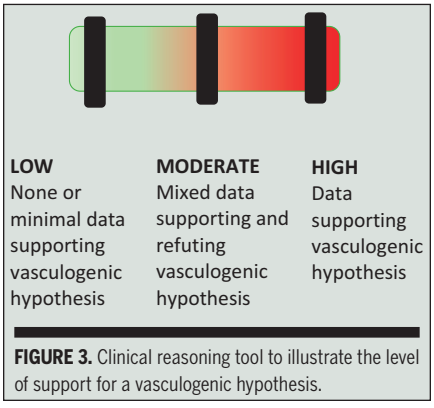


FIGURE 3. Clinical reasoning tool to illustrate the level of support for a vasculogenic hypothesis.

A visual tool (**FIGURE 3**) to illustrate the level of support for a vasculogenic hypothesis is used throughout (ie, the index of suspicion for vasculogenic pathology). All levels of support (low, moderate or high) influence the subsequent decision-making processes.

Case A illustrates an example narrative associated with managing people seeking advice without a formal process of patient examination. It highlights a "best guess" by the therapist based on limited, but informative, information.

PATIENT HISTORY

Patient history is used to establish and test hypotheses related to either the predisposition of vascular pathologies of the neck or the presence of frank vascular pathologies of the neck.

Case A

Synopsis: A headache described as "unusual" with progressive signs of likely central ischemia (slurred speech, lethargy, fatigue, confusion) is sufficient information for the therapist to recommend emergency medical attention.

Telephone History: A 50-year-old male brick layer complains of a headache. His headache is similar *but different* to previous *migraine* headaches that he intermittently experiences. This is different in that he also feels lethargic and "run down." With this in mind, he decides to go to bed sure that he will feel better in the morning as he does feel fatigued and "sleepy." Upon waking, his headache is still present. He thinks that he needs to exercise and "get out for some fresh air" (similar to previous headaches) so he walks to the shops to get some essentials. The checkout operator says that she cannot understand what he is saying and that his speech is slurred. He is confused as he knows what he is saying and feels this is due to his "over-doing it." He reflects and cannot understand why he is still lethargic and cannot concentrate on things. Upon his wife arriving home from work, she also comments that he is difficult to understand and that he needs to concentrate on their conversation as "he is he not listening to her." She calls a physical therapist friend to seek advice.

Clinical Reasoning: As a result of the discussion and reflection on the slurring of words and general description of his complaint, the physiotherapist friend recommends that the patient's wife take him to the hospital emergency department for assessment. Reasoning specifically based on fatigue, slurred speech (dysarthria), atypical headache *similar but not like* previous headaches (with no subjective cause).

Support for Vascular Hypothesis: HIGH

Action: Urgent medical investigation. Magnetic resonance arteriography reveals an established distal left M2 (the Sylvian fissure segment of the middle cerebral artery [MCA]) embolic ischaemic thromboembolus within the left M2 MCA superior division with evidence of an established acute cerebral infarct involving the anterior left MCA territory. The transthoracic echocardiogram report shows the presence of a shunt patent foramen ovale at atrial level upon Valsalva maneuver.

There are very limited diagnostic utility data for physical examination tests. Therefore, the clinician's aim is to use the patient history to make the best judgment on the *probability* of either contraindications to treatment or serious pathology. Subtle signs and symptoms of suspected pathologies should be recognized in patient history taking. It is also important to recognize risk factors indicating the *potential* for neurovascular pathology.

Considering Risk Factors

The etiology of a vascular pathology of the neck event is complex and multifactorial. Rarely is an event associated with a single causal factor. However, there are several factors known to be associated with an increased risk of arterial pathologies related to either internal carotid or vertebrobasilar vessels. These should be thoroughly considered during patient history taking. Recent data analysis allows some degree of understanding as to the degree of risk of certain factors. **TABLES 2** and **3** detail retrospective and prospective data,[62-65] complemented and supported by other available reviews,[50] including the most contemporary reviews.[10,27,55,56] **TABLES 2** and **3** detail risk factors for dissection and nondissection vascular events (combining vertebrobasilar artery [VBA] and internal carotid artery [ICA] pathologies). The percentages refer to the proportion of all observed patients (from the studies above) with the specified condition (eg,

TABLE 2 Risk Factors for Dissection Vascular Events

Risk Factor in Order of Most to Least Common	Dissection Event, %
Recent trauma	40-64
Vascular anomaly	39
Current or past smoker	30
Migraine	23
High total cholesterol	23
Recent infection	22
Hypertension	19
Oral contraception	11
Family history of stroke	9

TABLE 3 Risk Factors for Nondissection Vascular Events

Risk Factor in Order of Most to Least Common	Nondissection Event, %
Current or past smoker	65-74
Hypertension	53-74
High total cholesterol	53
Migraine	19
Vascular anomaly	16
Family history of stroke	14
Oral contraception	9
Recent infection	9
Recent trauma (mild-moderate, which may include recent OMT)	7

Abbreviation: OMT, orthopaedic manual therapy.

TABLE 4 Reported Clinical Features for Dissection Events

Clinical Features in Order of Most to Least Common	Dissection Vascular Event, %
Headache	81
Neck pain	57-80
Visual disturbance	34
Paresthesia (upper limb)	34
Dizziness	32
Paresthesia (face)	30
Paresthesia (Lower limb)	19

TABLE 5 Reported Clinical Features for Nondissection Events

Clinical Features in Order of Most to Least Common	Nondissection Vascular Event, %
Headache	51
Paresthesia (upper limb)	47
Paresthesia (lower limb)	33
Visual disturbance	28
Paresthesia (face)	19
Neck pain	14
Dizziness	7

TABLE 6 Clinical Features of VBA Dissection

Clinical Features in Order of Most to Least Common	VBA Dissection, %
Unsteadiness/ataxia	67
Dysphasia/dysarthria/aphasia	44
Weakness (lower limb)	41
Weakness (upper limb)	33
Dysphagia	26
Nausea/vomiting	26
Facial palsy	22
Dizziness/disequilibrium	20
Ptosis	19
Loss of consciousness	15
Confusion	7
Drowsiness	4

Abbreviation: VBA, vertebrobasilar.

TABLE 7 Clinical Features of ICA Dissection

Clinical Features in Order of Most to Least Common	ICA Dissection, %
Ptosis	60-80
Weakness (upper limb)	65
Facial palsy	60
Weakness (lower limb)	50
Dysphasia/dysarthria/aphasia	45
Unsteadiness/ataxia	40
Nausea/vomiting	30
Drowsiness	20
Loss of consciousness	20
Confusion	15
Dysphagia	0.5

Abbreviation: ICA, internal carotid.

"dissection event") who exhibit the specific risk factor stated in the first column. As no meaningful reference class data exist for these specific factors, these data are not intended to be used to judge relative risk. Rather, they indicate the known proportionality of observed features in each condition, thereby giving the clinician a developing idea of clinical patterns. The key message from these data is the general difference between the characteristics of dissection and nondissection events. It is equally important to note that spontaneous dissection events are not associated with these historical risk factors detailed in **TABLE 3**. Clinical reasoning must recognize that the absence of risk factors does not necessarily rule out the risk of serious neurovascular event.

Presenting Features of Vascular Pathologies of the Neck

It is important to recognize elements of a clinical pattern that may further support or refute a vascular hypothesis. Again, due to the extremely low prevalence, range of pathologies, and high variation of the presenting features of vascular pathologies of the neck, a definite clinical pattern is not possible to identify. However, certain consistent features of clinical presentation do emerge from historical case reports, which are supported by observations from systematic reviews.[32,64] These features (presented in **TABLES 4** to **8**) allow the clinician to begin to understand the way in which different vascular

TABLE 8 Clinical Features of Nondissection Event (VBA or ICA)

Clinical Features in Order of Most to Least Common	Nondissection Vascular Event, %
Weakness (upper limb)	74
Dysphasia/dysarthria/aphasia	70
Weakness (lower limb)	60
Ptosis	5-50
Facial palsy	47
Unsteadiness/ataxia	35
Confusion	14
Nausea/vomiting	14
Dysphagia	5
Loss of consciousness	5
Drowsiness	2

Abbreviation: ICA, internal carotid; VBA, vertebrobasilar.

