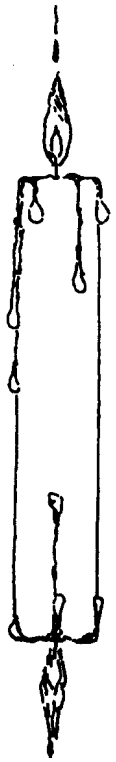
A REVIEW OF DIAGNOSTIC CRITERIA FOR WORK-RELATED UPPER LIMB DISORDERS

Dr P S Helliwell



Rheumatism Research Unit

THE UNIVERSITY OF LEEDS

A REVIEW OF DIAGNOSTIC CRITERIA FOR WORK-RELATED UPPERLIMB DISORDERS

Dr P S Helliwell

Address for correspondence:
Department of Rheumatology & Rehabilitation
36 Clarendon Road
Leeds
LS2 9NZ

Tel: 0113 2334952
Fax: 0113 2445533

February 1996

INDEX

SUMMARY

1. Work related upper limb disorder is a collective term for an heterogenous group of soft tissue disorders thought to have arisen as a result of work involving repeated use or constrained postures.
2. Two main groups of disorders are identiied: specific soft tissue syndromes and a non-specific disorder in which the responsible tissue cannot be identified.
3. Specific soft tissue syndromes occur in joint, muscle or nerve and are associated with characteristic symptoms and physical signs. These include shoulder tendonitis, epicondylitis at the elbow, tenosynovitis and nerve entrapments such as carpal tunnel syndrome.
4. The non-specific soft tissue syndrome is primarily described by symptoms of pain but may include muscular symptoms (such as weakness and cramp) or nerve symptoms (such as numbness, pins and needles and burning). Apart from muscle tenderness, physical signs are characteristically absent. The symptoms and signs may change as the condition evolves.
5. Different diagnostic criteria may be required in different situations. The primary care and occupational doctor may require sensitive criteria with a low false negative rate so that all cases are included. The secondary care, tertiary care and medico-legal doctor require more specific criteria with a low false positive rate so that over-diagnosis does not occur and only the most defenite cases are identified.
6. Observed discrepancies in diagnostic criteria may be explained by these differing requirements.

INTRODUCTION

This report is the result of a contract with the Health and Safety Executive (HSE) to perform a literature review of the diagnostic criteria for work-related upper limb disorders (WRULD), and to place these criteria into context by discussion with health professionals working in this field. The specific terms of the contract are outlined in Appendix 1. It should be noted at this point that although the criteria as specified by the HSE encompassed musculo-skeletal disorders of the upper limb arising from occupation, by agreement with the Project Officer, Dr C Mackay, hand/arm vibration syndrome was specifically excluded from this review. Furthermore, it was indicated that emphasis should be given to the main area of controversy in this field, non-specific arm pain associated with occupational use.

Clinical experience before commencing this project suggested that disorders listed under the title of "WRULD"consisted of a number of well defined soft tissue disorders of the upper limb and a less well defined condition of non-specific pain in the arm. The well defined soft tissue disorders generally offer little problem in diagnosis and treatment but constitute the minority of conditions associated with occupational use. The majority of complaints consist of pain in the arm which cannot be characterised medically as a specific tissue disorder, and may be associated with paucity of physical signs.

None of the conditions referred to, either specific or non-specific, with the possible exception of carpal tunnel syndrome, are characterised by rigorous validation criteria. Such criteria include pathological confirmation of the disorder and information on sensitivity and specificity of the diagnostic criteria in confirming the presence or absence of the disorder. This is not an unusual

situation in medicine, although recently the introduction of diagnostic logic has been introduced based on probability theory (Albert el at, 1988).

Two sets of criteria are available from the literature. Diagnostic criteria are clinical and investigative features which enable the practising physician to identify the disorder. Classification criteria are designed for use in epidemiological studies. The sensitivity, specificity and predictive value of clinical criteria should be known to the clinician so that he/she knows the amount of diagnostic uncertainty when employing these criteria. Classification criteria enable comparisons of different populations: they allow a common language to be spoken.

