Supplement

Scand J Work Environ Health 2001;27(1):1-102

doi:10.5271/sjweh.637

Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders

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Refers to the following texts of the Journal: 1997;23(4):299-307 1998;24(2):138-144 1997;23(6):435-439 2000;26(1):7-19 1997;23(2):130-139 1999;25(3):163-185 1996;22(3):176-181

The following articles refer to this text: 2002;28(5):293-303; 2004;30(4):261-278; 2007;33(1):58-65; 2007;33(2):131-140; 2008;34(5):374-380; 2009;35(3):222-232; 2009;35(4):301-308; 2010;36(1):25-33; 2010;36(5):384-393; 2012;38(5):436-446; 2013;39(5):506-514; 2014;40(4):400-410; 2017;43(1):75-85

Key terms: carpal tunnel syndrome; case definition; criteria document; cupital tunnel syndrome; De Quervain's disease; definition; elbow; evaluation; flexor-extensor peritendinitis; forearm; forearm-wrist region; guyon canal syndrome; hand; hand-arm vibration; lateral epicondylitis; medial epicondylitis; MSD; musculoskeletal disorder; neck; nonspecific upper-extremity musculoskeletal disorder; osteoarthrosis; peripheral neuropathy; radial nerve compression; radial tunnel syndrome; radiating neck complaint; raynaud's phenomenon; rotator cuff syndrome; shoulder; temporal criterion; tenosynovitis; ulnar nerve compression; upper back; upper extremity; upper-extremity joint; work-related musculoskeletal disorder; work-related upper-extremity musculoskeletal disorder; work-relatedness; wrist

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/11401243

10. Raynaud's phenomenon and peripheral neuropathy associated with hand-arm vibration

Description of the disorders and clinical features

A history of exposure to hand-arm vibration can result in a complex of disorders affecting the vascular, neurological, and osteoarticular systems of the upper limbs, especially the lower arm and hand. Taken together, this complex of disorders is called the hand-arm vibration syndrome (HAVS) (128).

Raynaud's phenomenon (RP) is characterized by local digital pallor upon exposure to cold or emotional stress (129, 130). When it occurs in isolation, this vasospastic disorder is called Raynaud's disease or primary Raynaud's phenomenon. When it is associated with a secondary condition, it is called Raynaud's phenomenon. The vascular component of the hand-arm vibration syndrome is a form of secondary Raynaud's phenomenon, commonly called vibration-induced white finger (VWF). The neurological component of the hand-arm vibration syndrome is characterized by peripheral, diffusely distributed neuropathy in the fingers with predominant sensory impairment (128). The osteoarticular component includes degenerative changes in the bones and joints of the upper extremities, mainly in the wrists and elbows (128, 131, 132).

Bovenzi (128) reviewed the current epidemiologic literature and suggested that the sensorineural symptoms and signs seem to appear earlier than vascular symptoms, although the latter seem to progress more rapidly after onset. He suggested that these findings support the notion of different pathogenic mechanisms for the sensorineural and vascular components of disorders caused by hand-transmitted vibration and that the disorders may develop independently of each other and at different rates.

The Stockholm workshop scales are commonly used to classify the severity of vascular and sensorineural symptoms of hand-arm vibration syndrome in epidemiologic studies (133, 134). These scales do not address the musculoskeletal symptoms associated with exposure to hand-arm vibration. In this document, we provide case definitions and diagnostic criteria for Raynaud's phenomenon and peripheral neuropathy in association with exposure to hand-arm vibration. The osteoarticular effects associated with hand-arm vibration exposure may not be specific to vibration exposure per se, and they are usually observed in combination with other physical factors (132). For this reason, we do not provide a case definition and diagnostic criteria for the osteoarticular component of the hand-arm vibration syndrome.

Differential diagnosis

Raynaud's phenomenon

Many conditions are associated with secondary Raynaud's phenomenon, the most common being connective tissue disorders such as systemic sclerosis, systemic lupus erythematosus, and rheumatoid arthritis. Other diseases related to Raynaud's phenomenon include fibromyalgia, carpal tunnel syndrome, cryoglobulinemia, diabetes mellitus, and thoracic outlet syndrome (135).

Peripheral neuropathy

Sensorineural symptoms in the hands can be caused by other entrapment neuropathies of the upper extremity. Carpal tunnel syndrome has been linked to vibration exposure (136, 137), but it is also common in jobs involving forceful and repetitive hand movements (118).

Information on test properties

Raynaud's phenomenon in association with hand-arm vibration

Maricq & Weinrich (138) developed a protocol to assist the diagnosis of Raynaud's phenomenon, not necessarily related to vibration exposure. This protocol included a simple questionnaire and color charts consisting of a 12-point color scale and a series of photographs illustrating blanching and cyanosis. The color charts were tested alone, and in combination with the questionnaire, on a group of 48 patients with Raynaud's phenomenon, whose Raynaud's phenomenon attacks were observed by the investigators as the gold standard, and on 246 negative subjects. Use of the color charts alone resulted in a sensitivity of 90% and a specificity of 100%. When combined with the questionnaire, the sensitivity increased to 100% in the gold standard group of positive subjects.

An international panel of experts convened at the 1994 Stockholm workshop on hand-arm vibration syndrome and evaluated the clinical and laboratory diagnostics of vascular symptoms associated with hand-arm vibration. They concluded that a medical interview is still the best method for diagnosing white finger triggered by cold and that none of the existing cooling tests are capable of grading the severity of vibration-induced white finger in individual cases [as reported by Gemne (139)].

Gemne (139) reported that the simple cold water provocation test (immersion of the hand in cold water) often fails to provoke symptoms (blanching or reduction in temperature of the finger skin) in patients with a clear history of white fingers. He suggested the critical opening pressure method (recording the systolic blood pressure of the finger during cold provocation) as the best way to measure a cold-induced reduction of blood flow in the skin of the finger.

Bovenzi et al (140) used finger systolic blood pressure (FSBP) during local cooling in their prospective study of chain-saw workers and manual workers not exposed to vibration. All the chain-saw operators showed a significant reduction in the percentage of finger systolic blood pressure at 10°C when compared with the referents ($P<0.001$), and the cold response observed in the group of workers with symptoms of vibration-induced white finger was significantly stronger than that seen in the 2 groups without such symptoms ($P<0.05$). The authors concluded that, when combined with reliable work and health histories, the measurement of finger systolic blood pressure after finger cooling is one of the most accurate tests for detecting cold-induced digital vasospasm and for objective confirmation of symptoms indicating vibration-induced white finger. The study also found that some vibration-exposed workers exhibited abnormal cold response before the appearance of vibration-induced white finger, suggesting that the measurement of finger systolic blood pressure during local cooling may be useful in revealing preclinical Raynaud's phenomenon. In a larger study of exposed and unexposed workers, Bovenzi (141) found finger systolic blood pressure similarly useful as a laboratory test for vibration-induced white finger.

Peripheral neuropathy in association with hand-arm vibration

Åkesson et al (142) studied neuropathy in female dental personnel (dentists and dental hygienists) exposed to vibration and dental assistants and medical nurses not exposed to vibration. The study found significant increases in vibrotactile perception thresholds, especially in the dominant hand, among the exposed groups when they were compared with referents, as well as decreased hand muscle strength as measured by dynamometry. The unexposed dental assistants also had significantly better performance on tests of manual dexterity. There were no significant differences among the groups in the 2-point discrimination testing.

Both Raynaud's phenomenon and peripheral neuropathy associated with hand-arm vibration

In their study to identify a diagnostic testing method with sufficient test properties to be used as a screening test for the hand-arm vibration syndrome in a working population, Kent et al (143) studied 40 currently working grinders with and 10 workers without vibration exposure from the same shipyard. The subjects' vascular and sensorineural symptoms were graded according to the Stockholm workshop scale. These results and the results of vibrometry testing were used as the gold standard and were compared with the results of a clinical evaluation. Similar to the findings of Brammer et al (134), the study results suggested that no single modality is sufficient for establishing the diagnosis or hand-arm vibration syndrome or the severity of the disorder. The general physical examination of the hands was the only modality that was uniformly abnormal in all the vibration-exposed workers and normal in 9 of the 10 referents, although it failed to distinguish between the symptomatic and asymptomatic workers. Mobility assessment of the extremities and various vascular maneuvers added little to the diagnostic regimen. Gross grip strength was of little value; pinch measurements were more sensitive and predictive. Two-point discrimination, dexterity testing, and monofilament testing for light touch sensitivity were found to provide valuable diagnostic information, but they lacked sensitivity and specificity as single test modalities. Vibrometry alone did not prove to have the necessary predictive value for this group of workers.

In their study of hand function in patients with hand-arm vibration syndrome, Cederlund et al (144) studied 20 male workers consecutively referred to a hand surgery department at a university hospital in Sweden for investigation for hand-arm vibration syndrome and 20 healthy referents. The patients were interviewed for subjective symptoms, completed a self-report of everyday activities, and had a physical examination, with a battery of 15 tests for sensibility, dexterity, grip function, and grip strength. Test results for each patient were compared with normative or control data. The study found that the tests varied in their sensitivity to detect impaired hand function. Among the best-standardized tests, the most discriminating was the use of Semmes-Weinstein monofilaments for the perception of light touch-deep pressure (whole hand), showing pathological outcomes for 18 of the 20 patients. The small-object shape identification test and the moving 2-point discrimination test were equally discriminating, although lacking in standardization. The standardized Purdue pegboard test detected reduced hand function in 17 of the 20 workers, and the authors considered this test to be one of the best for fingertip dexterity, despite its simplicity and the short testing time. Tactilometry to assess the perception of vibration was abnormal for 15 of the 20 patients. The least discriminating was the Jamar dynamometer, showing pathological outcomes for only 4 of the 20 patients.

Examples of case definitions and criteria proposed or used in different studies

Studies based on symptoms

Raynaud's phenomenon in association with hand-arm vibration. In a study of risk factors for Raynaud's phenomenon in workers exposed to cold but not to vibration in poultry slaughterhouses and canning factories in western France, investigators used the following case definition for Raynaud's phenomenon attacks of white and numb fingers provoked by exposure to cold (145).

In his study of 822 workers exposed to hand-transmitted vibration and 455 referents, Bovenzi (141) based the anamnestic diagnosis of vibration-induced white finger on a positive history of blanching attacks involving ≥1 fingers and occurring after the start of exposure to vibration produced by hand-held power tools.

Both Raynaud's phenomenon and peripheral neuropathy in association with hand-arm vibration. Kaewboonchoo et al (146) compared the use of the standardized Nordic questionnaire and the Japanese questionnaire to determine if the Nordic questionnaire translated into Japanese could be applied to workers exposed to hand-arm vibration. The Japanese questionnaire is used to screen for musculoskeletal disorders in workers exposed to hand-arm vibration. In addition to questions on general musculoskeletal pain, this self-administered questionnaire uses body charts and questions to collect symptom prevalence information on: (i) numbness, tingling, or dullness in fingers, palms at any time and (ii) white fingers. The questionnaire also asks about cold sensitivity, disability in activities of daily life, and duration, time of onset, and severity of symptoms.

Studies based on symptoms and signs

Raynaud's phenomenon in association with hand-arm vibration. Bovenzi et al (140) used the following criteria to diagnose vibration-induced white finger in their prospective study of the cold response of digital vessels in 68 forestry workers exposed to chain-saw vibration: (i) a positive history of cold-provoked episodes of well-demarcated blanching in ≥1 fingers after the exclusion of primary Raynaud's phenomenon, (ii) the initial appearance of finger blanching after the start of occupational exposure to hand-transmitted vibration and attacks of vibration-induced white fingers during the last 2 years, and (iii) an abnormal digital arterial response to cold provocation.