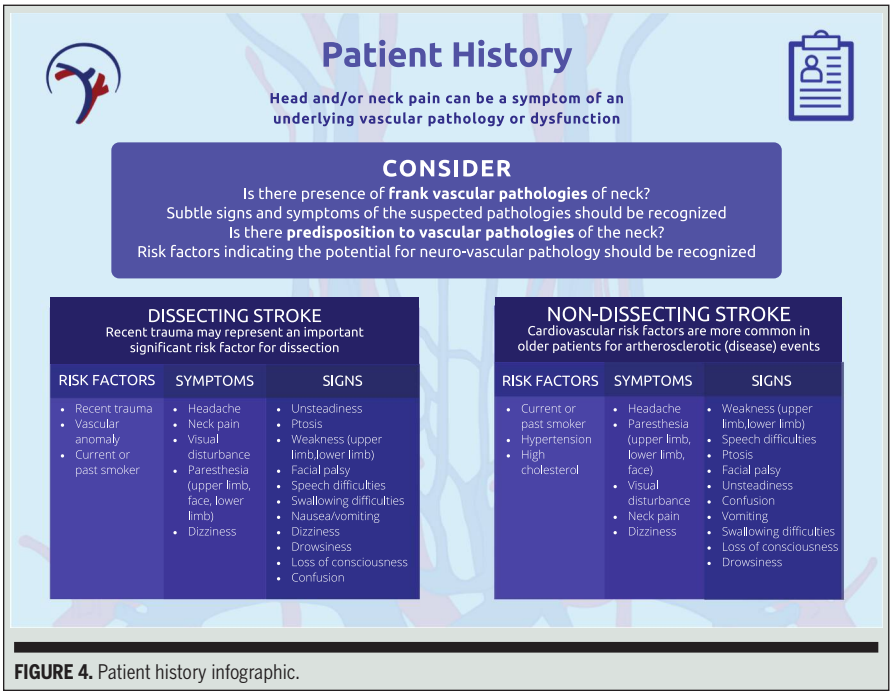


FIGURE 4. Patient history infographic.

Case B

Synopsis: Progressive "unusual" headache with emerging hindbrain/central neurology with history of trauma indicates additional testing to support a medical referral.

Patient History: A 46-year-old female supermarket worker presents for physical therapy with left-sided head (occipital) and neck pain described as "unusual." She reports a 10-day history of the symptoms following a road traffic accident. The symptoms are progressively worsening. The pain is eased by rest. The patient reports an onset of new symptoms after about 7 days, including "feels like might be sick," "throaty," and "feels faint"—especially after performing gentle exercise. Two days after this, she reports a stronger feeling of nausea, loss of balance, swallowing difficulties, speech difficulties, and acute loss of memory. She reports a history of previous road traffic accidents. Past medical history included hypertension, headaches, high cholesterol, and a maternal family history of heart disease and stroke.

Clinical Reasoning: The history reveals an emerging pattern of vascular risk factors for a possible arterial dissection. For this type of pathology, and in this age group, trauma is a primary risk factor. In this case, there are reports of repeated trauma (road traffic accidents), together with a classic pain distribution for vertebral arterial somatic pain that was worsening. There are also cardiovascular risk factors that, although have been found to absent in some dissection cases, can add strength to a vascular hypothesis. The patient reports a history of headaches, and it is important to explore the nature of these as migraine is a risk factor for dissection. She reports worsening and changing symptoms and signs, which are consistent with known descriptors for dissection events.

Support for Vascular Hypothesis: HIGH

Action: Physical examination including blood pressure measurement and cranial nerve testing, and avoiding provocative head and neck movements are indicated. These findings may add support to a referral for urgent medical investigation.

pathologies of the neck are most likely to present. These estimates are again split between dissection and nondissection events. For the list of clinical features, data are presented also by separating VBA dissection from ICA dissection as there is wide variation of clinical features. **TABLES 4** and **5** detail the reported features for dissection and nondissection vascular events in the neck.[32,64] The percentage figures refer to the proportion of all observed patients with the specified condition (eg, dissection vascular event) who exhibit the specific features stated in the first column. **TABLES 6-8** detail reported clinical features in the dissection and nondissection patients.[64] The percentage figures refer to the proportion of all observed patients (from the quoted studies above) with the specified condition (eg, ICA dissection) who exhibit the specific feature stated in the first column. These data are intended to contribute to the clinician's reasoning regarding the developing clinical pattern, not inform a judgement about relative risk.

Importance of Observation Throughout History

Signs and symptoms of serious pathology and contraindications/precautions to treatment may manifest while the clinician obtains the patient history. This is an opportunity to observe and recognize possible red flag indicators such as gait disturbances, subtle signs of disequilibrium, upper motor neuron signs, cranial nerve dysfunction, and behavior suggestive of upper cervical instability (eg, anxiety, supporting head/neck) early in the clinical encounter. **FIGURE 4** summarizes the patient history.

Case B illustrates an example narrative associated with the patient history.

PLANNING THE PHYSICAL EXAMINATION

Careful planning of the physical examination is a necessary step. Interpretation of the data from the patient history and defining the main hypotheses will help guide an effective physical examination to further explore a possible vasculogenic contribution.[36,41,51] Prior to starting the physical examination, it is important to reflect on the completeness of the patient history data and its quality with the following questions.

- Are there any precautions to physical examination/intervention?

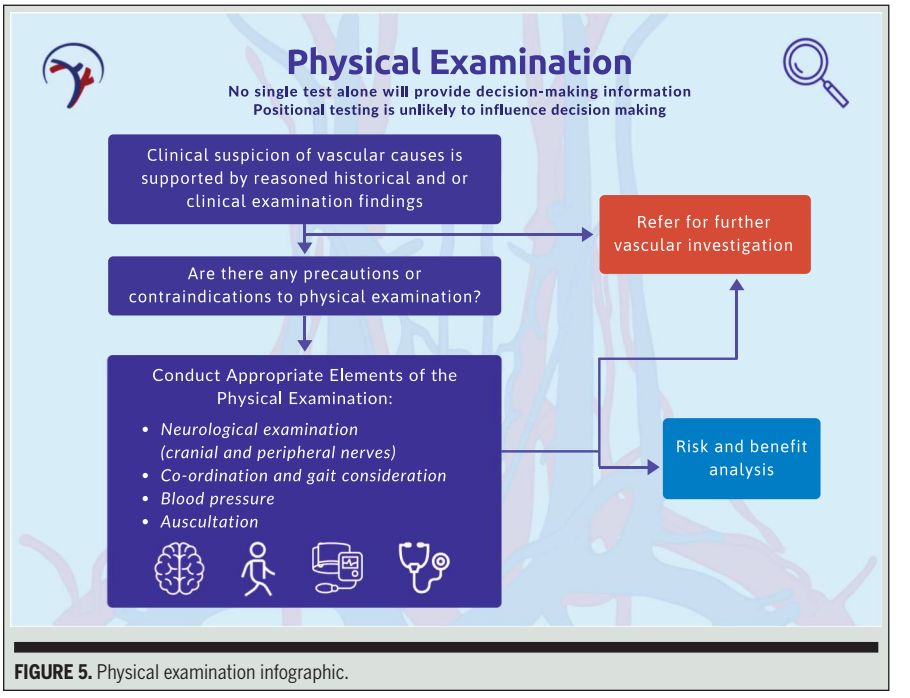


FIGURE 5. Physical examination infographic.

Case C

Synopsis: Neck pain and temporal headache related to sustained neck extension in a male with cardiovascular profile. Physical examination findings support vascular hypothesis and indicate urgent medical referral.

Patient History: A 42-year-old accountant presents to physical therapy with a 5-day history of unilateral (left-sided) neck and jaw pain, as well as temporal headache, following decorating the ceiling (sustained head/neck extension). The following day, the patient's pain is worse, and he has developed a left-sided ptosis. The patient had underlying risk factors for arterial disease, and the historical presentation was typical of ICA dissection, with a key differentiator being the ptosis.

Physical Examination: A physical examination focused on refuting a vascular hypothesis is indicated by the history. The physical examination should be conducted to acquire as much useful information as possible in the least provocative way. This information can then be used to support/refute the vascular hypothesis and as a tool to strengthen a medical referral. At rest, the patient's blood pressure is unusually high (210 systolic/175 diastolic). Left pupil dilation is substantially less than the right. There is a pulsatile mass of the left ICA with an unusually turbulent bruit on auscultation.