A frequently used classification is the International Classification of Diseases of the World Health Organisation. The 9th revision was issued in 1975 and the 10th edition in 1992. As indicated by Katz and Buchbinder (1995), this classification is most unsatisfactory for musculoskeletal disorders, eg: for a patient with neck pain, 11 separate diagnostic codes could be used. In the more recent edition (International Classification of Diseases 1992) a category described as 'soft tissue disorders related to use, over-use and pressure' (M70) has been introduced and this may simplify classification of work-related syndromes. However, no diagnostic criteria are given for these specific disorders: the decision to use this particular rubric is left to the individual physician or allied health professional.

In comparison with classification criteria, diagnostic criteria may in clinical use vary from text book descriptions based on clinical experience, anatomy and physiology (eg: lateral epicondylitis presents with symptoms of pain over the lateral epicondyle and pain can be reproduced at that site on resisted extension of the wrist) to clinical criteria related to definitive investigations or pathological

data (eg: carpal tunnel syndrome can be described clinically, electrophysiologically, or confirmed by operation to decompress the carpal tunnel).

Although having investigational and pathological confirmation of a diagnosis is ideal, diagnostic criteria without such confirmatory tests can be of use clinical and epidemiologically if agreement can be obtained on the clinical features comprising the disorder. In the latter case further information could be obtained on the reliability of these criteria. By analogy with low back pain, which in the majority of cases is diagnosed clinically as non-specific or 'mechanical' backache, Nelson et al. (1979) were able to perform reliability and reproducibility studies on clinical criteria employed in the diagnosis of this condition.

Using agreed but purely descriptive criteria accords with clinical practice and is in the best tradition of medicine. Simply because investigational or pathological data are not available to confirm the cliical picture does not mean that the condition does not exist. Clearly, the condition does exist phenomenologically (note a phenomenon is defined by the Oxford English Dictionary as "a thing that appears or is perceived or observed, applied chiefly to a fact or occurrence, the cause of which is in question"). Again, by analogy, early physicians relied heavily on their powers of observation and classified disorders in a phenomenological way; much of this careful clinical observation can now be corroborated with the advent of modern investigational techniques (see for example William Heberden: Physician of the Age of Reason, 1989). It is possible that, in future, the condition of non-specific pain in the arm associated with work will be supported by more objective findings from new investigational techniques.

METHODOLOGY

Literature review

Textbooks

Major textbooks of orthopaedic medicine, rheumatology, occupational medicine and ergonomics werereviewed. This was not an exhaustive review of available textbooks but the major books in use in Britain and North America were surveyed. All these books were available in The University of Leeds Medical and Dental Library.

Scientific literature

Use was made of the on-line databases available to users of The University of Leeds Medical and Dental Library. The databases searched were: Medline, CINAHL and the Applied Science and Technology database. The 11 year period from 1985 to 1995 was covered. Search criteria were as follows:

Repetition strain injury (MESH).

Repetitive strain disorder

Over-usesyndrome.

Occupational diseases.

In addition, key references of major reviews were sought. In this respect, an important work was 'Work Related Musculoskeletal Disorders: A Reference Book for Prevention', edited by Kuorinka and Forcier (1995), detailing a report produced for the Quebec Research Institute on Occupational Health and Safety. Specifically, the terms of this report were a review of the diagnostic criteria and evidence for work-relatedness of conditions of the upper limb. The scientific editors and authors of this report are all leaders in research on these conditions in North America and Scandinavia.

Other major reviews providing coverage of the relevant literature were the PhD thesis of Silverstein (1985), and the 'Meta Analysis of Workplace Ergonomic Factors in the Development of Musculo-skeletal Disorders' by Stock (1991).

Further available data were obtained from the authors' personal files covering a period of eight years.

Discussion with medical and non-medical personnel working in the field

The aim was to include a wide spectrum of people working in this field. Therefore an attempt was made to interview at least one person from the following areas:

General practice.

Occupational health nurse.

Occupational physician.

Health and Safety medical personnel.

Secondary and tertiary care doctors (including those involved in medico-legal work):

Orthopaedic surgeons.

Rheumatologists.

Ergonomists.

Interviews were carried out by telephone or, in preference, 'person-to-person'.