Peripheral neuropathy in association with hand-arm vibration. Dasgupta & Harrison (147) examined the prevalence of vibration-induced neuropathy in 66 jackhammer drillers exposed to hand-arm vibration and 35 unexposed blasters. The study collected information on vibration exposure and hand symptoms via questionnaires, and all the subjects were assessed clinically for signs of neuropathy, as well as for vascular and musculoskeletal abnormalities. Two objective assessments were done, consisting of motor conduction velocities at the median and ulnar nerves at the wrist and at the elbow in both arms and a finger circumference test to assess soft-tissue changes.

Both Raynaud's phenomenon and peripheral neuropathy in association with hand-arm vibration. In their study of hand-arm vibration syndrome in gas distribution operators in 3 regions of southern England, Palmer et al (81) assessed workers with an administered questionnaire, clinical examination, and cold challenge test applied to the hands. The questionnaire and examination were based on a model questionnaire proposed by the Royal College of Physicians Faculty of Occupational Medicine but modified to collected information on the distribution of symptoms and a detailed exposure history. Symptoms of blanching were only classified as present if persistent, recurrent, troublesome, well demarcated, and precipitated by cold. Blanching required a history of blanching as described, clinical signs on cold provocation, or both. Neurological symptoms of paresthesias, numbness, or both were only classified as present if troublesome, persistent, not related to the immediate use of tools, and without obvious alternative explanations. The physical examination included an undefined examination of the hands and upper limbs. The cold challenge test involved immersing both hands in cold water (2—8°C) for 4 minutes and then inspection for blanching. The test was graded as definite or probable, but only the definite findings were counted as blanching in the absence of a history of symptoms.

In their study of hand function in patients with hand-arm vibration syndrome, Cederlund et al (144) used the following inclusion criteria: long-term exposure to hand-held vibrating tools combined with sensory problems (numbness) or vascular problems (white fingers) of the hand or both.

Stockholm workshop scale

The Stockholm workshop scale is a result of a consensus conference held in Stockholm in 1986. It distinguishes sensorineural and vascular symptoms, unlike the previously and widely used Taylor Pelmear scale, which focused primarily on vasospastic changes (144). As described in Gemne et al (133), experts attending the Stockholm workshop on the symptomatology and diagnostic methods in the hand-arm vibration syndrome developed the classification system shown in table 6 for the severity of the vascular component of hand-arm vibration syndrome (cold-induced Raynaud's phenomenon in the hand-arm vibration syndrome, also called vibration-induced white finger).

As described earlier in this section (134), a similar classification was developed for the sensorineural symptoms commonly associated with the hand-arm vibration syndrome (table 7).

Proposed case definitions

Because hand-arm vibration has been associated with different types of symptoms and disorders, we propose the following 2 separate case definitions and criteria: one for Raynaud's phenomenon and another for peripheral neuropathy in association with exposure to hand-arm vibration. Some persons may experience both vascular and sensorineural symptoms.

Raynaud's phenomenon in association with exposure to hand-arm vibration

The temporal criteria used with the other disorders in this report are not included because of the uncertainties of environmental cold exposure.

At the 1994 Stockholm workshop on hand-arm vibration syndrome, the consensus from the Working Group on Clinical and Laboratory Diagnostics of Vascular Symptoms Induced by Hand-Arm Vibration was that the Stockholm workshop scale be used in clinical work and epidemiologic studies, and that the medical interview is the best available method for diagnosing vibration-induced white finger. The case definition and criteria follow those of the Stockholm workshop.

Palmer & Coggon (148) have argued that the Stockholm vascular grading scale for the hand-arm vibration syndrome is deficient in that it combines ambiguous measures of disease frequency with measures of disease extent. They have noted that the frequency of attacks depends of the time spent in cold environments, climate, latitude, and cultural habit (eg, glove wearing), and that Raynaud's phenomenon of any given severity will manifest different attack frequencies depending on these variables. They suggest that, for international comparisons, the extent of the disease is a more stable grading measure, but that information on attack frequency is desirable in clinical and medico-legal practice. Because our criteria are meant primarily for diagnosis and not for grading, they include both frequency and severity measures designed to identify Raynaud's phenomenon at the earliest possible stage.

Table 6. Stages of vascular symptoms of the hand-arm vibration syndrome in the Stockholm workshop scale, as reported by Gemne et al (133).

Stage	Grade	Description[a]
0		No attacks
1	Mild	Occasional attacks affecting only the tips of one or more fingers
2	Moderate	Occasional attacks affecting distal and middle (rarely also proximal) phalanges of ≥1 fingers
3	Severe	Frequent attacks affecting all phalanges of most fingers
4	Very severe	As in stage 3, with trophic skin changes in the fingertips

[a] Attack defined as: at least occasional attacks of well-demarcated local blanching of the hand-fingers accompanied by numbness of the affected parts of the finger skin triggered by exposure to environmental cold.

Table 7. Classification developed for the sensorineural symptoms commonly associated with the hand-arm vibration syndrome by Brammer et al (134).

Stage	Description
0SN	Exposed to vibration, but no symptoms
1SN	Intermittent numbness, with or without tingling
2SN	Intermittent or persistent numbness, reduced sensory perception
3SN	Intermittent or persistent numbness, reduced tactile discrimination or manipulative dexterity or both

Although Gemne (139) questioned the value of the simple cold water provocation test as a diagnostic sign for screening purposes, Palmer et al (81) used it in their study of gas distribution workers and found that a positive test had some diagnostic value. Bovenzi et al (128, 140, 141) suggested the measurement of systolic blood pressure after finger and body cooling as the best diagnostic test for the vascular component of the hand-arm vibration syndrome. However, it is unlikely that this test is feasible for most occupational physicians, and therefore it is not included in our criteria. Although the Stockholm Working Group suggested that a medical interview is the best method for diagnosing vibration-induced white finger, the observation of blanching is an additional piece of diagnostic evidence.

Peripheral neuropathy in association with exposure to hand-arm vibration

The symptoms included in the case definitions are based on the earliest stage of the scale commonly used to grade the sensorineural symptoms associated with the hand-arm vibration syndrome. The temporal criteria are consistent with those used with the other disorders in this document.

Objective signs evoked by sensory tests are needed to help diagnose and stage the sensorineural component of the hand-arm vibration syndrome consistently, although it may be difficult to verify the earliest stage with objective tests (134). Brammer et al (134) and Kent et al (143) have suggested that no single diagnostic sign is sufficient. Cederlund et al (144) demonstrated the sensitivity of many objective assessment tests for patients with moderate to severe symptoms. Thus our proposed criteria require positive responses to 2 commonly used sensory tests.

Additional tests to assess nerve damage can include electrodiagnostic studies, muscle force measurements (dynamometry), and finger vibrotactile threshold tests (149).

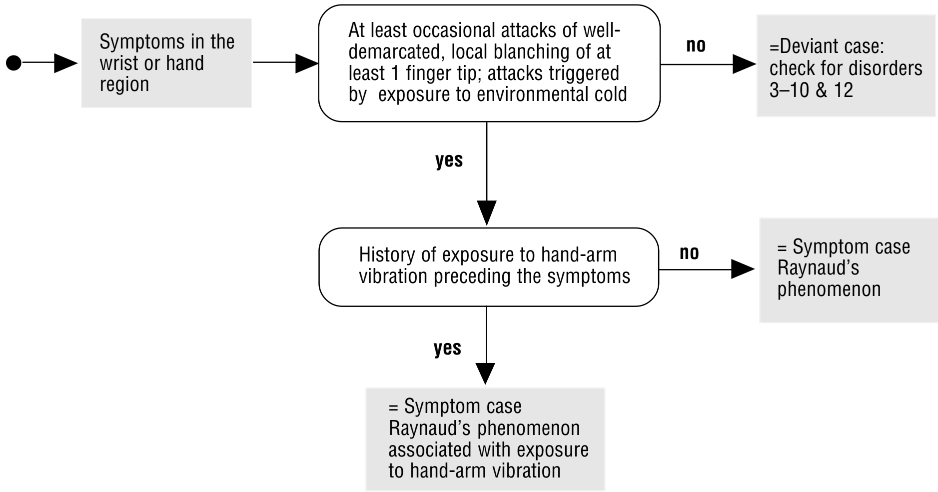
Case definition 1: Raynaud's phenomenon associated with exposure to hand-arm vibration, based on symptoms only	
Symptoms:	• At least occasional attacks of well-demarcated local blanching of at least 1 fingertip; attack triggered by exposure to environmental cold
	and
	• A history of exposure to hand-arm vibration preceding symptoms

Case definition 2: Raynaud's phenomenon associated with exposure to hand-arm vibration, based on symptoms and physical examination signs	
Symptoms:	• At least occasional attacks of well-demarcated local blanching of at least 1 finger tip; attack triggered by exposure to environmental cold
	and
	• A history of exposure to hand-arm vibration preceding symptoms
	AND
Signs:	• Blanching of at least 1 finger tip; blanching observed or provoked by the cold water test

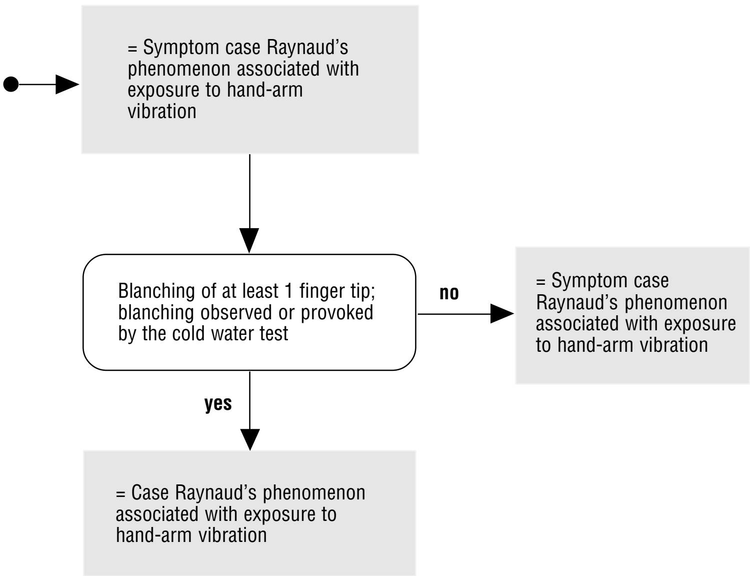
Case definition 1; peripheral neuropathy associated with exposure to hand-arm vibration, based on symptoms only	
Symptoms:	• At least intermittent numbness in the fingers, with or without tingling
	and
	• History of exposure to hand-arm vibration preceding symptoms
	AND
Time rule:	• Symptoms present now or on at least 4 days during the last 7 days
	or
	• Symptoms present on at least 4 days during at least 1 week in the last 12 months

Case definition 2: peripheral neuropathy associated with exposure to hand-arm vibration, based on symptoms and physical examination signs	
Time rule:	• Symptoms present now or on at least 4 days during the last 7 days
	AND
Symptoms:	• At least intermittent numbness in the fingers, with or without tingling
	and
	• History of exposure to hand-arm vibration preceding symptoms
	AND
Signs:	• Positive sensory tests (light touch, pain, temperature)
	and
	• Positive moving 2-point discrimination test