Clinical Reasoning: Clear and coherent data from the patient history and physical examination, indicative of possible carotid pathology. The patient is in the age group where dissection events are more probable than atherosclerotic events, and the examination findings suggest aneurysm formation, which is commonly associated with dissection events.

Support for Vascular Hypothesis: HIGH

Action: Urgent medical investigation. Magnetic resonance arteriography is indicated.

For example, precaution owing to vasculogenic hypothesis.

- Are there any contraindications to physical examination/intervention?

For example, avoiding end-of-range movements.

- What physical tests should be included or excluded in the physical examination, with consideration of any risks associated with performing the tests?

For example, blood pressure needs to be tested.

- What is the priority for these physical tests for this specific patient? This is to inform decisions regarding the order of testing and to determine which tests should be completed at the first visit.

For example, neurological examination required first.

- Do the physical tests need to be adapted for this specific patient?

For example, change in position.

Once the physical examination has begun, a process of refining, evaluating, reranking, and rejecting hypotheses facilitates optimal clinical reasoning in musculoskeletal practice.[28]

New data obtained during the physical examination is interpreted in the context of the existing hypotheses, to re-evaluate the level of support for a vasculogenic hypothesis. Specifically, the therapist needs to consider if the new data supports, negates, or does not make any difference to the vasculogenic hypothesis.

PHYSICAL EXAMINATION

The results of the history and physical examination serve to determine whether a medical referral for further vascular workup is warranted or whether the clinician can proceed with physical intervention. Unfortunately, data regarding the diagnostic utility of many of the recommended tests are often lacking. However, existing data support the use of conventional vascular examination,[16] where blood pressure, neurological examination, and examination of the carotid artery have moderate to good utility in supporting further investigation. Existing data evaluating *functional positional tests* for the identification of vertebral artery (VA) pathology does not support recommending these tests.[23] Clinicians should, as with any area of competence, reflect on their ability and seek additional training if unfamiliar with any test.

TABLE 9 Comparative Risks of Commonly Used Therapeutic Interventions for Head and Neck Pain

Intervention	Adverse Event	Baseline Prevalence (Events Occurring Without Any Intervention) per 100 000[a]	Absolute Risk (Absolute Percentage Increase if Intervention is Given)
NSAIDs (nonspecific)	Myocardial infarct[4]	2400	5.95%-6.6%
	Gastrointestinal bleed[37]	87	0.46%
NSAIDs (Cox-2)	Myocardial infarct[4]	2400	6.19%-8.67%
	Gastrointestinal bleed[37]	87	0.34%
Aspirin	Bleed[b]	87	0.21%-0.35%
Paracetamol[48,68]	Cardiovascular events[c]	2400 (eg, of MI)	5.26%-6.43%
	Gastrointestinal bleed[d]	87	0.18%-0.27%
	Renal	1350	3.24%-4.30%
Cervical OMT[e]	Stroke (VBA)	0.79	0.005%

Abbreviations: MI, myocardial infarction; NSAIDs, nonsteroidal anti-inflammatory drugs; OMT, orthopaedic manual therapy; VBA, vertebrobasilar.
[a]*Based on UK government data.*
[b]*Intracranial and extracranial, and gastrointestinal.*
[c]*Including MI, cerebrovascular accidents, and hypertension.*
[d]*Specifically, reductions in estimated glomerular filtration rate, increases in serum creatinine concentration, and the need for renal replacement therapy.*
[e]*Using a "worse-case" scenario of lowest baseline (0.79/100 000) and highest OMT-prevalence (5/100 000).*

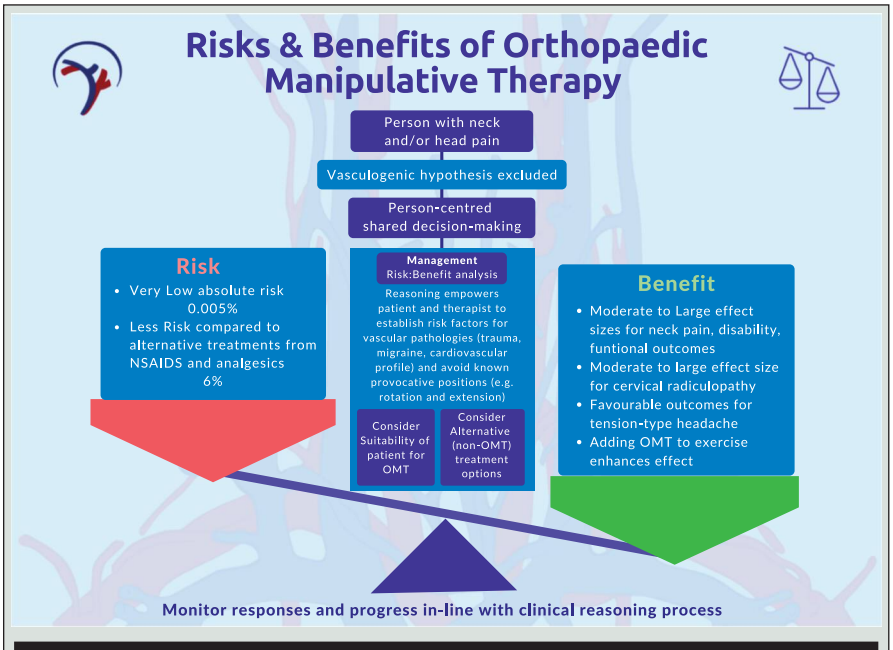


FIGURE 6. Risk versus benefit infographic. Abbreviations: NSAIDs, nonsteroidal anti-inflammatory drugs; OMT, orthopaedic manual therapy.

Blood Pressure

Examination of blood pressure informs clinical reasoning in 2 ways:

1. Assess the risk for stroke, particularly from carotid origin.[10,27,55,56]
2. Assess for acute arterial trauma in situ. An increase in blood pressure may be related to acute arterial trauma, including ICA and VA.[2]

Blood pressure measurement is reliable and valid if done well with the right equipment.[29] Updated guidelines provide a useful and comprehensive resource.[25] Hypertension is a strong predictor of cardiovascular disease.[53] There is no discreet threshold, and interpretation of readings must be in the context of other findings and sound clinical reasoning. There is a positive correlation between increased systolic and diastolic pressure and risk of stroke: the higher the pressure, the greater the risk. Vascular disease is an interplay between many factors, of which hypertension is just one. However, prospective data[64] suggest that in a subpopulation of dissection events in patients younger than 38 years, cardiovascular markers such as hypertension were not associated with the pathological event. Patients with hypertension who have not been previously identified should be advised to discuss the implications with their primary care provider.

Neurological Examination

Examination of peripheral and cranial nerves for an upper motor neuron lesion will assist in evaluating the potential for neurovascular conditions. Knowledge of a wide range of testing procedures is required owing to the diversity of possible clinical presentations associated with vascular pathologies of the neck, including balance and coordination tests. There are many useful resources to help with developing neurological examination skills, including the work of Fuller[19] and *The NeuroExam Video* by Hal Blumenfeld (https://learninglink.oup.com/access/the-neuroexam-video#tag01-introduction-to-the-neurological-exam).

Cranial nerve examination is particularly important,[39,45] and a useful summary of examination based on nerve function is provided by Taylor et al.[59] An increasing body of literature details clinical cases of arterial pathology with cranial nerve involvement to inform pattern recognition. Examples include the works of Peltz and Köhrmann,[40] Fujii et al,[18] and Hennings et al.[21] Moderate reliability and validity of cranial nerve examination are supported (eg, see the works of Damodaran et al,[12] Koch et al,[29] and Schmid et al[54]). Importantly, the absence of clinical findings in these examinations does not rule out an underlying pathology or impending dissection, and should therefore be viewed with caution.