The purpose of these interviews was to discuss points of controversy, particularly with regard to the category of non-specific arm pain. It also became clear during these interviews that with regard

to WRULD there is a discrepancy between clinical practice and medico-legal practice and these differences will be highlighted in the Results section.

RESULTS

Literature

The range of conditions covered in this survey are illustrated in Fig. 1, and a brief synopsis of each condition together with annotated diagnostic criteria are given in Table 1. The diagnostic criteria given in the Table are for descriptive purposes only and are not a summary of the literature survey, the details of which are given in the text.

Diagnostic criteria for WRULD are, of course, not complete without reference to occupational exposure. This may be no more than the patient relating the symptoms to their occupation. However, Silverstein (1985) defined occupational exposure rather more precisely, categorising each job as low force/high force, low repetition/high repetition and used combinations of these to estimate risk for a range of occupations. Silverstein also specified the duration of symptoms as a minimum period of one week, or more than 20 times in the previous 12 months, or both. Other requirements were the absence of an acute precipitating event, no evidence of systemic illness (eg. rheumatoid arthritis) and the symptoms should have appeared only since starting the current job.

Ranney (1993) is also specific about occupational use. He, being an anatomist, is keen to identify the specific muscle that is causing the pain and to relate this to specific occupational use (or over-use).

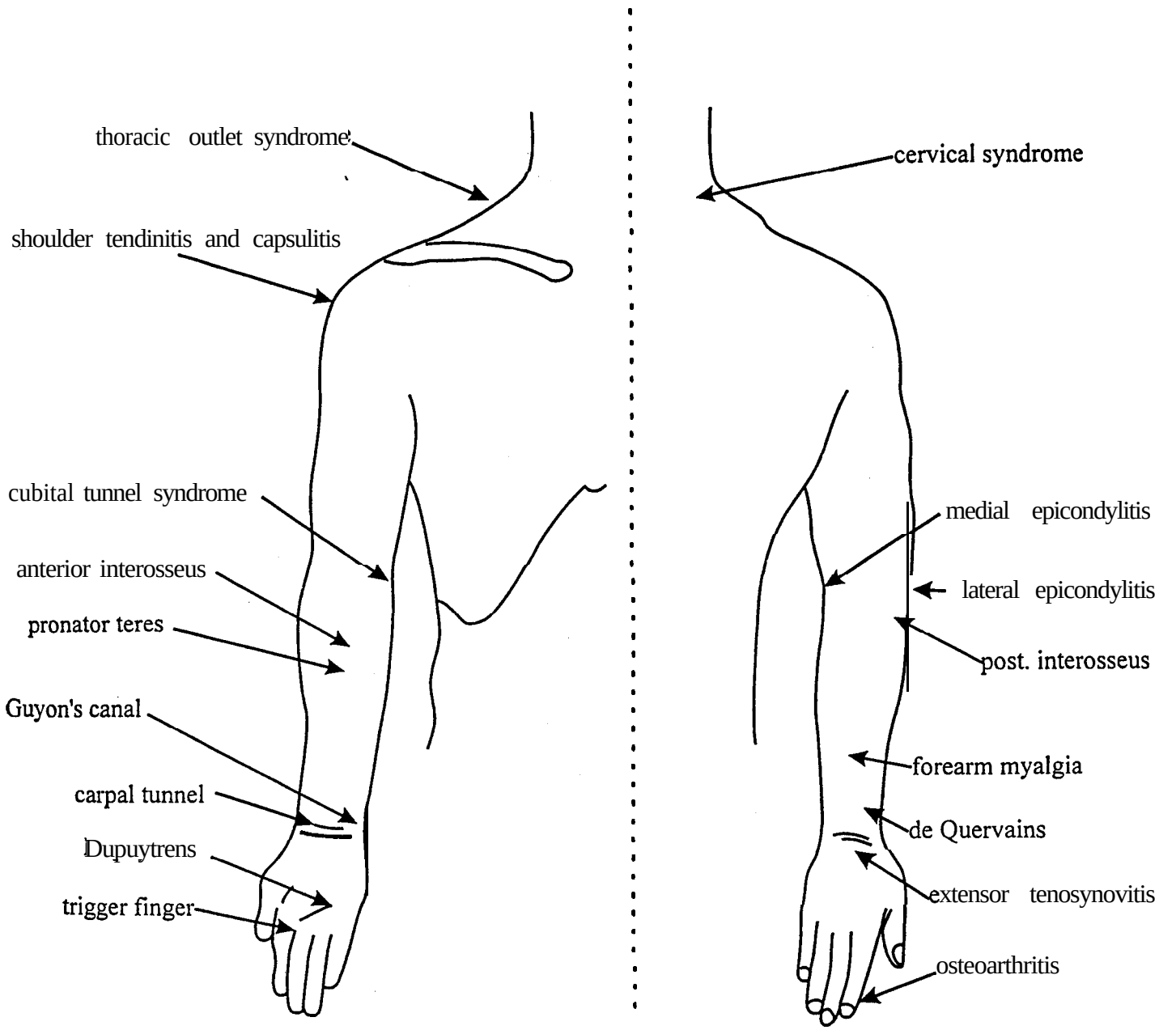


Figure 1. Range of specific soft-tissue syndromes covered in this report

Table 1. Specific soft-tissue syndromes and their symptoms and signs

SOFT TISSUE SYNDROME	SYMPTOMS	SIGNS
Cervical syndrome	Pain in the neck with radiation into the arm.	Painful movements of the neck (at least 3 out of six) Pain radiating **into arm on movement of neck**
Tension neck syndrome	Pain in the neck and shoulder	Tender cervical and trapezius muscles
Thoracic outlet syndrome	Pain in the arm, parasthesiae in the inner aspect of the arm, weakness of grip	**Roos manoevre (hyperabduction, external rotation of** shoulder) positive. Signs of ulna nerve dysfunction may be present.