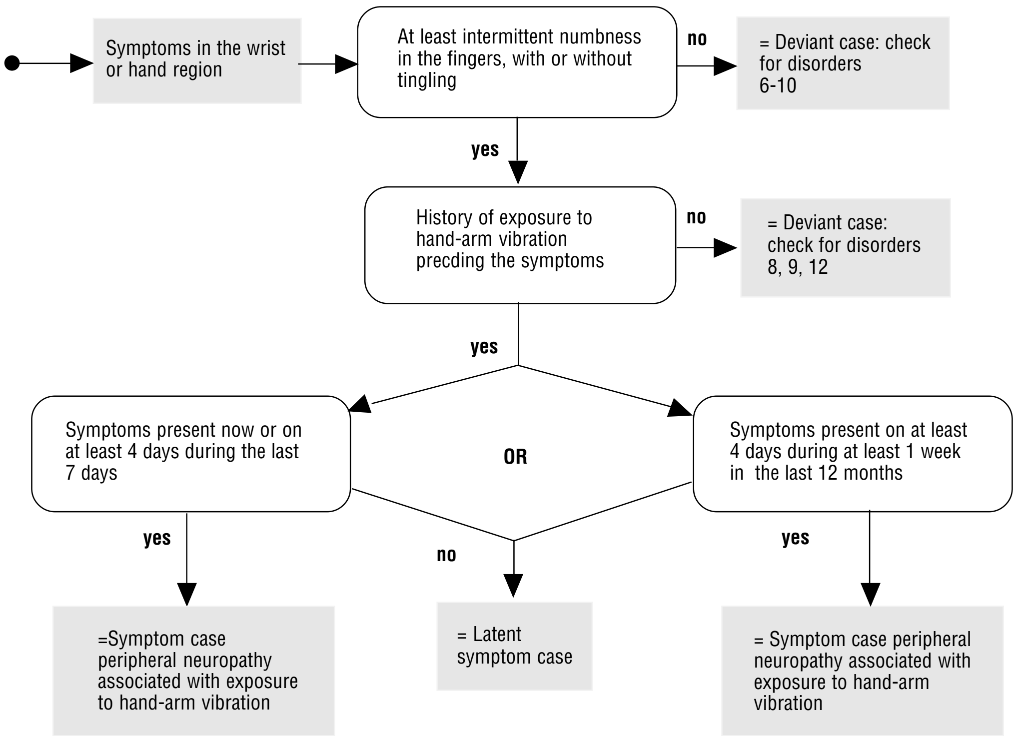
SYMPTOM CRITERIA FOR RAYNAUD'S PHENOMENON ASSOCIATED WITH HAND-ARM VIBRATION



SIGN CRITERIA FOR RAYNAUD'S PHENOMENON ASSOCIATED WITH HAND-ARM VIBRATION



SYMPTOM CRITERIA FOR PERIPHERAL NEUROPATHY ASSOCIATED WITH HAND-ARM VIBRATION



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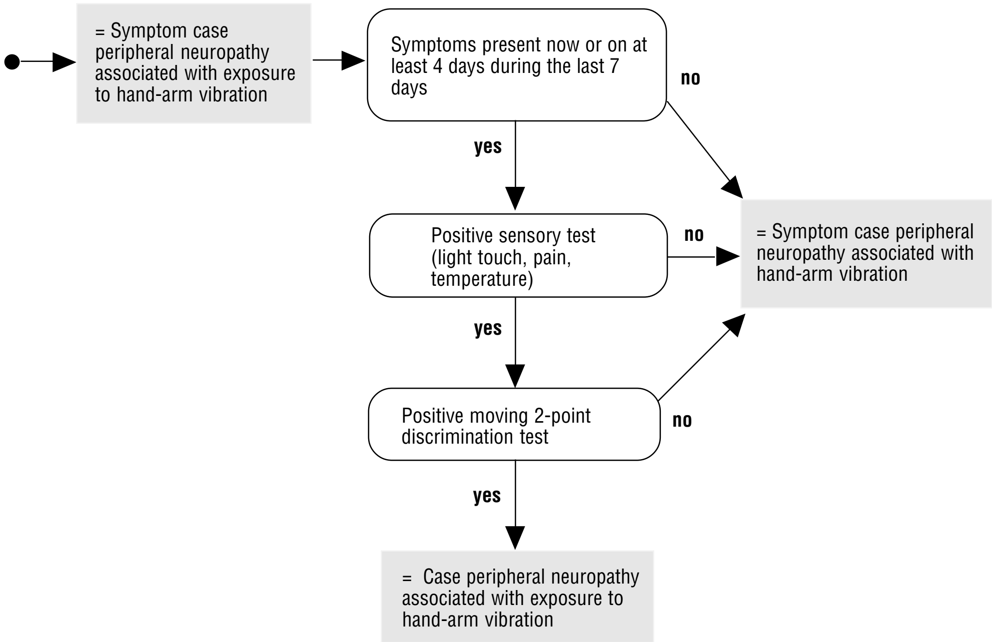


11. Osteoarthrosis of distal upper-extremity joints

Description of the disorder and clinical features

In textbooks, osteoarthrosis (OA) is described as a disease of joints, in which the cartilage and subchondral bone have primarily become degenerative. In time, sequellae are a disturbance in joint functionality, crepitus during movements, and (sometimes) development of deformity of the joint surfaces. Because the prevalence of osteoarthrosis in the shoulder joint is very low, the focus here is on the more distal upper-extremity joints. The elbow joint consists of 3 joints (humeroradial, humeroulnar, and proximal radioulnar joint). The wrist consists of the radiocarpal joints and the distal radioulnar joint). In the fingers, a carpal-metacarpal (CMC), distal-inter-phalangeal (DIP), and proximal-interphalangeal (PIP) joint can be distinguished. The thumb base joints (CMC I and trapezio-scaphoideal joint) are described separately.

Clinically, osteoarthrosis is characterized by complaints of stiffness and intermittent pain on movement of the joint involved. Most commonly, stiffness or pain on movement is present after a rest period. The severity of complaints can differ strongly from week to week. Patients have pain complaints regularly, depending on the activities performed. In advanced stages, the pain might be present at rest as well. The range of motion of the joint involved is restricted in a capsular pattern. Allan (150) reported the effects of occupationally induced repetitive strain on the joints of the upper extremity. The positive relation between the severity of the radiographic diagnosis of osteoarthrosis and age is very high, although a weak relation is found with the clinical presentation of patients (151—153).

Patients with osteoarthrosis in one of the distal upper-extremity joints [ie, elbow, wrist, CMC, and fingers (DIP and PIP joints)] usually have pain locally around the joint.

Differential diagnosis of osteoarthrosis and other upper-extremity musculoskeletal disorders

Depending on the localization of the osteoarthrosis and the possible somatic pain patterns, a differential diagnosis of specific musculoskeletal disorders in that region is needed. When rheumatoid arthritis or other arthritic diseases (eg, arthritis psoriatica) are suspected, additional testing is required.

Information on test properties

There is a general consensus on the existence and form of the capsular patterns in osteoarthrosis per joint in orthopedic and physiotherapeutic textbooks.

Examples of case definitions and criteria proposed or used in different studies

Definitions based on symptoms

No studies were found which describe this disorder on the basis of symptoms only. However, textbooks and studies that are diagnosed on the basis of symptoms and signs highly agreed on the symptoms involved.

Definitions based on symptoms and signs

In their diagnostic classification system of work-related upper-extremity musculoskeletal disorders (WRUEMSD), De Marco et al (31) used the following requirements for the clinical examination of trapezio-metacarpal rhizoarthrosis (OA CMC I): pain in the wrist or hand is continuous or occasional with pain-free intervals shorter than 30 days, or it occurs as a reaction to a specific triggering cause. Physical examinations require inspection of swelling or deformation (in the advanced stage) of the joint-area and tests for positive findings (acute pain) at thumb abduction and opposition.

Toomingas (53) lists the following symptoms and signs for “arthrosis” in his thesis: mainly ache and pain on loading of the joint and restriction of active and passive joint movement, tenderness, and pain at loading.

In the development of a diagnostic instrument for osteoarthrosis of the shoulder, elbow, wrist, or hand, the most weighted symptoms and signs of Sluiter et al (29) that minimally led to a “probable” diagnosis were intermittent pain and stiffness around the joint, reduced functionality, and at least one of the following: presence of the capsular pattern of the symptomatic joint, palpation of swelling or a rise in temperature or both, or joint deformity (only for the elbow and wrist-hand).

In different textbooks [eg, those by Winkel & Fisher (154) and Loudon et al (155)], the following capsular patterns are reported with a hierarchy in restricted movements (the 1st-mentioned movements are the most restricted):

- elbow joint – flexion, extension
- wrist joint – wrist flexion, wrist extension
- CMC joints – flexion, extension
- CMC I joint – thumb abduction, thumb extension
- fingers – flexion, extension.

Proposed case definitions

The case definitions for osteoarthrosis are described at once for all upper-extremity joints. The criteria relating to time were selected according to the previously mentioned time rule.

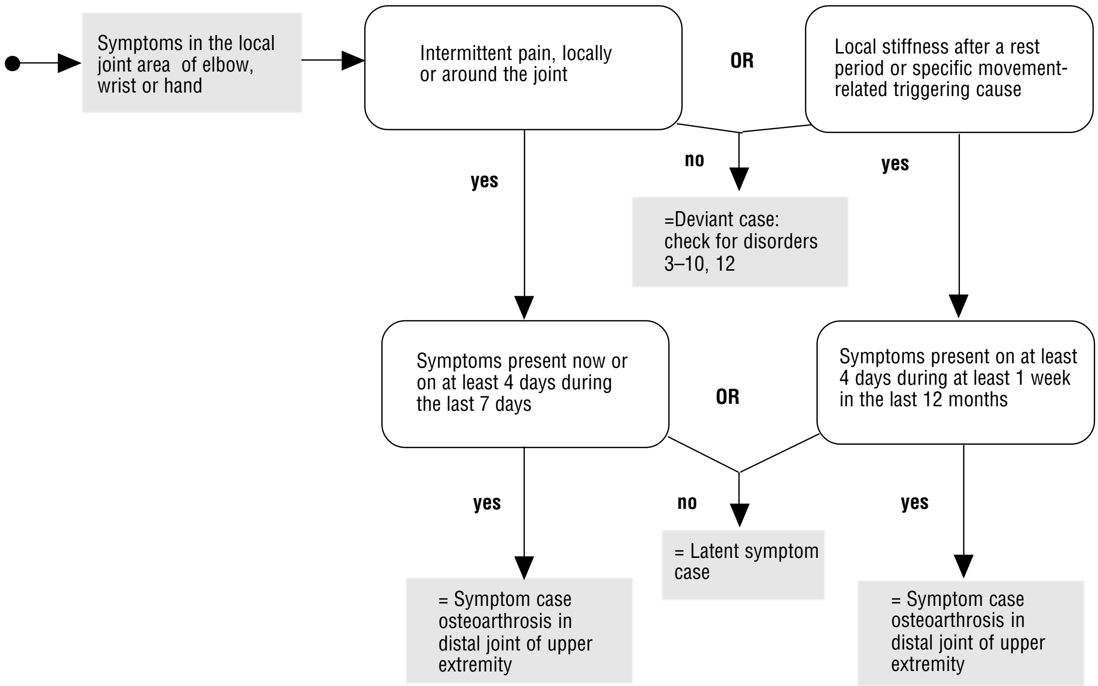
In relation to *secondary tests*, it should be noted that, although degenerative joint changes may be seen in radiographs, these bone injuries develop over long time periods. Early changes with less than 50% bone loss are not detected in radiographs. Additional tests like the Doppler or magnetic resonance imaging of joint damage after exposure to repetitive movements have to be perfected (150).