Examination of the Carotid Artery

Auscultation and palpation of the common and internal carotid arteries are possible due to the size of these vessels

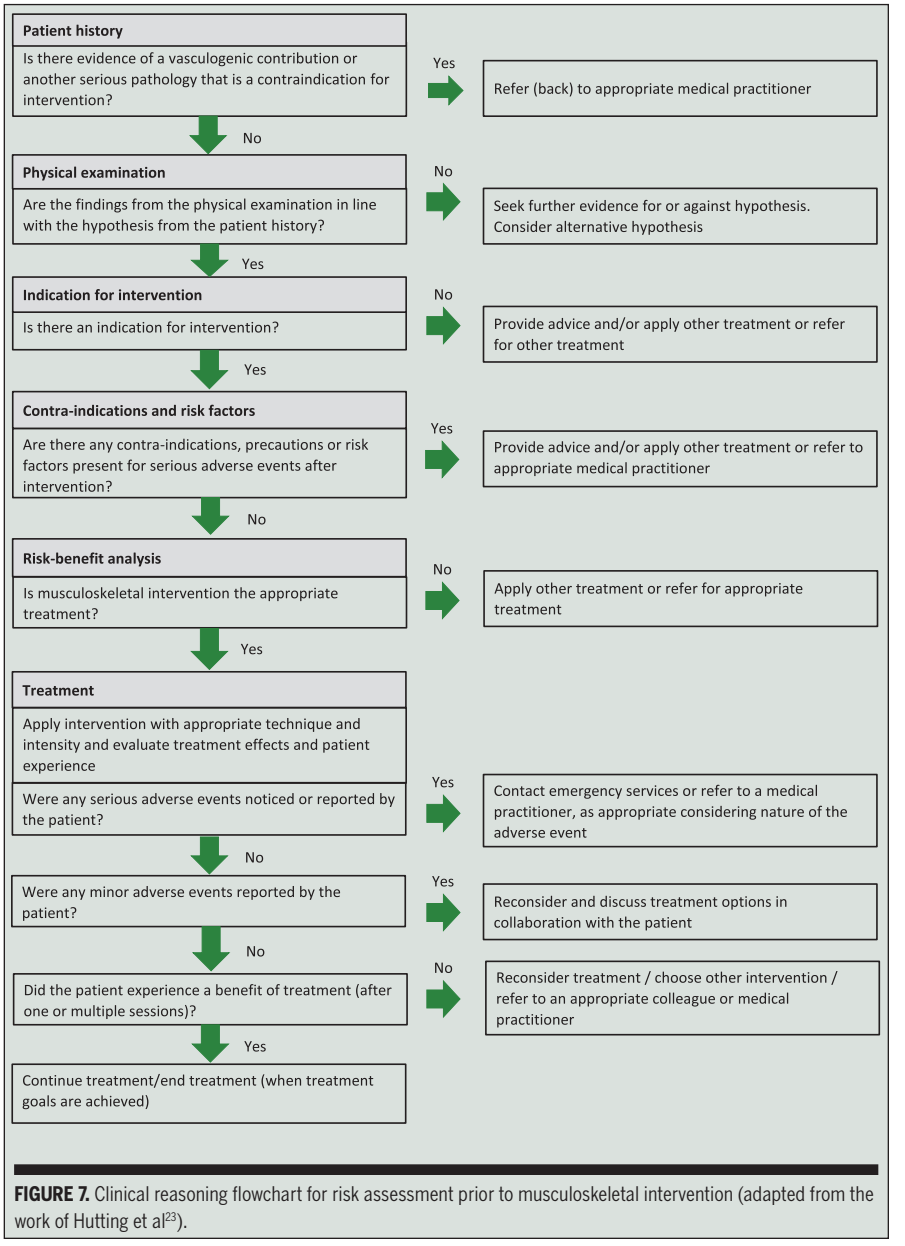


FIGURE 7. Clinical reasoning flowchart for risk assessment prior to musculoskeletal intervention (adapted from the work of Hutting et al[23]).

and their relatively superficial anatomy.[43] There is some evidence to support an alteration of pulse as a feature of internal carotid disease.[39] Asymmetry between left and right vessels is considered significant. A pulsatile, expandable mass is indicative of arterial aneurysm.[16] A bruit on auscultation (controlling for normal turbulence) is a significant finding and should be considered in the context of other clinical findings. It is possible for dissections and steno-occlusive disease of the carotid arteries to exist in the absence of aneurysm formation. Therefore, a negative finding does not rule out the hypothesis of arterial dysfunction. In isolation, pulse palpation is neither sensitive nor specific, but it can offer important data leading to specific diagnoses and treatment.[3,43] Pulse auscultation is informed by the use of appropriate anatomical landmarks and vessel palpation.[46] Understanding of both normal and pathological pulse quality is recommended. **FIGURE 5** summarizes the physical examination.

Differentiation During the Patient Examination

Differentiation of a patient's symptoms originating from a vasculogenic cause with complete certainty is not currently possible from the physical examination, and as discussed earlier, headache/neck pain may be the early presentation of an underlying rare vascular pathology.[47,60] The task for the clinician is therefore to differentiate the symptoms by

1. having a high index of suspicion, and
2. testing the vascular hypothesis.

This process of differentiation should take place early in patient history taking as the symptomatology and history of a patient experiencing vascular pathology may alert the clinician to the underlying problem.[47,60] A high index of suspicion of cervical vascular involvement is required when acute neck/head pain is described as "unlike any other."[60]

Refer on for Further Investigation

It is recommended that clinicians refer for immediate medical investigation when

Case D

Synopsis: History of headaches indicates focused questioning that fails to support vascular hypothesis. Further findings are consistent with musculoskeletal disorder.

Patient History: A 45-year-old male is referred with a 6-month history of gradual onset unilateral neck pain, and more recently, headaches. The pain is manageable and not worsening, but the patient is worried that the pain has not resolved. Focused questioning for vascular pathology and dysfunction does not indicate a vascular hypothesis: no trauma, no history of migraine, no significant cardiovascular factors. The nature of the pain is consistent with typical musculoskeletal dysfunction, and there are no signs and symptoms associated with vascular pathology or dysfunction.

Physical Examination: There is no indication from the history that any part of the physical examination should be focused on testing for vascular pathology or dysfunction. There is sufficient information to proceed with a conventional musculoskeletal examination.

Clinical Reasoning: Neck pain and headache, not worsening, and no symptoms of vascular pathology or dysfunction. A reasonable hypothesis is a musculoskeletal disorder affecting the cervical and cranial regions.

Support for Vascular Hypothesis: LOW

Action: Begin a trial of therapy for neck pain/headache with no avoidance of craniocervical movements

Case E

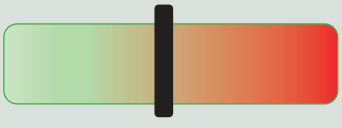
Synopsis: Patient history and physical examination findings support a vascular hypothesis but an alternative, more likely explanation for the presenting complaint is also supported. There are insufficient data to support medical referral. Safety netting is indicated.

Patient History: A 72-year-old female is referred with episodic neck pain and headache. She has responded very well to manual therapy in the past. This episode is described as very severe and very irritable, like previous episodes. She has a cardiovascular history of hypertension, high cholesterol levels, and 2 previous strokes (the last one was 3 years ago).

Physical Examination: On examination, the patient's resting blood pressure is high: 165 systolic/96 diastolic, but normal for her. All cranial testing is negative, and there are no abnormal findings on palpation and auscultation of the carotid arteries. She had a movement restriction typical of cervical musculoskeletal dysfunction.

Clinical Reasoning: Although there are several cardiovascular risk factors, the episodic neck pain is not unusual for this patient, and although severe, it is not worsening or changing. It is prudent of the therapist to consider further questioning, and a vascular hypothesis is warranted in the physical examination, focused on establishing what is normal for the patient. On the balance of probabilities, the patient is presenting with musculoskeletal dysfunction, but she does have risk factors for a further vasculogenic episode (stroke).

Support for Vascular Hypothesis: MODERATE



Action: Safety netting is required. It is important that the patient knows that she must act immediately if new signs and symptoms present. The clinical evidence suggests the presenting pain is more likely to be musculoskeletal. This is supported by the known low prevalence of vascular pathology and dysfunction. Therapeutic advice and interventions can be trialed during safety netting, but these interventions must avoid known vasculo-provocative positions (end-of-range rotation and extension). A shared decision-making conversation should be developed, which includes full and explicit informed consent, expressing all known risk and benefits of management options.

their clinical suspicion supported by the reasoned patient history and physical examination findings suggest vascular pathology. Conventionally, duplex ultrasound, magnetic resonance imaging/arteriography, and computed tomography are used.

Case C illustrates an example narrative associated with the physical examination.

PLANNING INTERVENTION

This section relates to patients who are *not* presenting with a discrete vascular pathology, but rather with neuromusculoskeletal craniocervical dysfunction suitable for musculoskeletal intervention inclusive of mobilization, manipulation, and exercise intervention. Therefore, this assessment of risk and benefit relates to the risk associated with treatment, not misdiagnosis.