Shoulder tendinitis	Pain in the shoulder worse on movement	**Painful** arc, painful resisted movements (for supraspinatus, abduction; for infraspinatus, external rotation; for subscapularis, internal rotation). Normal passive movements
Shoulder capsulitis	Pain in the shoulder worse at night	Loss of passive movements, particularly external rotation. Resisted movements non-painful.
Lateral epicondylitis	Pain around the lateral epicondyle	Tenderness on or just inferior to lateral epicondyle. Symptoms reproduced by resisted extension of wrist with elbow fully extended.
Medial epicondylitis	Pain around the medial epicondyle	Tenderness on the medial epicondyle. Symptoms reproduced by resisted flexion of the wrist, as for LE.

SOFT TISSUE SYNDROME	SYMPTOMS	SIGNS
Cubital tunnel syndrome	Pain, paraesthesiae and numbness 4th. 5th. fingers of hand	Decreased sensation 4th. 5th. fingers. Weakness interossei. Positive Froment's sign.
Pronator teres syndrome	Aching in proximal forearm. Pain and paraesthesiae in median nerve distribution in hand	Reproduction of symptoms on resisted pronation of forearm.
Anterior intcrosseous syndrome	Aching volar aspect of forearm.	Weakness of pronator quadratus, flexor pollicis longus and/or flexor digitorum profundus.
Posterior interosseous syndrome	Pain distal to lateral epicondyle	Tendreness distal to elbow. Weakness of extension of middle finger
Carpal tunnel syndrome	Pain and paraesthesiae (particularly nocturnal) median nerve distribution (thumb, indes and middle fingers) of hand.	Positive Tinel's and Phalen's sign. Sensory loss in median nerve distribution. Weakness of abductor pollicis brevis and opponens pollicis.
de Quervains tenovaginitis	Pain on radial aspect of wrist	Positive Finkelstein's test. Pain on resisted estension and abduction of the thumb.
Tenosynovi tis	Pain, swelling and crepitus over affected tendon.	Tenderness, swelling and crepitus along affected tendon.
Stenosing tenosynovitis	Pain and triggering of finger on extension	Palpable nodule. Triggering.
Osteoarthritis	Pain, swelling, deformity and loss of function	Heberden's nodes, Bouchard's nodes. Mucinous cysts. Loss of movement. Joint instability.
Hypothenar hammer syndrome	Blanching, paraesthesiae, pain in hand.	Positive Allen's test

Table 1 (continued)

Carpal tunnel syndrome

carpal tunnel syndrome is presented as the prototype for other conditions in that there is a wealth of data comparing clinical diagnostic criteria with investigational and pathological evidence such that the issues relevant to all diagnoses in this field can be discussed.