Case definition 1: osteoarthrosis of the distal upper extremity joints, based on symptoms only	
Symptoms:	• Intermittent pain, locally or present around the joint
	or
	• Local stiffness after a rest period or specific movement-related triggering cause
	AND
Time rule:	• Symptoms present now or on at least 4 days during the last 7 days
	or
	• Symptoms present on at least 4 days during at least 1 week in the last 12 months

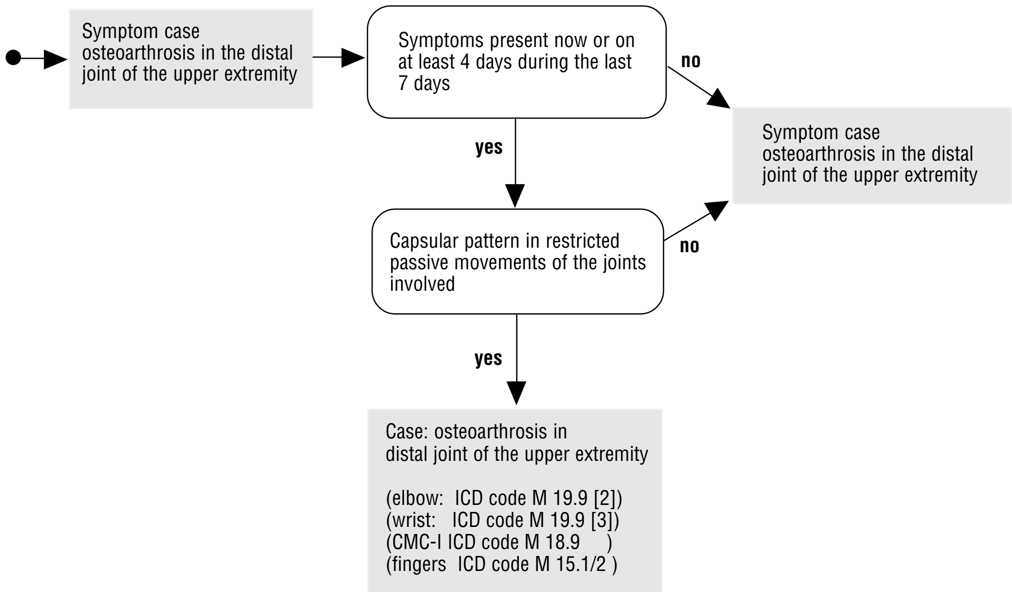
Case definition 2: osteoarthrosis of the distal upper extremity joints, based on symptoms and physical examination signs	
Time rule:	• Symptoms present now or on at least 4 days during the last 7 days
	AND
Symptoms:	• Intermittent pain, locally or present around the joint
	or
	• Local stiffness after a rest period or specific movement-related triggering cause
	AND
Signs:	• Capsular pattern in restricted passive movements of the joint involved

! Note ! : Descriptions of how to perform passive movements of the joints involved can be found in most orthopedic textbooks. Always compare the right (R) and left (L) side.

SYMPTOM CRITERIA FOR OSTEOARTHROSIS OF DISTAL JOINTS OF THE UPPER EXTREMITIES



SIGN CRITERIA FOR OSTEOARTHROSIS OF DISTAL JOINTS OF THE UPPER EXTREMITIES



12. Nonspecific upper-extremity musculoskeletal disorders

Description of the disorder and clinical feature

Nonspecific upper-extremity musculoskeletal disorders (UEMSD) are generally characterized by pain in muscles, tendons, nerves, or joints (other sensations may also be present) without evidence of a specific combination of symptoms and signs typical for one of the specific UEMSD. Pain as a major symptom of nonspecific musculoskeletal disorders pleads for explanatory causational models of this bodily response. It has become clear that a strict biomedical model of pain is insufficient to explain the complexity of pain experience (156). The International Association for the Study of Pain (157) has adopted this perspective in their definition of pain: "A sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage". The often more chronic character of complaints is found for patients whose disorders are sometimes labeled "chronic pain syndrome", "myofascial syndrome", "fibromyalgia", "regional pain syndrome", and "complex region pain syndrome" (101).

Originally, work-related upper-extremity musculoskeletal disorders (WRUEMSD) were called repetitive strain injury (RSI), occupational overuse syndrome (OOS), occupational cumulative disorder (OCD), occupational cervicobrachial disorder (OCD), or cumulative trauma disorder (CTD), depending on the author and country (158). Most authors agree that, within these umbrella terms, the specific disorders must be differentiated from the nonspecific ones (7, 158—160). Only 10—20% of the patients with repetitive strain injury is said to have a specific UEMSD. Specific syndromes were categorized for musculoskeletal disorders and given names when a certain combination of symptoms and signs were generally observed. When symptoms and signs cannot be classified into specific categories, the complaints may reflect mild early cases of specific disorders of chronic pain processes, or they may be caused by the simultaneous occurrence of multiple diagnoses. Because most studies of UEMSD direct their patient follow-up towards those with specific disorders, knowledge about the group of patients in the nonspecific category remains inadequate. Overuse is seen as a general factor that might cause nonspecific UEMSD. Commonly mentioned aspects of overuse — in terms of what people do — are muscle tension for long periods (especially in joint-specific extreme postures), repeated (forceful) or jerky movements, and reaction to social stressors (101).

The following studies have focused on nonspecific complaints:

- a descriptive study of 229 patients referred to a rheumatologist with repetitive strain injury, 29 of whom received a secondary diagnosis of a specific disorder (161)
- a review of studies that focused on nonspecific work-related upper-extremity musculoskeletal disorders and concluded that the heterogeneity of work-related musculoskeletal disorders poses challenges for the development of a case definition (25)
- a follow-up study that found only 3 nonspecific disorders among 24 patients with upper-extremity repetitive-use syndromes in a physical examination (26)
- a 24-year prospective study in which patients with specific upper-extremity disorders were excluded, but no description of the remaining symptoms and signs were given (28).

Although combinations of complaints have been categorized as tension neck syndrome (TNS) in previous studies (8, 29 pp 61—67, 51, 82, 162, 163), these symptoms are categorized as nonspecific complaints in this document. The reasons for this approach are numerous, for example, the label tension neck syndrome suggests a cause without there being adequate evidence, the symptoms and signs mentioned in studies on tension neck syndrome are all nonradiating in nature, without specific underlying mechanisms, and tension neck syndrome is not well accepted as a specific syndrome in general medicine or in certain countries.

Differential diagnosis of nonspecific upper-extremity musculoskeletal disorders

Specific UEMSD should be excluded.

Information on test properties

No additional information is available.

Examples of case definitions and criteria proposed or used in different studies

Definitions based on symptoms

Viikari-Juntura (82) studied upper-limb disorders among 113 slaughterhouse workers using self-reports and clinical diagnoses. Sixty percent reported pain or trouble in the arms and hands as symptoms, 49% reported pain or trouble in the neck and shoulders. For only 17 subjects could a specific clinical diagnosis be made for the arms and hands or neck and shoulders.

Questionnaires like the Nordic questionnaire (32) sample regional symptoms on a body chart without differentiating between specific and nonspecific disorders. The Nordic "week" criterion requires that the person have pain, ache, tingling or numbness in the upper limb at some point in the last 7 days. The Nordic "interfere" criterion requires that the person have pain, ache, tingling, or numbness in the upper limb to the degree that it interfered with their work ability at some point in the last 12 months. Most primary occupational studies have used the Nordic questionnaire or a modified version of it to obtain data on self-reported upper-extremity musculoskeletal complaints.

The case-definition of the National Institute for Occupational Safety and Health (NIOSH) in the United States for UEMSD is moderate, severe or unbearable pain, ache, tingling, or numbness in an upper extremity either once per month or for longer than 1 week's duration over the last year.

Harrington et al (55) reached a multidisciplinary consensus on the following minimum diagnostic surveillance criteria for nonspecific diffuse forearm pain: pain in the forearm and failure to meet the diagnostic criteria for other specific diagnoses and diseases.

In their practice guidelines for occupational medicine, Harris and his co-workers (42 pp 11—17) provide the following diagnostic criteria for nonspecific regional problems: "diffuse pain" for regional neck pain (ICD-9 723.1,3,5,7,8,9), "pain in shoulder" for nonspecific shoulder pain (ICD-9 719.41,51, 726.0, 729.89), "no unique symptoms" for nonspecific elbow pain (ICD-9 726.39) and, finally, "varying with underlying disorder" for nonspecific pain in the forearm, wrist or hand (ICD-9 719.43,44, 719.5).

Ireland (160) described the symptoms of repetitive strain injury in the Australian workforce as the collection of symptoms affecting the upper limb, pain being the most prominent.

Melhorn (7) defined cumulative trauma disorder as not a medical diagnosis but a label for pain perception.

Definitions based on symptoms and signs

Harrington et al (55) reached a multidisciplinary consensus on the following minimum diagnostic surveillance criteria for the diagnosis of nonspecific diffuse forearm pain: pain in the forearm and failure to meet the diagnostic criteria for other specific diagnoses and diseases. Palmer et al (164) added the signs (between brackets): "sometimes includes loss of function, weakness, muscle tenderness, allodynia, slowing of fine movements".

Additional information on nonspecific upper-extremity musculoskeletal disorders

Little information is available on patients' symptoms and signs that exclusively belong to the group with nonspecific complaints, mainly because many studies do not differentiate specific from nonspecific complaints and the studies that do differentiate by means of clinical diagnosis focus on specific disorders and give diffuse information on the characteristics of the nonspecific group.

One exception is the study of Miller & Topliss (161), who describe 229 patients with repetitive strain injury and referred to a rheumatologist with chronic upper-extremity pain. In their description of the population under study they described a gradual onset of pain in 73% of the patients. The pain started in only one upper-extremity region in 91% of the patients, but during the course of the complaints, this percentage dropped to 8%. The mean duration of the pain was 21 (range 6-54) months and, at the moment of examination, 87% was never completely pain free. Besides pain, paresthesias occurred in 91% (while 24% of these patients had normal nerve conduction studies), subjective swelling in 73%, brief morning stiffness in 52%, and, in some cases, subjective temperature and color change. In a physical examination, pain during or at the limit of the range of motion of at least 1 peripheral joint was found for 96% of the patients, although the full passive range of motion of all the peripheral joints and the cervical spine was found in 94% of the patients. Decreased sensation to pinprick in one or both hands relative to the sternum was documented for 78% of the patients.

In order to gather more information on nonspecific upper-extremity musculoskeletal complaints, a questionnaire was sent from the Coronel Institute to all 1700 members of the Dutch RSI-Patient Association in February 1999 by the authors of this document. The results from this question"naire were comparable with those in the aforementioned study by Miller & Topliss (161), except that they did not reveal only one case definition, for example, a profile of nonspecific complaints.

How to handle nonspecific upper-extremity musculoskeletal disorders

Because there is not enough evidence to categorize the nonspecific upper-extremity complaints, this document does not provide a case definition or diagnostic criteria for nonspecific UEMSD. Rather, it provides a guide for handling these complaints in practice. It is hoped that this guide will help physicians and, at the same time, facilitate the collection of data that may begin to provide the evidence needed for nonspecific diagnostic criteria.