Framework for Evaluating Risk

Given that serious adverse events are (extremely) rare, it is difficult to express the association between risk and benefit as this would require a large, prospective observational study including (potentially) hundreds of thousands of participants.

The risks of a serious adverse event from musculoskeletal intervention (manual and/or exercise interventions) are extremely low in comparison to other noninvasive treatments and vary depending on the patient's individual clinical presentation and presence of known risk factors. The clinician must recognize and consider whether a patient is at increased risk and work to minimize the risk. In the context of the IFOMPT cervical framework, there are 2 substantive, but related, risks:

1. misdiagnosis of an existing vascular pathology, and
2. serious adverse event following intervention.

Misdiagnosis occurs, although it is difficult to assess quantitatively. The current hypothesis is that patients presenting with neck pain and headache who go on to develop a serious adverse event, such as a dissection, have underlying pathology that is subsequently aggravated by treatment. These patients present with a clinical condition that appears musculoskeletal related, but is a different pathology. The majority of the existing literature focuses on spontaneous dissection, of which physical treatments represent a small proportion. The framework attempts to summarize these risks and to provide balance against known benefits.

Risk

The rate of VA dissections in the general population is estimated at 0.75-2.9 per 100 000 people.[5,7,9,32,34,49,67] Internal carotid artery dissections occur more frequently than VA dissections in a general population.[14,15] In contrast, the vast

TABLE 10 The SHARE Conversation

Step	Clinician
1. Seek your patient's participation	Case D. The good news despite suffering from this for the last 6 months is that your nerves, muscles, and arteries are healthy, and you should respond very well to therapy. Case E. I know you have responded very well to manual therapy in the past. However, your overall health status of your cardiovascular system puts you at higher risk for experiencing safety incidents with this type of therapy.
2. Help your patient explore and compare treatment options	Case D. There are several treatments that have been shown to rapidly improve your discomfort. Today I would recommend we begin with some manual therapy and exercise. Before I begin, you should know there is some risk involved when treating neck pain with movement therapies. These include minor worsening of symptoms and, in extremely rare instances, a vascular pathology such as a stroke. However, these risks are extremely low, and when compared to many pharmaceuticals or invasive procedures to your neck, manual therapy, and exercise are much safer. The good news is these types of problems get better quickly with the plan we have outlined. Case E. Given your overall health status, you are at greater risk of a stroke, and this risk could be increased with manual therapy to your neck. The good news is that on balance, these risks are extremely low and, when compared to many pharmaceuticals or invasive procedures to your neck, they are likely much safer.
3. Assess your patient's values and preferences	Case D. Do you have any questions or concerns before we get started? Case E. Do you have any questions or concerns before we begin our treatment today?
4. Reach a decision with your patient	Case D. It appears that we both feel this approach would be of benefit so let's begin. Case E. Given that you have responded to this in the past and you want to try this therapy again, we can proceed.
5. Evaluate your patient's decision	Case D. Throughout your care, we will be continuously seeing how you respond and adjust our therapies based on this. Case E. It is important that we monitor your cardiovascular system and your overall response to therapy on an ongoing basis. If you have any new or unusual symptoms or • numbness or weakness of face, arm, or leg, especially on only one side of the body; • confusion or trouble speaking or understanding; • trouble seeing in one eye or both eyes; • trouble walking, dizziness, or loss of balance or coordination; • severe headache with no known cause, you need to seek immediate medical attention. Also, I want you to monitor your blood pressure daily.

majority of serious adverse events associated with physical treatments involve the VA rather than the ICA.

The best data available regarding prevalence of VA dissections associated with physical treatments suggest the rate is approximately 0.4:100 000 to 5:100 000 patients (converted for comparison from the work of Nielsen et al[38]). The relative risk of stroke following physical treatment varies between 0.14 and 6.66. These broad estimates suggest both a reduced or much greater risk of stroke, which indicates a fundamental problem with definitions and identification of cases, and bias in the design of studies that have examined this issue. **TABLE 9** shows known risk of management options for those with headache and/or neck pain. This table presents meaningfully comparable adverse events for the outcomes of quality of life, morbidity and mortality, and uses the baseline prevalence of these events to calculate absolute risk given the intervention. Due to the very low baseline prevalence of vascular pathologies of the neck, the absolute risk of physical treatments is much less than that of comparable therapies (eg, pharmacotherapy).

While those exposed to physical treatments have a potentially increased risk, physical treatment in those presenting with neck pain and headache does not increase the risk compared to a visit to the general practitioner. The underlying hypothesis is that patients present with an existing or impending vascular pathology, which is subsequently aggravated by treatment.[9] This might suggest that physical intervention, as part of treatment, does not result in vascular pathology in those who are otherwise *healthy*. Additionally, biomechanical studies in healthy individuals suggest that physical treatment itself, especially if undertaken in a combination of midrange positions of the neck, cannot generate sufficient vessel stress or hemodynamic changes to singularly explain the onset of a dissection event.[58]

There are fewer data examining nondissecting events following physical treatments, primarily due to a lack of proper reporting. Although this is likely to be higher than dissection events (because nondissection pathology is generally more prevalent), it is likely that the overall absolute risk is extremely low.[57]

Benefit of Physical Interventions

The benefits of mobilization and manipulation are supported by high-quality systematic reviews and meta-analyses (summarized below). Mobilization, manipulation, and exercise interventions are also included in the most recent Clinical Practice Guidelines linked to the International Classification of Functioning, Disability, and Health.[6] The known effectiveness of interventions for neck pain and associated disorders (headache, radiculopathy) are presented below.

Mobilization and Manipulation

Mobilization and manipulation for neck pain[20] have moderate to large clinically beneficial effects compared to inactive or active interventions for pain and functional outcomes. These benefits were independent of follow-up (short-, intermediate-, or long-term) and duration of the neck pain (acute, subacute, or chronic). For tension-type headache, there are more favorable outcomes from mobilization and manipulation.[35] However, data were clinically heterogeneous, and the methodological quality varied greatly across the trials, precluding strong recommendations. Nevertheless, this conclusion is supported by the updated Bone and Joint Decade Task Force on neck pain and associated disorders.[66] Cervical manipulation had an immediate effect with moderate to large effects on cervical radiculopathy compared to no treatment, placebo, or traction interventions.[69]

Adding Exercise to Mobilization and Manipulation

There is moderate to strong quality evidence suggesting various forms of mobilization and/or manipulation in combination

Case F

Synopsis: Young patient with a history of migraine and recent trauma presents with "unusual" headache. Onset of vascular signs and symptoms during care should alert the therapist to test a vascular hypothesis in line with best practice guidance and refer appropriately.

Patient History: A 33-year-old male presents with right-sided suboccipital neck pain/headache. Worse is in the mornings and aggravated by left rotation of the neck. Symptoms began 2 weeks ago (he recalls "cricking" his neck in a football tackle)—they are gradually worsening. No previous similar episode of this type of pain, but some lower neck pains several years ago. Good health; history of migraine. The patient had manual therapy 5 days ago (soft tissue massage to his bilateral neck and shoulder; dry needling/acupuncture to his right trapezius; mobilization of the upper cervical spine [C0-C2]). Immediate increased pain in left cervical spine and episode of feeling very unsteady/dizziness. The therapist attempted to continue with soft-tissue massage when the dizziness settled, but the patient then became unwell and vomited.

Physical Examination: Mild restrictions of cervical movement. The previous therapist had performed functional positional testing when patient reported changing "red flag" symptoms, which was negative. No other neurological or vascular examination was performed.

Clinical Reasoning: Worsening neck pain with neurovascular symptoms following therapy. History of trauma and migraine, and "unusual" neck pain. The progressive onset of signs and symptoms indicates vascular pathology and should trigger an urgent change in management. It is not possible to understand whether or not the early presentation was a masquerading vascular pathology, but therapists should be alert to changes of signs and symptoms following interventions and over time.

Support for Vascular Hypothesis: HIGH

Action: When the patient became unwell, an emergency medical referral (ambulance) should have been made.