The carpal tunnel is formed by the bones of the wrist arranged in a semi-circle and bounded by the tough volar carpal ligament. Through this tunnel pass the median nerve and nine flexor tendons. Anything which increases the volume of the contents or decreases the internal dimensions of the tunnel will cause compression of the constituent parts. The dimensions of the tunnel are largely genetically determined: there is some evidence that the size of other potential sites of compression correlate with the dimensions of the carpal tunnel, such that people with carpal tunnel syndrome have a narrower antero-posterior diameter of the cervical spine (Murray-Leslie and Wright, 1976). The commonest cause of median nerve entrapment in the carpal tunnel is an increase in the volume of the contents, most commonly due to inflammation of the synovial lining (eg: rheumatoid arthritis), deposition of abnormal protein (eg: multiple myeloma), and finally endocrine disorders such as pregnancy, diabetes and myxoedema.

Symptoms

The main symptoms of this discrder are pain, paraesthesiae and loss of function. The pain typically occurs in the area of skin supplied by the median nerve, that is the thumb, index and middle finger and radial half of the ring finger. However, the pain may be experienced proximally as far UP the arm as the shoulder and some patients complain of pain throughout the hand. Paraesthesiae may occur within the same area. Symptoms typically occur at night, waking the patient. Relief at night

is often obtained by hanging the hand over the bed or shaking the hand. Loss of grip strength is an early symptom.

Clinical signs

Clinical signs may conveniently be divided into two sections: *provocation tests* and *nerve dysfunction.*

(i) Provocation tests are principally Tinel's test and Phalen's test. Tinel's test consists of lightly tapping over the median nerve at the wrist: pain and paraesthesiae felt in the distribution of the median nerve distally indicate a positive test. Phalen's test consists of full active flexion of the wrist for 60 seconds: onset of pain and paraesthesiae in the distribution of the median nerve is indicative of a positive test (this test by also be performed by inflating a sphygmomanometer cuff above the systolic blood pressure for 60 seconds).

Recently the 'flick' sign has been described for carpal tunnel syndrome (Pryse-Phillips, 1984); in response to the question "what do you do when your symptoms are worse?": if the patient demonstrates a flicking action like shaking a thermometer then this sign is said to be positive.

(ii) Nerve dysfunction. The median nerve carries fibres to both muscle (motor fibres) and skin (sensory fibres). The two main muscles supplied by this nerve are the abductor pollicis brevis and opponens pollicis. With the thumb adducted towards the 5th finger, the patient is asked to abduct against resistance. The opponens pollicis is tested by asking the patient to touch the tip of the thumb to the tip of the 5th finger,and then attempting to break the pinch. In severe cases muscle atrophy may be apparent on the outer half of the thenar eminence. Loss of sensation may be tested with either pin-prick, vibration, 2 point

discrimination or monofilament hairs. The advantage in using one of the three latter methods is that they can be quantified and therefore, in theory, be compared to normal values.

Diagnostic tests

Electrophysiology is used to **confirm** the diagnosis of carpal tunnel syndrome. However, electrophysiological tests may be normal in some cases of early disease. More sophisticated techniques are thought to increase the sensitivity of these tests and will be discussed in a later section. Both motor and sensory nerve conduction are tested by applying suitable stimulation either distally or proximal to the tunnel and determining the speed of impulse conduction in both sensory and motor nerves using the ipsilateral ulnar nerve and the contralateral median nerve and ulnar nerve as comparators.

Imaging of the carpal tunnel has recently been described using the technique of magnetic resonance imaging and the dimensions of the tunnel may be determined by ultrasound scanning.

At operation to decompress the tunnel, a clear macroscopic sign that in **vivo** compression is present is flattening and atrophy of the nerve at the site of compression with distal swelling and oedema of the nerve. In vivo measurement of carpal tunnel pressures has recently been described (Nashel, 1994).