On the next page, a structured means of gathering information is proposed as a guide for all physicians and epidemiologic researchers. It allows the registration of nonspecific complaints by body region.

This approach can be used in different settings. In direct contact between the physician and patient, the approach will provide insight into the number of episodes, the course, and the extent of the complaints, as well as into the probability of their work-relatedness. In active surveillance activities, the approach may guide the type of questions that should be included in questionnaires or interviews. In time, the guide may also serve as input for data to be sampled and databases to be formed for passive surveillance activities. Registration of this information may facilitate the future development of case definitions for nonspecific complaints.

Guidance

1. **Consider and rule out the existence of specific upper-extremity diagnoses.**
2. **Collect and record information about symptoms and time with a structured format.**
3. **Assess and record the work-relatedness of the symptoms.**

Check list as guidance for registering information on nonspecific upper-extremity musculoskeletal disorders

Check and register the following:

1. Rule out specific disorders in region of complaints: ❍ **YES**

2. Register (by filling the ❍ ✏ ●) below which symptoms have been present in what regions on what side (R= right side, L = left side):

Region	Symptom									
	Any pain		**Stiffness**		**Tingling**		**Numbness**		**Cold feeling**	
Neck	❍		❍		❍		❍		❍	
Upper back	❍		❍		❍		❍		❍	
	R	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
Shoulder	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Elbow	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Forearm	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Wrist	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Hand	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

3. Symptoms are present now or have been on at least 4 days during the last 7 days. ❍ **YES** ❍ **NO**

Duration of the present episode: ✏ days

4. Symptoms have been present on at least 4 days during at least 1 week in the last 12 months. ❍ **YES** ❍ **NO**

Frequency of episodes in the last 12 months: ✏ times

Mean duration of the episodes: ✏ days

5. When was the onset of the complaints of the last episode ? ✏ Year/Month/Day:

6. Check requirements for work-relatedness for the regions involved and register (by filling in the ❍ ✏ ●) when work-relatedness is probable (red) or possible (yellow):

	RED	**YELLOW**
Region	**Probably work-related**	**Possibly work-related**
Neck	❍	❍
Shoulder-upper arm	❍	❍
Elbow-forearm	❍	❍
Wrist-hand	❍	❍

7. Current occupation of patient: ✏

Criteria for the work relatedness of upper-extremity musculoskeletal disorders

Introduction

Criteria for the 11 specific musculoskeletal disorders and guidance for regional nonspecific upper-extremity musculoskeletal disorders were presented in the former parts of this document. Once the diagnosis is made, the issue of work-relatedness can be addressed. The process of determining work-relatedness is described in this section of the document.

In its 1985 technical report (16), the World Health Organization (WHO) expert committee described "work-related diseases" as those that are multifactorial in nature. Because upper-extremity musculoskeletal disorders (UEMSD) have been associated with a variety of work and nonwork factors, this document uses the term "work-related" in reference to UEMSD in accordance with the WHO definition.

For this criteria document, evidence- and consensus-based criteria for factors at work that are related to the specific and nonspecific work-related upper-extremity musculoskeletal disorders (WRUEMSD) are described for the following 4 main regions of the upper-extremities: neck, shoulder and upper arm, elbow and forearm, and wrist and hand.

TYPES OF WORK FACTORS

1. Physical factors, including posture, force, movement, and vibration
2. Nonphysical factors, including those related to work organization (eg, work:rest ratios) and other work characteristics (eg, job strain in relation to psychological demands and decision latitude and social support.

ACTION COLORS

• Green =	NO ACTION	➨	the disorder is "most likely not work-related"
• Yellow =	PLAN ACTION	➨	the disorder is "possibly work-related"
• Red =	TAKE ACTION	➨	the disorder is " probably work-related"

4-STEP PROCESS

1. Evaluate the general criterion on the relationship of UEMSD to the current job
2. Examine the work-factor criteria by body region
3. Check for nonoccupational origins of the UEMSD
4. Decide on the level of work-relatedness and needed action

For these 4 upper-extremity regions, the document provides criteria on the following 2 types of work factors: (i) physical factors, including posture, force, movement and vibration, and (ii) nonphysical factors, including those related to work organization (eg, work:rest ratios) and other work characteristics (eg, job strain from psychological demands and decision latitude) and social support.

Because the evidence for some risk factors may still be lacking and no one work factor or a combination of work factors can be said to be the sole cause of UEMSD, the criteria for the risk factors at work and for the final decision on work-relatedness will use a *traffic light probability format.* In all the settings (micro, meso, and macro), there are 3 action colors, green for no action needed, yellow for a need to plan action, and red for a need to take action.

In summary, the final determination of the work-relatedness of a UEMSD involves 4 steps, which are described in detail later in this section (see page 69).

The remainder of this section includes the following:

- some background information
- general rationale
- information on the traffic light model
- decision rules
- region-specific criteria
- tabular summary of evidence

Background information

References

The primary documents used to develop these criteria were recent reviews of epidemiologic studies of WRUEMSD, like the NIOSH document of 1997 (12), the work of Punnett & Bergqvist (14), the Dutch report of guidelines for the establishment of the work-relatedness of UEMSD (29), ISO/DIS 11226 (165), and the 1999 consensus document of the International Ergonomics Association (IEA) and the the International Commission on Occupational Health (ICOH) (166). In addition, the outcomes of a recent DG-5 project were used (24), as were primary studies from 1997 to 1999, which were searched for both new and confirmatory evidence. These studies were occupational, clinical, epidemiologic, or laboratory in nature. The references are listed by region and disorder in appendix C.

Evidence and practical use of the criteria on work-relatedness

The causation of UEMSD is multifactorial in nature, and work may be important when workers are exposed to risk factors that are entermeshed with the workers' tasks. In general, there is more direct evidence for the effects of physical work factors on the development of UEMSD than for the effects of nonphysical factors in the workplace. In addition, no studies were found in which nonphysical risk factors alone were associated with UEMSD risk. Physical factors were always present in conjunction with nonphysical factors. The evidence for each of the factors was gathered from the literature as quantitatively as possible in terms of frequency, duration, or intensity. For the interested reader, this quantitative information is summarized in appendix C.

For the purpose of this document, the quantitative information has been translated into qualitative descriptions per factor since the results are not yet entirely evidence-based. When specific work factors are known for specific disorders and they differ from those shown for the accompanying body region, they are stated separately.

In all occupational studies, data on work factors are sampled from individual workers by means of observations or self-reports. Statistical reports of the relation between work factors and UEMSD, however, always take place on the group level. In this document, it is assumed that the qualitative level of the statistical evidence of the work factors listed is high enough to give valid risk estimations for both the individual and group levels. In addition, the 1st and 3rd general requirements included in the decision process in association with the work-relatedness of a disorder will enhance the validity on the individual level.

A detailed description of methods for the assessment of physical and nonphysical work factors is beyond the scope of this document. Interested readers are referred to references like Colombini et al (166), Moore & Garg (167), Winkel & Westgaard (168), and Kilbom (169).

In the review of the National Institute for Occupational Health (NIOSH) in the United States (12), it was acknowledged that, for example, individual factors, may influence the degree of risk from specific exposures. Controlling for these personal factors, however, did not substantially alter the association with work factors. Furthermore, the definition for work-relatedness presented by the World Health Organization (WHO) says " . . . exposed to work activities and work conditions that significantly contribute to their development or exacerbation but not acting as the sole determinant of causation" (16).

General rationale for the description of physical and nonphysical risk factors in the criteria

Physical factors

Analogous to the NIOSH document of 1997 (12), physical work factors are categorized into posture, movement (repetition), force, and vibration. Combinations of physical factors are included as well. The criteria can include qualitative descriptors, such as extreme posture or high repetitiveness. The quantification of these descriptors is detailed on the following pages in italics and summarized in table 8.

Posture. Postures associated with a higher percentage of the range of motion (ROM) of a joint have more risk than neutral postures. In this document, when extreme posture is mentioned in relation to a joint as a risk factor, it is assumed that the posture of interest is *at least more than half of the joint ROM for the movement of interest and used during a substantial part of the workday.*

As a risk factor, posture must always be evaluated in relation to duration or frequency or both. In the upper extremity, the main function of more proximal muscles is postural in nature. The further the body part of interest is from the trunk, the greater the chance of higher muscle moments needed in proximal parts to stabilize a certain posture. Therefore, a rule of thumb could be to evaluate the distance of the region from the trunk and the recovery time when the duration is not mentioned: The more distal the region, the more important the duration of posture in relation to the recovery period given during work.

Table 8. Quantification of the parameters used in the criteria for work-relatedness. (ROM = range of movement)

Qualitative descriptor of parameter	Quantification or unit used in the criteria
Extreme posture	Over half of ROM of a joint with respect to the movement of interest, present regularly during the workday
High repetitiveness	Actions performed more than 2 to 4 times a minute, or cycles less than 30 seconds
Most of the day	(Repetitive) movements or postures performed for more than a total of 4 hours per workday
Substantial part of the day	For more than a total of 2 hours per workday
High force	Hand weights of more than 4 kg
Low social support	Scale score lower than 25% of the maximum score
High psychological demands	Scale score higher than 75% of the maximum score
Too little recovery time	Less than 10-minute break possible within every 60 minutes that highly repetitive movements are performed

Movement (repetition). Movements up to the *maximal possible ROM of a joint* are often considered risk factors. The *frequency* of the movement is another important aspect of interest. Most studies define high repetitiveness as *actions performed more than 2 to 4 times a minute or cycles of less than 30 seconds*, depending on the upper-extremity region involved. Even when the repetitiveness of the movement does not exceed these guidelines, *duration* might play a role when the movements are performed most of the day, namely, *for more than a total of 4 hours per workday*.

Force. The classical muscular physiology study of Rohmert (170) suggests criteria for the amount of force and duration-recovery time for static actions. These criteria were used in many later studies. Force up to 20% of the maximal voluntary contraction (MVC) during 2 minutes requires a 50% recovery time. Static positions of the head hardly ever load the neck and shoulder muscles in excess of 20% of the MVC. It can be argued, therefore, that static *head-neck postures that exceed half of the worktime during a workday* present a risk to musculoskeletal health. *High force* is defined as *hand weights of more than 4 kilogram force* (24).

Vibration. Workers operating local vibrating sources like vibrating handtools are known to be at risk of developing UEMSD. This document includes vibration in the regions where *exposure to vibrating handtools* might influence the risk of developing UEMSD.

Combinations of physical factors. Occupational studies commonly examine a combination of risk factors, and there is substantial evidence that combinations of certain physical factors create higher musculoskeletal risks than exposure to one factor alone.

Nonphysical work factors

The existence of certain nonphysical factors in the workplace is known to increase the risk of WRUEMSD in association with physical factors.

Nonphysical factors are found in the work-organization and psychological environment of the workplace. Examples of work-organization factors include work:rest ratios, decision latitude, and autonomy. Work characteristics like psychological demands and social support at work may also be important. *Perceived work stress, work tempo, work pressure, deadline involvement, and mental demands* can be seen as psychologically demanding work factors.

Factors in studies that involve psychological demands are very often measured subjectively through self-reports and include work tempo and work pressure, mental demands, and deadlines. Social support at work comprises *the workers' relationship with colleagues and supervisors or company management.* The original psychological demand and social support scales from the Job Content Questionnaire of Karasek contain items like "my job is very hectic", "my job requires long periods of intense concentration on the task", and "people I work with are friendly". In answering these items, people are asked to give a general mean score to their work environment. A sum score of the items in one scale makes up the scale scores, and within- and between-group quartiles are formed for analyses to say something about low or high scores.