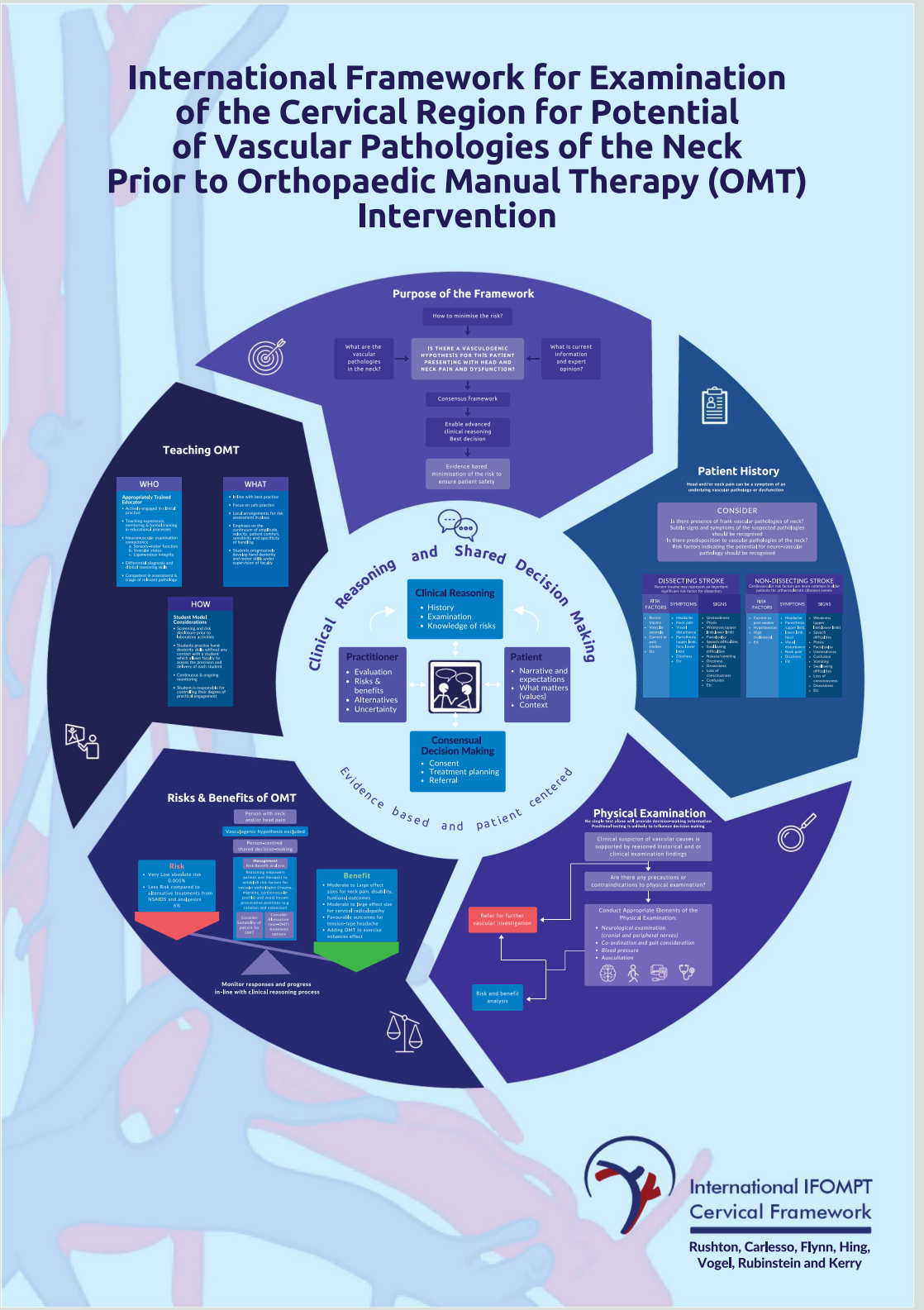


FIGURE 8. Summary poster of the framework infographic.

with exercise results in better outcomes (ie, pain relief, improvement in physical functioning, greater patient satisfaction, and quality of life) than exercise alone for people with subacute and chronic nonspecific neck pain.[22] Approximately half the included trials demonstrated moderate to large clinically beneficial effects when mobilization and/or manipulation was added to the treatment at short- and medium-term follow-up. These findings were, however, not supported by another review[17] reporting moderate quality evidence that the addition of mobilization and/or manipulation to exercise therapy did not provide additional benefit for pain, disability, or quality of life in adults with low-grade neck pain. The evidence is, therefore, conflicting.

In summary, the risks of serious adverse events following mobilization and manipulation are very small and related to some known risk factors. As such, risk can be somewhat mitigated via a thorough history taking and physical examination. No specific data exist for risk following exercise. The benefits of mobilization, manipulation, and exercise are largely positive, with many interventions resulting in moderate to large effects sizes for meaningful outcomes, with some moderate quality evidence suggesting effects are long term. **FIGURE 6** summarizes risk versus benefit.

Person-centered Decision-making

From an individual level, based on the background literature, which highlights various risk factors for specific pathologies in specific people, the epidemiological data must be contextualized to the specific patient encounter, as illustrated by the cases. This is also the case for decision-making regarding choice of intervention and its predicted benefit. Accurate data to inform precise level of risk at an individual level are lacking, so it is not possible to develop valid clinical prediction rules for risk nor benefit. An absolute risk judgement cannot be made by the clinician. The clinician must accept that the clinical decision is made in the absence of certainty, and a decision based on a *balance of probabilities* is the aim of analysis. When in doubt about intervention, the clinician should consider not intervening and assess the chance of natural recovery of pain and function (assuming a musculoskeletal dysfunction). **FIGURE 7** summarizes the decision-making process. It is the responsibility of the clinician to make the best decision regarding intervention in these situations using their clinical reasoning skills.[23,28,30]

Cases D and E illustrate key issues associated with decision-making for intervention.

Shared decision-making is an effective means of reaching agreement on the best strategy for treatment. The SHARE framework provides a step-by-step guideline to having these conversations. Like any new skill, if a clinician is not currently using this, it is recommended to practice this format with a colleague prior to implementing it. Using the SHARE framework, **TABLE 10** details a possible SHARE conversation relating to cases D and E (https://www.ahrq.gov/professionals/shareddecisionmaking/tools/tool-1/share-tool1.pdf).

EVALUATING AN INTERVENTION

Clinical reasoning should enable effective, efficient, and safe management of the cervical spine. Using the principles described in the IFOMPT cervical framework to aid patient-centered clinical reasoning through intervention, evaluation, and progression is important.

Case F illustrates key issues associated with evaluation of intervention.

CONCLUSION

The IFOMPT cervical framework provides a starting point to guide clinical reasoning when clinicians are assessing and managing patients who are presenting with potential vascular pathologies. **FIGURE 8** summarizes the framework. While evaluation of the measurement properties of a starting point framework is challenging, a recent study identified support for the framework's interexaminer reliability.[13] The IFOMPT framework is important for all clinicians.[24] It identifies priorities for future research including diagnostic utility of history and physical data clusters of information to prioritize. ◉

KEY POINTS

FINDINGS: There are distinguishing features between patients presenting with vascular pathologies of the neck and patients who present with features of a musculoskeletal disorder. Vascular pathologies may be recognizable if the appropriate questions are asked during the patient history–taking process, if interpretation of elicited data enables recognition of this potential, and if the physical examination can be adapted to explore any potential vasculogenic hypothesis.

IMPLICATIONS: Within the cervical spine, events and presentations of vascular pathologies of the neck are rare but are an important consideration as part of patient examination. The framework is designed to aid patient-centered clinical reasoning in a subject area where uncertainty is an important consideration.

CAUTION: Data available to inform clinical reasoning will improve and change with ongoing research. The framework provides a starting point, while encouraging clinicians to stay current in the topic area, to enable support for their clinical decisions.

STUDY DETAILS

AUTHOR CONTRIBUTIONS: All authors provided substantial intellectual content contributions to the conception and development of the framework document during the early draft and revision stages. All authors provided final approval of the manuscript to be published and have agreed to be accountable for all aspects of the work to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

DATA SHARING: No data are available. Feedback on iterative drafts of the framework was provided confidentially from International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) member organizations.

PATIENT AND PUBLIC INVOLVEMENT: Patients/athletes/public partners were not involved in this consensus process.