Discussion **of diagnostic criteria**

There are extensive data on the sensitivity, specificity and predictive value of the symptoms and signs of carpal tunnel syndrome (see Table 2). In the following discussion attention is drawn to Appendix 2 which explains the significance of the terminology used. In clinical studies,

Table 2. Sensitivity and specificity of clinical findings in carpal tunnel syndrome (after Katz et al 1991)

(1) 2 point discrimination >4mm.
(2) National Institute of Occupation, Safety and Health

PPV: positive predictive value. NPV: negative predictive value
a: population prevalence 15%

	sensitivity	specificity	PPV	NPV	PPVa	NPVa
symptoms only	.93	.25	.44	.86	.18	.96
occupational risk factors	.83	.40	.46	.78	.21	.93
Tinel	.62	.66	.53	.74	.24	.91
Phalen	.73	.36	.40	.70	.17	.88
sensory loss (1)	.23	.82	.47	.62	.19	.86
NIOSH (2)	.67	.58	.50	.74	.22	.91

electrophysiological measurements provide definitive information on the presence of carpal tunnel syndrome However, it is claimed that in 15% of genuine cases nerve conduction tests are normal (Nashel, 1994). In some cases this is thought to occur because the syndrome is in its early stages before gross changes in the nerve have occurred, but in some cases this may be due to anatomical variations. In such cases, more sophisticated neurophysiology may detect abnormalities and a number of new techniques have been described (see below). Because of these uncertainties, relief of symptoms and signs following operation is felt by some to be the only definitive way of making a final diagnosis.

A further problem is outlined in Appendix 2. The positive and negative predictive value of a test is dependent on the pre-existing prevalence of the disease in the population. The significance of this in the context of the studies reported is that the prevalence of the index condition is artificially high, such that positive and negative predictive values may be artificially inflated. Scaling the figures to known occupational or population prevalences can make a dramatic change to the figures, as illustrated in Table 2.

Symptoms only

A Lancet leader in 1991 suggested that if symptoms were highly suggestive of median nerve compression then these should be sufficient for diagnosis even in the presence of normal nerve conduction tests. Using the definition of 'transient or persisting numbness or paraesthesiae of the fingers in an area innervated by the median nerve, aggravated by activities using the hands, the incidence of carpal tunnel syndrome in Rochester, Minnesota, was estimated to be 99 per million Person years (Stephens et al, 1988). Nerve conduction tests were carried out for confirmation. By

the nature of their study, 100% of their patients had sensory symptoms, 71% of these occurring nocturnally and 38% occurring proximally. The American National Institute of Occupational Safety and Health (NIOSH) used three criteria, all of which must be met, in the definition of carpal tunnel syndrome: firstly, the patient must have suggestive symptoms somewhere in the distribution of the median nerve. Secondly, the patient must either have Tiiel's or Phalen's sign or decreased pin-prick in the median nerve distribution or an EMG abnormality suggesting carpal tunnel syndrome. Thirdly, the symptoms must be work-related, which work must involve repetition, force, awkward position or vibration. Boniface et al (1994), however, feel that symptoms are poor discriminators for carpal tunnel syndrome: of 100 patients referred for electrophysiology with symptoms of pins and needles or numbness in the hand, only 64 had positive nerve conduction tests.

Signs

(I) sensitivity and specificity of Tinel's and Phalen's signs.

According to a study by Stewart and Eisen (1978) the sensitivity of Tinel's sign is 0.61, the specificity 0.56. These are similar figures to those obtained by Katz et al. (1991). In both these cases, confirmation was by electrophysiology. These figures are good in comparison with those obtained by Golding et al (1986) who found the sensitivity to be 0.26, specificity 0.80. The results are summarised, together with the figures for Phalen's sign, in Table 3. Overall, in comparison, Phalen's sign has marginally better sensitivity and marginally worse specificity.

To improve the sensitivity and specificity of Phalen's test, Durkan (1991) has described a new provocation test where an inflated cuff produces pressure over the median nerve in a standardised fahion: better sensitivity (0.87) and specificity (0.90) were reported.