In most studies, the risk factors are described in terms of having *high psychological demands* (*scale score higher than 75% of maximum score*) and *low social support* (*scale scores lower than 25% of maximum score*).

Too little recovery time in the work:rest ratio is defined as a *break of less than 10 minutes within every 60 minutes that highly repetitive movements are performed.*

Traffic light model

Similar to the Swedish ordinance (23) and the Dutch guidelines on establishing work-related upper-extremity disorders (29), this document uses a "traffic light model" (red, yellow, and green zones) to establish the risk for certain factors at work in relation to regional UEMSD and the final level of work-relatedness of a disorder. This approach is analogous to the procedure used in the CEN standard EN 614-1 (171) and the proposal of the 3-zone model for action of Buckle & Devereux (24).

The existence of certain work factors in relation to regional UEMSD are categorized as *green (acceptable) or red (unacceptable). Yellow (not suitable),* by definition, covers situations for which no red or green delineation is possible. For example, when at least one nonphysical risk or "red" factor is present but all the physical risk factors fall into the "green" (acceptable) category, a "yellow" (not suitable) warning sign is given that should influence the decision on the final action color. The physical and nonphysical risk factors are listed per region in the next section. This categorization should be used in the final decision on the work-relatedness of the UEMSD.

ACTION COLORS

Red	TAKE ACTION	➨	the disorder is "probably work-related"
Yellow	PLAN ACTION	➨	the disorder is "possibly work-related"
Green	NO ACTION	➨	the disorder is "most likely not work-related"

As described in the next section, this document provides a 4-step process for assessing the final probability of work-relatedness and categorizing the disorder as “red”, “yellow”, or “green” in terms of necessary action.

Four-step process of making decisions on work-relatedness

The final decision process is summarized in the table 9, but the 4 steps of this process will be described first,

Step 1

The 1st step is to apply a general criterion of work-relatedness. This criterion requires the answer to the following specific question: "Did the symptoms begin, recur or worsen after the current job was started?"

1. Ask whether or not the symptoms began, recurred, or worsened after the current job was started.

If the answer to this question is “yes”, the final action color is *yellow*, at the very least and action planning is required.

Step 2

The 2nd step is to check the work factors associated with the body region in which the UEMSD is located and determine whether or not the worker has been exposed to any of these factors.

2. Check whether or not the worker is exposed to occupational factors known to be associated with UEMSD in the specific body region. For this purpose
   a. check the pertinent requirements for the “green” (acceptable) code.
   b. check the pertinent requirements for the “red” (unsuitable) code.

The requirements for the “green” code should be checked before the requirements for “red” are checked. If the requirements for “green” are met, but the answer to step 1 was “yes”, then further investigation is warranted. At the group level, one possibility is to evaluate the information about the work factors. If the information arose from self-reports, observations would be the next step towards obtaining objective worksite information. On the individual level, it would be useful to ascertain whether or not the UEMSD could be a problem on the group level as well, and the person should be followed for changes in or exacerbation, or remission of the same complaints.

Step 3

Before the final decision on work-relatedness is made, another general criterion should be applied. This step also requires the answer to a specific question: "Are there any nonoccupational origins for the symptoms?"

3. Ask whether or not there are nonoccupational origins for the symptoms.

Whether or not there are nonoccupational origins for the symptoms is determined by asking about possible causative factors outside the workplace, like injuries or hobbies. If the answer to this question is “yes”, but work-related risk factors are also present (ie, the factors were coded “red”), then the final action code is “yellow” because workplace factors may also contribute to the disorder.

Table 9. Rules for the final decision on the work-relatedness of upper-extremity musculoskeletal disorders in step 4.

Step 1		Step 2		Step 3		Step 4 (final decision)
Yes	+	Green	+	NO	➨	Yellow
Yes	+	Green	+	YES	➨	Yellow
Yes	+	Yellow	+	YES	➨	Yellow
Yes	**+**	**Yellow**	**+**	**NO**	**➨**	**Red**
Yes	**+**	**Red**	**+**	**YES**	**➨**	**Red**
Yes	**+**	**Red**	**+**	**NO**	**➨**	**Red**
No	+	Green	+	YES or NO	➨	Green
No	+	RED	+	YES or NO	➨	Yellow

Step 4

The former 3 steps lead to the final decision about the level of work-relatedness of the UEMSD. The action code can be “red”, “yellow”, or “green”.

4. Make a decision about the level of work-related ness.

The final decision rules for step 4 are shown in table 9.

Criteria

Neck region

The risk factors used for the criteria of the neck region are based on evidence (gathered) from reviews and primary studies or consenses (12, 14, 28, 29, 162, 165, 166, 168, 172—181).

For the interested reader, evidence for each factor is extractable from appendix C.

In some studies, the factor “high number of workhours per week” is mentioned as a risk factor for musculoskeletal problems in the neck region. However, this factor is hard to quantify for all countries in the European Union (EU) and also for different occupations and regular day work versus shift work. Along with a country’s own “time rules”, a high number of workhours per week can be added as a potential nonphysical risk factor.

Shoulder and upper-arm region

The risk factors used for the criteria of the shoulder region are based on evidence (gathered) from reviews and primary studies or consenses (12, 14, 28, 29, 162, 165, 166, 168, 172, 175—180, 182—186).

For the interested reader, evidence for each factor is extractable from appendix C.

In some studies, the factor "number of high workhours per week" is mentioned as a risk factor for musculoskeletal problems in the shoulder and upper-arm region. However, this factor is hard to quantify for all EU countries and for different occupations and regular day work versus shift work. Along with a country's own "time rules", a high number of workhours per week can be added as a potential risk factor.

Elbow and forearm region

The risk factors used for the criteria of the elbow and forearm region are based evidence (gathered) from reviews and primary studies or consenses (12, 14, 29, 151, 165, 166, 172, 179, 183, 184, 187, 188).

For the interested reader, evidence for each factor is extractable from appendix C.

In some studies, the factor "duration of employment" is mentioned as a risk factor for musculoskeletal problems in the elbow or forearm region. However, this factor is hard to quantify for all EU countries and also for different occupations. However, as a potential risk factor for complaints concerning the elbow or forearm region, duration of employment can possibly be added.

Wrist and hand region

If no requirements for a "red" or "green" code are met, the symptoms can be coded "yellow". The risk factors used for the criteria of the wrist and hand region are based on evidence (gathered) from reviews and primary studies or consenses (12, 14, 28, 29, 128, 140, 141, 145, 151, 153, 165, 166, 172, 178, 179, 183, 184, 188—198).

For the interested reader, evidence for each factor is extractable from appendix C.

Overview of evidence

Table 10 provides a summary of the evidence used to develop the regional criteria.

Table 10. Summary of evidence included in this criteria document of work factors to be related to disorders in the different upper-extremity body regions.

	Neck region	Shoulder and upper arm region	Elbow and forearm region	Wrist and hand region
Physical factors				
Posture related to frequency or duration or both	✓	✓	✓	✓
Force related to frequency or duration or both			✓	✓
Repetitive movement related to duration	✓	✓	✓	✓
Vibrating handtools			✓	✓
Combination of physical factors		✓	✓	✓
Cold				✓
Risk-increasing nonphysical factors				
Too little recovery time	✓	✓	✓	✓
High psychological demands	✓	✓	✓	✓
Low social support	✓	✓	✓	✓

Neck — green

I = acceptable AREA: all factors must be present	
Physical factors	Nonphysical factors
Posture during a workday ❏ Not holding the chin opposite the breast bone during most of the workday (extreme neck flexion) ❏ No sitting work during most of the day with static postures of the neck and upper extremity and without rest pauses ❏ No unsupported arms when work with the upper extremities is performed during most of the day *Movement during a workday* ❏ No highly repetitive neck extension movements during most of the day ❏ No highly repetitive extreme neck flexion movements during most of the day ❏ No highly repetitive upper-extremity movements during most of the day	❏ Not too little recovery time per hour when highly repetitive upper-extremity movements are performed ❏ No high psychological demands ❏ No low social support

Neck — red

RED = unsuitable AREA: at least one physical risk factor must be present	
Physical factors	Nonphysical factors
Posture during a workday ❏ Holding the chin opposite the breast bone during most of the day (extreme neck flexion) ❏ Sitting work during most of the day with static postures of the neck and upper extremity and without rest pauses ❏ Unsupported arms when work with the upper extremity is performed during most of the day *Movement during a workday* ❏ Highly repetitive neck extension movements during most of the day ❏ Highly repetitive extreme neck flexion movements during most of the day ❏ Highly repetitive upper extremity movements performed during most of the day	*Work:rest ratio during a workday* ❏ Too little recovery time per hour when highly repetitive movements are performed *Work characteristics in period before complaints started* ❏ High psychological demands ❏ Low social support

Elbow and forearm — green

GREEN = acceptable AREA: requiring all factors mentioned	
Physical factors	Nonphysical factors
Posture during a workday ❏ Not holding the hand close to the upper body during a substantial part of the day (extreme elbow flexion) ❏ Not holding the elbow fully extended during a substantial part of the day ❏ Not holding the forearm in an extreme twisted position during a substantial part of the day (pronation or supination) *Movement during a workday* ❏ No highly repetitive elbow and wrist movements during most of the day *Force during a workday* ❏ No high forceful work for forearm muscles during a substantial part of the day (eg, squeezing or pinching with the hands) *For elbow osteoarthrosis* ❏ No exposure to vibrating hand tools during more than a total of 1 hour per workday	❏ Not too little recovery time per hour when highly repetitive upper extremity movements are performed ❏ No high psychological demands ❏ No low social support

Elbow and forearm — red

RED = unsuitable AREA: at least one physical risk factor must be present	
Physical factors	*Nonphysical factors*
Posture during a workday ❏ Holding the hand close to the upper body during a substantial part of the day (extreme elbow flexion) ❏ Holding the elbow fully extended during a substantial part of the day ❏ Holding the forearm in an extreme twisted position during a substantial part of the day (pronation or supination) *Movement during a workday* ❏ Highly repetitive elbow and wrist movements during most of the day *Force during a workday* ❏ High forceful work for forearm muscles during a substantial part of the day (eg, squeezing or pinching objects or handtools with the hands) *Combination of factors during a workday* ❏ Combination of the aforementioned posture, repetition, and force *For elbow osteoarthrosis* ❏ Exposure to vibrating handtools during more than a total of 1 hour per workday	Work:rest ratio during a workday ❏ Too little recovery time per hour when highly repetitive movements are performed *Work characteristics in the period before the complaints started* ❏ High psychological demands ❏ Low social support

Shoulder and upper arm — green

GREEN = acceptable AREA: all factors must be present	
Physical factors	Nonphysical factors
Posture during a workday ❑ Not holding the hand behind the trunk (extension) during a substantial part of the day ❑ Not holding the hand before the opposite side of the trunk (extreme adduction) during a substantial part of the day ❑ Not holding the shoulder in extreme outward rotation during a substantial part of the day ❑ Not holding an unsupported arm away from the body for a couple of minutes during a substantial part of the day *Movement during a workday* ❑ No work in which the hands move above shoulder height during a substantial part of the day ❑ No highly repetitive upper-extremity movements during most of the day *Combination of factors during a workday* ❑ Not applying high force together with high repetitive movements and extreme postures	❑ Not too little recovery time per hour when highly repetitive upper extremity movements are performed ❑ No high psychological demands ❑ No low social support