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REFERENCES

1. Arca KN, Singh RB. The hypertensive headache: a review. *Curr Pain Headache Rep*. 2019;23:1-8. https://doi.org/10.1007/s11916-019-0767-z
2. Arnold M, Bousser MG, Fahrni G, et al., Vertebral artery dissection: presenting findings and predictors of outcome. *Stroke*. 2006;37:2499-2503. https://doi.org/10.1161/01.STR.0000240493.88473.39
3. Atallah PC, Atallah P, Kashyap V. Internal carotid artery aneurysm discovered by palpation of asymmetric pulses. *Am J Med*. 2010;123:e1-e2. https://doi.org/10.1016/j.amjmed.2009.12.034
4. Bally M, Beauchamp ME, Abrahamowicz M, Nadeau L, Brophy JM. Risk of acute myocardial infarction with real-world NSAIDs depends on dose and timing of exposure. *Pharmacoepidemiol Drug Saf*. 2018;27:69-77. https://doi.org/10.1002/pds.4358
5. Béjot Y, Daubail B, Debette S, Durier J, Giroud M. Incidence and outcome of cerebrovascular events related to cervical artery dissection: the Dijon Stroke Registry. *Int J Stroke*. 2014;9:879-882. https://doi.org/10.1111/ijs.12154
6. Blanpied PR, Gross AR, Elliott JM, et al. Neck pain: revision 2017. *J Orthop Sports Phys Ther*. 2017;47:A1-A83. https://doi.org/10.2519/jospt.2017.0302
7. Boyle E, Côté P, Grier AR, Cassidy JD. Examining vertebrobasilar artery stroke in two Canadian provinces. *J Manip Physiol Ther*. 2009;32:S194-S200. https://doi.org/10.1097/BRS.0b013e31816454e0
8. Carolei A, Sacco S. Headache attributed to stroke, TIA, intracerebral haemorrhage, or vascular malformation. In: Handbook of Clinical Neurology. Elsevier; 2010:517-528. https://doi.org/10.1016/S0072-9752(10)97047-4
9. Cassidy JD, Boyle E, Côté P, et al. Risk of vertebrobasilar stroke and chiropractic care. *Eur Spine J*. 2008;17:176-183. https://doi.org/10.1007/s00586-008-0634-9
10. Chauhan G, Debette S. Genetic risk factors for ischemic and hemorrhagic stroke. *Curr Cardiol Rep*. 2016;18:124. https://doi.org/10.1007/s11886-016-0804-z
11. Coulter A, Collins A. *Making Shared Decision-making a Reality*. London, UK: King's Fund; 2011. https://www.kingsfund.org.uk/sites/default/files/Making-shared-decision-making-a-reality-paper-Angela-Coulter-Alf-Collins-July-2011_0.pdf
12. Damodaran O, Rizk E, Rodriguez J, Lee G. Cranial nerve assessment: a concise guide to clinical examination. *Clin Anat*. 2014;27:25-30. https://doi.org/10.1002/ca.22336
13. De Best RF, Coppieters MW, Van Trijffel E, et al. Interexaminer agreement and reliability of an internationally endorsed screening framework for cervical vascular risks following manual therapy and exercise: the Go4Safe project. *Phys Ther*. 2021;101:pzab166. https://doi.org/10.1093/ptj/pzab166
14. Debette S, Compter A, Labeyrie MA, et al. Epidemiology, pathophysiology, diagnosis, and management of intracranial artery dissection. *Lancet Neurol*. 2015;14:640-654. https://doi.org/10.1016/S1474-4422(15)00009-5
15. Debette S, Leys D. Cervical-artery dissections: predisposing factors, diagnosis, and outcome. *Lancet Neurol*. 2009;8:668-678. https://doi.org/10.1016/S1474-4422(09)70084-5
16. Elder A, Japp A, Verghese A. How valuable is physical examination of the cardiovascular system? *BMJ*. 2016;354:i3309. https://doi.org/10.1136/bmj.i3309
17. Fredin K, Lorås H. Manual therapy, exercise therapy or combined treatment in the management of adult neck pain–a systematic review and meta-analysis. *Musculoskelet Sci Pract*. 2017;31:62-71. https://doi.org/10.1016/j.msksp.2017.07.005
18. Fujii H, Ohtsuki T, Takeda I, Hosomi N, Matsumoto M. Isolated unilateral hypoglossal nerve paralysis caused by internal carotid artery dissection. *J Stroke Cerebrovasc Dis*. 2014;23:e405-e406. https://doi.org/10.1016/j.jstrokecerebrovasdis.2014.03.004
19. Fuller G. Neurological Examination Made Easy. Elsevier Health Sciences; 2019.
20. Gross A, Langevin P, Burnie SJ, et al. Manipulation and mobilisation for neck pain contrasted against an inactive control or another active treatment. *Cochrane Database Syst Rev*. 2015. https://doi.org/10.1002/14651858.CD004249.pub4
21. Hennings JM, Höhn D, Schumann-Spaeth E, Weber F. Painless hypoglossal palsy as an isolated symptom of spontaneous carotid dissection. *J Stroke Cerebrovasc Dis*. 2014;23:1988-1990. https://doi.org/10.1016/j.jstrokecerebrovasdis.2014.02.001
22. Hidalgo B, Hall T, Bossert J, Dugeny A, Cagnie B, Pitance L. The efficacy of manual therapy and exercise for treating non-specific neck pain: a systematic review. *J Back Musculoskelet Rehabil*. 2018;30:1149-1169. https://doi.org/10.3233/BMR-169615
23. Hutting N, Kerry R, Coppieters MW, Scholten-Peeters GG. Considerations to improve the safety of cervical spine manual therapy. *Musculoskelet Sci Pract*. 2018;33:41-45. https://doi.org/10.1016/j.msksp.2017.11.003
24. Hutting N, Kerry R, Kranenburg R, Mourad F, Taylor A. Assessing vascular function in patients with neck pain, headache, and/or orofacial pain: part of the job description of all physical therapists. *J Orthop Sports Phys Ther*. 2021;51:418-421. https://doi.org/10.2519/jospt.2021.10408
25. National Institute for Health and Care Excellence. Hypertension in adults: diagnosis and management. 2016. https://www.nice.org.uk/guidance/cg127/chapter/1-guidance#measuring-blood-pressure
26. Institute of Medicine (US) Committee on Quality of Health Care in America. Crossing the Quality Chasm: A New Health System for the 21st Century. National Academies Press (US); 2001.
27. Isabel C, Calvet D, Mas JL. Stroke prevention. *Presse Méd*. 2016;45:e457-e471. https://doi.org/10.1016/j.lpm.2016.10.009
28. Jones MA, Rivett DA. Improving clinical reasoning in manual therapy. In: Clinical Reasoning for Manual Therapist. Elsevier Health Sciences; 2004. https://doi.org/10.1016/B978-0-7506-3906-4.50031-9
29. Kallioinen N, Hill A, Horswill MS, Ward HE, Watson MO. Sources of inaccuracy in the measurement of adult patients' resting blood pressure in clinical settings: a systematic review. *J Hypertens*. 2017;35:421-441. https://doi.org/10.1097/HJH.0000000000001197
30. Kerry R, Taylor AJ. Cervical arterial dysfunction assessment and manual therapy. *Man Ther*. 2006;11:243-253. https://doi.org/10.1016/j.math.2006.09.006
31. Koch I, Ferrazzi A, Busatto C, et al. Cranial nerve examination for neurogenic dysphagia patients. *Otolaryngol (Sunnyvale)*. 2017;7:319. https://doi.org/10.4172/2161-119X.1000319
32. Kranenburg HA, Schmitt MA, Puentedura EJ, Luijckx GJ, Van der Schans CP. Adverse events associated with the use of cervical spine manipulation or mobilization and patient characteristics: a systematic review. *Musculoskelet Sci Pract*. 2017;28:32-38. https://doi.org/10.1016/j.msksp.2017.01.008
33. Lebedeva ER, Gurary NM, Olesen J. Headache in transient ischemic attacks. *J Headache Pain*. 2018;19:60. https://doi.org/10.1186/s10194-018-0888-5
34. Lee VH, Brown RD, Mandrekar JN, Mokri B. Incidence and outcome of cervical artery dissection: a population-based study. *Neurology*. 2006;67:1809-1812. https://doi.org/10.1212/01.wnl.0000244486.30455.71