Table 3. Summary of sensitivity and specificity of Tinel's and Phalen's signs

	TINEL		PHALENS	
	sensitivity	specificity	sensitivity	specificity
Katz et al 199 1	.62	.66	.73	.36
Golding et al 1986	.25	30	.lO	.86
Gellman et al 1986	.44	.94	.71	.80
Durkan 1991	.56	.80	.70	.84
Overall	.47	.80	.56	.72

'(ii) sensory testing

Sensory testing is felt to be less sensitive but more specific. The figures for loss of 2 point discrimination (defined as greater than 4mm on the pad of the index finger) are:- 0.28 for sensitivity and 0.91 for specificity (mean values from Gellman et al, 1986, Katz et al, 1991). Testing with monofilaments gave a sensitivity of 0.91 and a specificity of 0.80 (Gellman et al, 1986).

ofher techniques are vibration perception with a standardised technique commonly used for detecting early peripheral neuropathy in diabetics and a gap detection method analogous to 2 point discrimination (Jeng and Radwin, 1995).

(iii) weakness

Higgs et al (1993) regard loss of grip and pinch strength as critical signs of carpal tunnel syndrome. They recommend comparison of strength with standard tables for age and sex and use 2 standard deviations from the mean as the lower limit of normal.

Electrodiagnostic testing

Normal values for routine electrophysiological testing vary from laboratory to laboratory. Standardised conditions are recommended: a relaxed patient and a warm hand are pre-requisites for meaningful results. There is some evidence that normalisation for age and sex should be made (Nathan et al, 1988). Representative values for normality include a distal motor latency of less than 4.5msec., sensory action potential conduction velocity of less than 4msec. and a right to left difference than less than 0.5msec. Paradoxically, clinical findings have been used as the standard in many electrophysiological investigations although some studies have used response to surgery.

Performing provocation tests may be one way of increasing the sensitivity of nerve conduction tests; Schwartz et al, 1980, found an increase in motor latency of 0.2ms in patients with carpal

tunnel syndrome following two minutes of Phalen's manoeuvre. Other techniques for increasing sensitivity have been described by Feldman and Jabre (1987) who point out that routine electrophysiological testing miss about 20% of genuine cases. These authors mention the provocative testing of Schwartz and also comment on segmental testing of the distal part of the median nerve - a technique introduced by Kimura in 1979. Kimura's technique is based on one centimetre segment latency testing over a section of the median nerve from a point just distal to the carpal tunnel to mid-palm. A sharp change in the latency occurs at the segment 2 - 4 cms distal to the distal palmar crease in carpal tunnel syndrome. Kimura claimed that this test increased the sensitivity of electrophysiological testing from 0.81 to 0.92. These techniques have been refined by Nathan and colleagues (1988) using fairly tight clinical criteria to define carpal tunnel syndrome. They found the following figures: sensitivity 0.81, specificity 0.81, positive predictive value 0.77, negative predictive value 0.85.

In the later stages of a carpal tunnel syndrome denervation of muscle may occur, such that electromyography is abnormal. As with the clinical sign of muscle wasting, electromyographical abnormalities are likely to be specific but relatively insensitive.

Comment

Carpal tunnel syndrome is a well described condition with clear-cut clinical signs, unequivocal investigations and a straightforward surgical treatment. As the prototype work-related syndrome this should offer the best chance we have of describing clear physical signs with high reliability and validity. However, as Table 3 shows, the sensitivity of the two main provocative tests is little different from 0.5 which means in effect that 50% of patients with this condition will have a

negative test.A figure for specificity of about 0.76 means that 25% of patients without the disorder will have a positive test. It is likely that these figures can be improved by electrophysiological testing, but the authors this is impractical in a clinical situation where potentially large numbers of subjects are examined. The data used by NIOSH have been validated and show comparable sensitivity and specificity to other clinical tests (see Table 2) and since they are already in use epidemiologically it would be sensible to use these criteria. It must be remembered, however, that reliability data are not available so that we are still not clear whether two observers would agree on the diagnosis using these criteria. In summary, the criteria of NIOSH as presented by Matte et al are as follows - carpal tunnel syndrome is present if all three criteria are met.

Criterion (a) - sensory symptoms somewhere in the median nerve distribution.

Criterion (b) - either Tinel's test positive or Phalen's test positive or decreased pin-prick in the median nerve distribution or an abnormality on neurophysiological testing.

Criterion (c) - appropriate work-relatedness (which would include repetition, force, awkwardness of position and the use of vibrating tools) and a temporal relationship between work and symptomatology.