Shoulder and upper arm — red

RED = unsuitable AREA: at least one physical risk factor must be present	
Physical factors	Nonphysical factors
Posture during a workday ❑ Holding the hand behind the trunk (extension) during a substantial part of the day ❑ Holding the hand before the opposite side of the trunk (extreme adduction) during a substantial part of the day ❑ Holding the shoulder in extreme outward rotation during a substantial part of the day ❑ Holding an unsupported arm away from the body for a couple of minutes during a substantial part of the day *Movement during a workday* ❑ Moving the hands above shoulder height during a substantial part of the day ❑ Highly repetitive upper extremity movements during most of the day *Combination of factors during a workday* ❑ Applying high force with the aforementioned repetitive movements and posture	*Work:rest ratio during a workday* ❑ Too little recovery time per hour when highly repetitive movements are performed *Work characteristics in period before the complaints started* ❑ High psychological demands ❑ Low social support

Wrist-hand— green

GREEN = acceptable AREA: all factors must be present	
Physical factors	Nonphysical factors
Posture during a workday ❑ Not holding the wrist in extreme postures during a substantial part of the day ❑ Not holding of tools or objects in pinch or grip position during most of the day *Movement during a workday* ❑ No highly repetitive movements of the wrist-hand or fingers during most of the day *Force during a workday* ❑ No high force exerted by the hand(s) during a substantial part of the day *Combination of factors during a workday* ❑ No computer or mouse work during most of the day *For wrist-finger osteoarthrosis, carpal tunnel syndrome and vibration white finger and hand-arm vibration syndrome* ❑ No exposure to vibrating handtools during more than a total of 1 hour per workday *For vibration white fingers* ❑ No cold environment during most of the day	❑ Not too little recovery time per hour when highly repetitive upper extremity movements are performed ❑ No high psychological demands ❑ No low social support

Wrist-hand — red

RED = unsuitable AREA: at least one physical risk factor must be present	
Physical factors	Nonphysical factors
Posture during a workday ❑ Holding the wrist in extreme postures during a substantial part of the day ❑ Holding tools or objects in a pinch or grip position during most of the day *Movement during a workday* ❑ Highly repetitive movements of wrist-hand or fingers during most of the day *Force during a workday* ❑ High exertion by the hand(s) during a substantial part of the day (eg, mediated by use of handtools) *Combination of factors during a workday* ❑ Combination of the aforementioned posture, repetition, and force ❑ Computer or mouse work during most of the day *For wrist-finger osteoarthrosis, carpal tunnel syndrome and vibration white finters and hand-arm vibration syndrome* ❑ Exposure to vibrating handtools during more than a total of 1 hour during the workday *For vibration white finger* ❑ Cold work environment during most of the day	*Work:rest ratio during a workday* ❑ Too little recovery time per hour when highly repetitive movements are performed *Work-characteristics in period before complaint started* ❑ High psychological demands ❑ Low social support

Acknowledgments

This project was carried out by the Coronel Institute for Occupational and Environmental Health, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands. It was partly funded by SALTSA, Solna, Sweden. We would especially like to thank the following Swedish experts for commenting on the final draft of the document: E Wigaeus Tornqvist, H Johansson, G Hägg, M Barnekow-Bergkvist, U Bergqvist, and A Toomingas. We thank C Hersbach and T Jonker for their help with the photographs.

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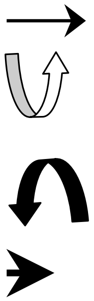
Appendix A

Description of provocative tests

This appendix describes the objective tests included as criteria for the different disorders in this document. Photographs of these tests are also included at the end of the table. The full citation of the given references can be found in the reference list of this document (pages 73-78). The tests are grouped by body region.

Arrows used in the photographs mean the following:



= force given by patient

= active movement by patient

= movement direction by doctor

= force applied by doctor

- **Right (=R) – Left (=L) comparison**
  To decide whether a test is positive, the right-left comparison is important in most tests. In addition, it is normal clinical practice to start a test on the nonsymptomatic side of the body.
- **Force applied by doctor during resistance tests**
  During resistance tests, the physician directs his or her force in the direction opposite the way the muscle works. For example: during the resisted elbow **flexion** test, the doctor builds the force towards elbow extension, and therefore the elbow flexor of the patient must contract.
- **Additional tests**
  A test is called an additional test when it is normally not performed as a basic physical examination test in the physician's office.

NECK REGION

Photo 1

Name of test	**Active movements cervical spine**
Kind of test	Active — to get impression of movements and severity, perform before passive rotation test is done
Starting position — patient	Sitting
Starting position — doctor	Sits or stands in front of the patient
Description	Patient is asked to move the head gently towards maximal flexion, extension, rotation (R-L), and lateroflexion (R-L), respectively
Positive when	Symptoms are provoked by movements or movements are restricted (R-L difference) Test is used to get an indication of the range of motion and irritability before the passive rotation test is performed
Reference	Orthopedic textbooks [eg, Loudon et al, 1998 (155)]

Photo 2

Name of test	**Passive rotation of cervical spine (R-L)**
Kind of test	Passive — for radiating neck pain
Starting position — patient	Sitting (or lying when dizziness is symptom in test 1) For mid cervical spine: head in neutral position For low cervical spine: head in some extension
Starting position —doctor	Standing behind the patient
Description (for rotation R)	R hand is placed at the L side of the head with the possibility for the fingers to palpate the spine, the L hand is placed at the back of the head with the L elbow stabilizing the ventral side of the shoulder: the head is slowly rotated to the R
Positive when	Radiating pain is elicited during, at the end of the range of motion, or immediately after the movement is performed
Reference	Orthopedic textbooks [eg, Loudon, et al 1998 (155)]

SHOULDER-UPPER ARM REGION

Photo 3

Name of test	**Painful arc test (abduction-elevation) R & L**
Kind of test	Active shoulder girdle, for rotator cuff syndrome
Starting position —patient	Standing with arms hanging downwards and thumbs directed to ventral side
Starting position — doctor	Standing in front of the patient
Description assignment	"Lift your arms to the side up to shoulder height, turn the palms of your hands upwards and lift the arms until your hands touch above your head"
Positive when	Pain is felt during a part of the movement (somewhere between 60 and 120 degrees abduction)
Reference	Hoppenfeld, 1976 (199)

Photo 4

Name of test	**Active elevation test 1: Apley's scratch test (abd/exorot) compare R WITH L!**
Kind of test	Active shoulder girdle, for rotator cuff syndrome
Starting position — patient	Standing
Starting position — doctor	Standing behind patient
Description assignment	"Take your hand behind your head and touch the upper part of your other shoulder blade with the top of your fingers"
Positive when	Local pain in shoulder during or at the end of the movement
Reference	Hoppenfeld, 1976 (199); Starkey & Ryan, 1996 (200)

Photo 5

Name of test	**Active elevation test 2: Apley's scratch test (abd/endorot) compare R WITH L!**
Kind of test	Active shoulder girdle, for rotator cuff syndrome
Starting position — patient	Standing
Starting position — doctor	Standing behind patient
Description assignment	"Take your hand backwards and touch the lower part of your other shoulder blade on your back with the tip of your middle finger"
Positive when	Local pain in shoulder during or at the end of the movement
Reference	Hoppenfeld, 1976 (199); Starkey & Ryan, 1996 (200)

Photo 6

Name of test	**Active elevation test 3:Apley's scratch test (add) compare R WITH L!**
Kind of test	Active shoulder girdle, for rotator cuff syndrome
Starting position — patient	Standing
Starting position — doctor	Standing in front of the patient
Description assignment	"Grab the top of your other shoulder"
Positive when	Local pain in shoulder during or at the end of the movement
Reference	Hoppenfeld, 1976 (199); Starkey & Ryan, 1996 (200)

Photo 7

Name of test	**Resisted abduction G-H joint R-L!**
Kind of test	Isometric resistance, for rotator cuff syndrome
Starting position — patient	Sitting, L upper arm in 10-20 degrees abduction
Starting position — doctor	Standing on L side of patient
Description (for L)	R hand stabilizes top of shoulder, L hand on lateral upper arm and force is built up towards adduction
Assignment	"Keep your arm in this position and resist my force"
Positive when	Local pain in shoulder (supraspinate muscle)
Reference	Starkey & Ryan, 1996 (200); Loudon et al, 1998 (155)

SHOULDER-UPPER ARM REGION (continued)

Photo 8

Name of test	**Resisted external rotation G-H joint R-L!**
Kind of test	Isometric resistance, for rotator cuff syndrome
Starting position — patient	Sitting, L upper arm against body; elbow in 90 degrees’ flexion, forearm in neutral position
Starting position — doctor	Standing on L side patient
Description (for L)	R hand controls position of elbow; L hand against dorsal side forearm and force is built up towards internal rotation G-H joint
Assignment	“Keep your elbow against your body and resist my force”
Positive when	Local pain in shoulder (infraspinate muscle)
Reference	Starkey & Ryan, 1996 (200); Loudon et al, 1998 (155)

Photo 9

Name of test	**Resisted internal rotation G-H joint R-L**
Kind of test	Isometric resistance, for rotator cuff syndrome
Starting position — patient	Sitting, L upper arm against body; elbow in 90 degrees’ flexion, forearm in neutral position
Starting position — doctor	Standing in front of the patient
Description (for L)	R hand controls position of elbow; L hand against ventral side of forearm and force is built up towards external rotation of the G-H joint
Assignment	“Keep your elbow against your body and resist my force”
Positive when	Local pain in shoulder (subscapular muscle)
Reference	Starkey & Ryan, 1996 (200); Loudon et al, 1998 (155)

Photo 10

Name of test	**Resisted elbow flexion test (=speed’s test) R-L!**
Kind of test	Isometric resistance biceps brachii muscle, for rotator cuff syndrome
Starting position — patient	Sitting, R upper arm in 90 degrees’ anteflexion, forearm supinated, elbow in light flexed position
Starting position — doctor	Standing on L side of the patient
Description (for R)	R hand stabilizes R G-H joint, L hand placed on ventral side of R forearm and force is built up towards elbow extension.
Assignment	“Keep your arm in this position and resist my force”
Positive when	Local pain over insertion biceps tendon
Reference	Loudon et al, 1998 (155)

ELBOW-FOREARM REGION

Photo 11

Name of test	**Resisted wrist extension test R-L!**
Kind of test	Isometric resistance of wrist extensors, for lateral epicondylitis
Starting position — patient	Sitting or standing; upper arm kept in 90 degrees’ anterior elevation, elbow fully extended, forearm pronated and wrist in extension
Starting position — doctor	Standing
Description for L	R hand stabilizes upper arm and elbow of patient; L hand is placed on the dorsal side of hand of patient and force is built up towards palmar flexion
Assignment	“Keep your hand in this position and resist my force”
Positive when	Pain or weakness in elbow region or both, locally around the lateral epicondyle
Reference	Starkey & Ryan, 1996 (200)

ELBOW-FOREARM REGION (continued)

Photo 12

Name of test	**Resisted wrist flexion test R-L!**
Kind of test	Isometric resistance wrist flexors, for medial epicondylitis
Starting position patient	Sitting or standing; upper arm is kept in 90 degrees' anteflexion, elbow fully extended; forearm is pronated; wrist in palmar flexion
Starting position doctor	Standing
Description for L	R hand stabilizes elbow; L hand placed on palmar side of hand of patient and force is built up towards extension
Assignment	"Keep your hand in this position and resist my force"
Positive when	Pain or weakness or both in elbow region, locally around the medial epicondyle
Reference	Starkey & Ryan, 1996 (200)