35. López CL, Jiménez JM, de la Hoz Aizpurúa JL, Grande JP, de Las Peñas CF. Efficacy of manual therapy in the treatment of tension-type headache. A systematic review from 2000 to 2013. *Neurología (English Edition)*. 2016;31:357-369. https://doi.org/10.1016/j.nrleng.2016.05.001
36. Maitland GD, Hengeveld E, Banks K, English K. Maitland's Vertebral Manipulation: Elsevier Butterworth; 2005.
37. Masclee GM, Valkhoff VE, Coloma PM, et al. Risk of upper gastrointestinal bleeding from different drug combinations. *Gastroenterology*. 2014;147:784-792. https://doi.org/10.1053/j.gastro.2014.06.007
38. Nielsen SM, Tarp S, Christensen R, Bliddal H, Klokker L, Henriksen M. The risk associated with spinal manipulation: an overview of reviews. *Syst Rev*. 2017;6:64. https://doi.org/10.1186/s13643-017-0458-y
39. Patel RR, Adam R, Maldjian C, Lincoln CM, Yuen A, Arneja A. Cervical carotid artery dissection: current review of diagnosis and treatment. *Cardiol Rev*. 2012;20:145-152. https://doi.org/10.1097/CRD.0b013e318247cd15
40. Peltz E, Köhrmann M. Internal-carotid-artery dissection and cranial-nerve palsies. *N Engl J Med*. 2011;365:e43. https://doi.org/10.1056/NEJMicm1009319
41. Petty NJ. Neuromusculoskeletal Examination and Assessment: A Handbook for Therapists. 4th ed. London, UK: Churchill Livingstone, Elsevier; 2011.
42. Petty NJ. Becoming an expert: a masterclass in developing clinical expertise. *Int J Osteopath Med*. 2015;18:207-218. https://doi.org/10.1016/j.ijosm.2015.01.001
43. Pickett CA, Jackson JL, Hemann BA, Atwood JE. Carotid artery examination, an important tool in patient evaluation. *South Med J*. 2011;104:526-532. https://doi.org/10.1097/SMJ.0b013e31821e9493
44. Pollak L, Shlomo N, Korn Lubetzki I, National Acute Stroke Israeli Survey Group. Headache in stroke according to National Acute Stroke Israeli Survey. *Acta Neurol Scand*. 2017;135:469-475. https://doi.org/10.1111/ane.12621
45. Redekop GJ. Extracranial carotid and vertebral artery dissection: a review. *Can J Neurol Sci*. 2008;35:146-152. https://doi.org/10.1017/S0317167100008556
46. Rich K. Carotid bruit: a review. *J Vasc Nurs*. 2015;33:26-27. https://doi.org/10.1016/j.jvn.2014.12.002
47. Rivett DA. Adverse effects of cervical manipulative therapy. In: Grieve's Modern Manual Therapy: The Vertebral Column. London, UK: Churchill Livingstone, Edinburgh; 2004:534-536.
48. Roberts E, Nunes VD, Buckner S, et al. Paracetamol: not as safe as we thought? A systematic literature review of observational studies. *Ann Rheum Dis*. 2016;75:552-559. https://doi.org/10.1136/annrheumdis-2014-206914
49. Rothwell DM, Bondy SJ, Williams JI. Chiropractic manipulation and stroke: a population-based case-control study. *Stroke*. 2001;32:1054-1060. https://doi.org/10.1161/01.STR.32.5.1054
50. Rubinstein SM, Peerdeman SM, Van Tulder MW, Riphagen I, Haldeman S. A systematic review of the risk factors for cervical artery dissection. *Stroke*. 2005;36:1575-1580. https://doi.org/10.1161/01.STR.0000169919.73219.30
51. Rushton A, Lindsay G. Defining the construct of masters level clinical practice in manipulative physiotherapy. *Man Ther*. 2010;15:93-99. https://doi.org/10.1016/j.math.2009.08.003
52. Rushton A, Rivett D, Carlesso L, Flynn T, Hing W, Kerry R. International framework for examination of the cervical region for potential of cervical arterial dysfunction prior to orthopaedic manual therapy intervention. *Man Ther*. 2014;19:222-228. https://doi.org/10.1016/j.math.2013.11.005
53. Saiz LC, Gorricho J, Garjon J, Celaya MC, Erviti J, Leache L. Blood pressure targets for the treatment of people with hypertension and cardiovascular disease. *Cochrane Database Syst Rev*. 2020:CD010315. https://doi.org/10.1002/14651858.CD010315.pub4
54. Schmid AB, Brunner F, Luomajoki H, et al. Reliability of clinical tests to evaluate nerve function and mechanosensitivity of the upper limb peripheral nervous system. *BMC Musculoskelet Disord*. 2009;10:1-9. https://doi.org/10.1186/1471-2474-10-11
55. Selwaness M, Hameeteman R, Van't Klooster R, et al. Determinants of carotid atherosclerotic plaque burden in a stroke-free population. *Atherosclerosis*. 2016;255:186-192. https://doi.org/10.1016/j.atherosclerosis.2016.10.030
56. Selwaness M, van den Bouwhuijsen QJ, Verwoert GC, et al. Blood pressure parameters and carotid intraplaque hemorrhage as measured by magnetic resonance imaging: the Rotterdam study. *Hypertension*. 2013;61:76-81. https://doi.org/10.1161/HYPERTENSIONAHA.112.198267
57. Swait G, Finch R. What are the risks of manual treatment of the spine? A scoping review for clinicians. *Chiropr Man Ther*. 2017;25:37. https://doi.org/10.1186/s12998-017-0168-5
58. Symons B, Herzog W. Cervical artery dissection: a biomechanical perspective. *J Can Chiropr Assoc*. 2013;57:276-278.
59. Taylor A, Mourad F, Kerry R, Hutting N. A guide to cranial nerve testing for musculoskeletal clinicians. *J Man Manip Ther*. 2021;29:376-390. https://doi.org/10.1080/10669817.2021.1937813
60. Taylor AJ, Kerry R. A 'system based' approach to risk assessment of the cervical spine prior to manual therapy. *Int J Osteopath Med*. 2010;13(3):85-93. https://doi.org/10.1016/j.ijosm.2010.05.001
61. Taylor AJ, Kerry R. When chronic pain is not "chronic pain": lessons from 3 decades of pain. *J Orthop Sports Phys Ther*. 2017;47:515-517. https://doi.org/10.2519/jospt.2017.0606
62. Thomas LC, Rivett DA, Attia JR, Levi C. Risk factors and clinical presentation of cervical arterial dissection: preliminary results of a prospective case-control study. *J Orthop Sports Phys Ther*. 2015;45:503-511. https://doi.org/10.2519/jospt.2015.5877
63. Thomas LC, Rivett DA, Attia JR, Levi CR. Risk factors and clinical presentation of craniocervical arterial dissection: a prospective study. *BMC Musculoskelet Disord*. 2012;13:1-6. https://doi.org/10.1186/1471-2474-13-164
64. Thomas LC, Rivett DA, Attia JR, Parsons M, Levi C. Risk factors and clinical features of craniocervical arterial dissection. *Man Ther*. 2011;16:351-356. https://doi.org/10.1016/j.math.2010.12.008
65. Thomas LC, Rivett DA, Parsons M, Levi C. Risk factors, radiological features, and infarct topography of craniocervical arterial dissection. *Int J Stroke*. 2014;9:1073-1082. https://doi.org/10.1111/j.1747-4949.2012.00912.x
66. Varatharajan S, Ferguson B, Chrobak K, et al. Are non-invasive interventions effective for the management of headaches associated with neck pain? An update of the Bone and Joint Decade Task Force on Neck Pain and Its Associated Disorders by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *Eur Spine J*. 2016;25:1971-1999. https://doi.org/10.1007/s00586-016-4376-9
67. Vaughan B, Moran R, Tehan P, et al. Manual therapy and cervical artery dysfunction: identification of potential risk factors in clinical encounters. *Int J Osteopath Med*. 2016;21:40-50. https://doi.org/10.1016/j.ijosm.2016.01.007
68. Zheng SL, Roddick AJ. Association of aspirin use for primary prevention with cardiovascular events and bleeding events: a systematic review and meta-analysis. *JAMA*. 2019;321:277-287. https://doi.org/10.1001/jama.2018.20578
69. Zhu L, Wei X, Wang S. Does cervical spine manipulation reduce pain in people with degenerative cervical radiculopathy? A systematic review of the evidence, and a meta-analysis. *Clin Rehabil*. 2016;30:145-155. https://doi.org/10.1177/0269215515570382

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