Photo 13

Name of test	**Resisted forearm supination R-L!**
Kind of test	Isometric resistance of forearm supinators, for radial nerve compression
Starting position — patient	Sitting or standing; elbow almost extended; forearm in neutral position; hand makes fist
Starting position — doctor	Standing, thigh stabilizes upper arm of patient
Description for L	Hands are placed in "pray-grip" around and just proximal of wrist; force is built up towards pronation in forearm
Assignment	"Keep you forearm in this position and resist my force"
Positive when	Pain point at dorsal side forearm
Reference	Barnum et al, 1996 (85); Völlinger & Partecke, 1998 (201)

Photo 14

Name of test	**Combined pressure and elbow flexion test (ulnar nerve) R-L!**
Kind of test	Additional passive test: stretch and compression test of ulnar nerve, for cubital tunnel syndrome
Starting position — patient	Sitting or standing
Starting position — doctor	Standing at L side of patient
Description for L	L hand places patient's elbow in maximal flexion; compression is given with R first and middle fingers on the ulnar nerve just proximal of the cubital tunnel for 30-60 seconds
Positive when	Paresthesias occur in ulnar nerve distribution distal to elbow
Reference	Novak et al, 1994 (80); MacKinnon, personal communication (1999)

Photo 15

Name of test	**Resisted middle finger extension R-L!**
Kind of test	Isometric resistance finger-wrist extensor, for radial nerve compression
Starting position — patient	Sitting; elbow extended, forearm resting on table, wrist in neutral position, middle finger extended
Starting position — doctor	Standing or sitting
Description for R	R hand stabilizes wrist, the L first and middle finger built up force towards flexion of the middle finger
Assignment	"Keep your finger in this position and resist my force"
Positive when	Positive when pain is produced at the point of maximal tenderness on the dorsal-proximal side of forearm
Reference	Barnum et al, 1996 (85)

Photo 16

Name of test	**Resisted wrist extension R-L!**
Kind of test	Isometric resistance wrist extensors, for extensor tendinitis of forearm-wrist extensors
Starting position — patient	Sitting; elbow flexed about 30 degrees, forearm resting on table in pronation; wrist held in extension
Starting position — doctor	Sitting or standing
Description for L	L hand stabilizes upper arm; R hand held on dorsal side of hand and force built up towards palmar flexion
Assignment	"Keep your wrist in this position and resist my force"
Positive when	Pain is felt in the dorsal wrist-forearm region
Reference	Starkey & Ryan, 1996 (200)

ELBOW-FOREARM REGION (continued)

Photo 17

Name of test	**Resisted wrist flexion R-L!**
Kind of test	Isometric resistance wrist flexors, for flexor tendinitis of forearm-wrist flexors
Starting position — patient	Sitting; elbow flexed about 30 degrees, forearm resting on table in supination; wrist held in palmar flexion
Starting position — doctor	Sitting or standing
Description for L	L hand stabilizes upper arm; R hand held on palmar side of hand and force is built up towards extension
Assignment	"Keep your wrist in this position and resist my force"
Positive when	Pain is felt in ventral wrist-forearm region
Reference	Starkey & Ryan, 1996 (200)

Photo 18

Name of test	**Palpation of supinator muscle R-L!**
Kind of test	Palpation for point of maximal tenderness, for compression radial nerve
Starting position — patient	Sitting, forearm may rest on table in pronation
Starting position — doctor	Sitting or standing, R hand stabilizes wrist, L thumb palpates dorsal side forearm
Description for R	Gentle palpation with thumb in muscle belly of extensors of the forearm (4-7 cm distally from lateral epicondyle on the extensor side of the lower arm)
Positive when	Point of maximal tenderness experienced
Reference	Barnum et al, 1996 (85)

WRIST-HAND REGION

Photo 19

Name of test	**Resisted thumb extension R-L!**
Kind of test	Isometric resistance of the extensor pollicis brevis, for Quervain's disease
Starting position — patient	Sitting, forearm resting on table in neutral position between pronation and supination, wrist extended about 20 degrees
Starting position — doctor	Sitting or standing
Description for L	L hand stabilizes hand, R thumb is placed against dorsal side of thumb just proximal from the distal interphalangeal I joint and force is built up towards palmar side of hand
Assignment	"Keep your thumb in this position and resist my force"
Positive when	Pain just proximal of wrist on radial side
Reference	Starkey & Ryan, 1996 (200)

Photo 20

Name of test	**Resisted thumb abduction R-L !**
Kind of test	Isometric resistance of the abductor pollicis longus, for Quervain's disease
Starting position — patient	Sitting, forearm resting on table in neutral position between pronation and supination, wrist extended about 20 degrees
Starting position — doctor	Sitting or standing
Description for L	L hand stabilizes hand, R thumb is placed on top of the thumb just proximal from distal interphalangeal I joint and force is built up towards the table side
Assignment	"Keep your thumb in this position and resist my force"
Positive when	Pain just proximal of wrist on radial side
Reference	Starkey & Ryan, 1996 (200)

WRIST-HAND REGION (continued)

Photo 21

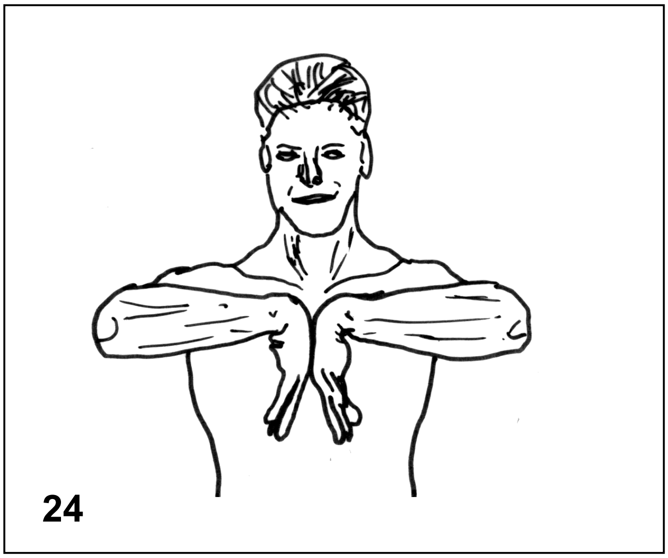
Name of test	**Finkelstein's test R-L!!**
Kind of test	Additional passive stretch test, for Quervain's disease
Starting position — patient	Sitting, forearm resting on table in pronated position, wrist extended about 20 degrees, a clenched fist is made with thumb tucked in fingers
Starting position — doctor	Sitting or standing
Description for R	L hand stabilizes distal forearm from ulnar side, R hand is placed around fist from radial side and ulnar abduction is gently performed
Positive when	Pain over first extensor compartment (abductor pollicis longus and extensor pollicis brevis muscles)
Reference	Loudon et al, 1998 (155); Hoppenfeld, 1976 (199)

Photo 22

Name of test	**Reversed Phalen's test R-L!**
Kind of test	Additional passive stretch-compression test of ulnar nerve, for Guyon's canal syndrome
Starting position — patient	Sitting, elbow in 90 degrees flexion, forearm pronated
Starting position — doctor	Sitting or standing
Description for R	L hand stabilizes forearm, R hand placed at palmar side of fingers and wrist-fingers are maximally dorsal flexed for 60 seconds
Positive when	Paresthesias occur in ulnar distribution of hand-fingers
Reference	Sluiter et al, 1998 (29)

Photo 23

Name of test	**Tinel's sign (over ulnar nerve) R-L!**
Kind of test	Additional ulnar nerve provocation, for Guyon's canal syndrome
Starting position — patient	Sitting, forearm supinated, wrist in neutral position
Starting position — doctor	Sitting or standing; R hand stabilizes hand; test is performed with L hand
Description for L	4-6 times gently tapping just distal from pisiforme bone with top of first and middle finger (or blunted end of the neurological hammer)
Positive when	Paresthesias or hyperesthesias occur distally from test position
Reference	Loudon et al, 1998 (155); Alfonso & Dzwierzynski, 1998 (202); del Pino et al, 1997 (113)



WRIST-HAND REGION (continued)

Photo 25

Name of test	**Phalen's test R-L!**
Kind of test	Additional passive median nerve compression, for carpal tunnel syndrome
Starting position — patient	Sitting, elbow in 90 degrees' flexion, forearm pronated, wrist and fingers relaxed in flexion
Starting position — doctor	Sitting or standing; L hand stabilizes forearm, R hand performs test
Description for R	R wrist moved into maximal palmar flexion; position kept for 60 seconds
! Note	Instead of the traditional version of the test **(see photo 24)**, no active double-sided performance by patient because of the differentiation with thoracic outlet syndrome
Positive when	Pain or paresthesias in thumb, first finger, or other fingers or all (note time for positive test)
Reference	Starkey & Ryan, 1996 (200)

Photo 26

Name of test	**Tinel's sign (over median nerve) R-L!**
Kind of test	Additional median nerve provocation, for carpal tunnel syndrome
Starting position — patient	Sitting, forearm supinated, wrist resting in neutral position
Starting position — doctor	Sitting or standing in front of patient; R hand stabilizes hand; test is performed with L hand
Description for L	4-6 times gently tapping on volar part of carpal ligament with top of first and middle fingers (or blunted end of the neurological hammer)
Positive when	Paresthesias or hyperesthesias occur distally from wrist
Reference	Loudon et al,1998 (155); Alfonso & Dzwierzynski,1998 (202); del Pino et al, 1997 (113)

Photo 27

Name of test	**Carpal compression Test R-L!**
Kind of test	Additional median nerve compression test, for carpal tunnel syndrome
Starting position — patient	Sitting, elbow flexed 90 degrees, forearm resting on table in supinated position
Starting position — doctor	Sits or stands
Description for L	Surrounds wrist with both hands and applies moderate pressure for 30 seconds with both thumbs transversally and direct over the flexor retinaculum (most proximal thumb just distal from wrist crease) with the aim of increasing the pressure within the carpal tunnel
Positive when	Paresthesias or numbness occurs distal from wrist within a maximum period of 30 seconds
Reference	Description of Durkan (1991), cited in del Pino et al, 1997 (113)

Photo 28

Name of test	**Flexion and compression test R-L! (at wrist)**
Kind of test	Additional median nerve compression test, for carpal tunnel syndrome
Starting position — patient	Sitting, elbow near extended position, forearm supinated
Starting position doctor	Stands in front of patient on side of test; surrounds wrist with both hands
Description for R	Wrist flexed to 60 degrees and a constant even pressure with minimum one thumb transversally over the carpal tunnel is given for 30 seconds
Positive when	Paresthesias or numbness in the distribution of the median nerve is recorded within 30 seconds
Reference	Tetro et al, 1998 (115)

Name of test	**Cold water provocation test**
Kind of test	Additional provocation test, for Raynaud's phenomenon associated with hand-arm vibration
Starting position — patient	Sitting, arm hanging in neutral position
Starting position — doctor	Sitting or standing in such way that observing the hand is possible
Description	Patient's hand immersed in cold water (about 10 degrees Celsius) for maximum of 4 minutes
Positive when	Observed blanching of at least 1 fingertip
Reference	Palmer, personal communication (1999)