OTHER SPECIFIC UPPER LIMB DISORDERS

In the following section, specific neck and upper limb disorders will be reviewed (see Figure 1). As pointed out previously, the diagnostic criteria are not thoroughly validated, nor are reliability data available. For each disorder, the source material consist of 10 review articles. These are supplemented by individual journal articles as indicated in the text. The 10 source articles listed in chronological order are as follows:-

1. Cyriax - Textbook of Orthopaedic Medicine, 1978
2. Viikari-Juntura, 1983 (adapted from Waris et al, 1979)
3. Silverstein, 1985 (see also Silverstein et al, 1986)
4. Dalton and Hazleman in Hunter's Diseases of Occupations, 1987
5. McCormack et al, 1990
6. Millender et al, Occupational Disorders of the Upper Extremity, 1992
7. Ranney et al, 1995
8. Dawson, 1993
9. Ohlsson et al, 1994
10. Klippel and Dieppe, Textbook of Rheumatology, 1994.

Neck disorders

Cyriax identifies both articular and root signs in the clinical presentation of neck problems. There are six basic movements of the cervical spine: flexion, extension, right and left side flexion, right and left rotation. Reduction of 4 to 6 of these movements (according to the condition) constitutes articular signs. Root signs depend on the specific root involved, both in terms of symptoms (pain, paraesthesiae, weakness, numbness) and signs (weakness, wasting, loss of reflex, sensory deficit). The diagnostic spectrum can range from pain in the neck with painful limitation of two or three movements to overt radiculopathy with weakness and wasting.

Viikari-Juntura identifies two conditions. The ***tension neck syndrome*** is characterised as follows. A feeling of fatigue or stiffness in the neck, neck pain or headache radiating from the neck. Signs consist of at least two tender spots or palpable hardenings. The ***cervical syndrome*** consists of pain radiating from the neck to the upper extremity, or pain in the neck and numbness in the hand with limited neck movement and pain on neck movement.

As pointed out by Katz and Buchbinder, 1995, there is little information on whether two independent examiners can agree upon the presence of muscle hardening, muscle tenderness or limited neck movement. Further studies by Viikari-Juntura (1987) examined inter-rater

Table 4. Reproducibility of clinical signs on examination of the neck (after Viikari-Juntura 1987)

Note Kappa statistic of < 0.4 is poor, 0.4-0.75 is fair to good, > 0.75 is excellent

	Kappa statistic
Muscle atrophy	0.48
Muscle strength	0.47
Muscle tenderness	0.43
Sensitivity to light touch	0.63
Sensitivity to pain	0.48
Sensitivity to vibration	0.50
Range of movement	0.48

reproducibility and found kappa statistics varying from 0.4 to 0.6 (a value of ≥ 0.4 is probably acceptable in clinical practice). These results are summarised in Table 4.

Leffert (in Millender) defined cervico-brachial pain as pain in the neck, para-cervical muscles and shoulder in subjects who do repetitive motion of the shoulder or who must retain a constant position of the neck while performing tasks with the hands. Signs may be: muscle-wasting in the neck, trigger points (these are well-defined acutely tender areas in muscle) and weakness in the neck.

Ranney defines neck myalgia as pain on one or both sides of the neck increased by neck movement, together with tenderness over the paravertebral neck muscles.

Hagberg and Wegman (1987), defined tension neck syndrome as pain in the shoulder and neck and tenderness in the descending trapezius muscle. Cervical syndrome is defined as pain in the neck radiating into the arm in a segmental distribution. Cervical spondylosis is only diagnosed radiographically with either a reduced disc height or osteophyte formation.

These criteria are poorly defined but contain a number of areas of overlap. In this context it would seem that certain minimal criteria are met:

(1) pain the neck and upper back in the area defined in Figure 2 (overpage).

(2) pain the neck, upper back or shoulder on movement of the neck.

(3) appropriate workplace factors and temporal relationships.

Thoracic outlet syndrome

The thoracic outlet syndrome is a compression neuropathy affecting the lower roots of the brachial plexus, particularly the nerves derived from the 8th cervical and 1st thoracic roots. Classically, this

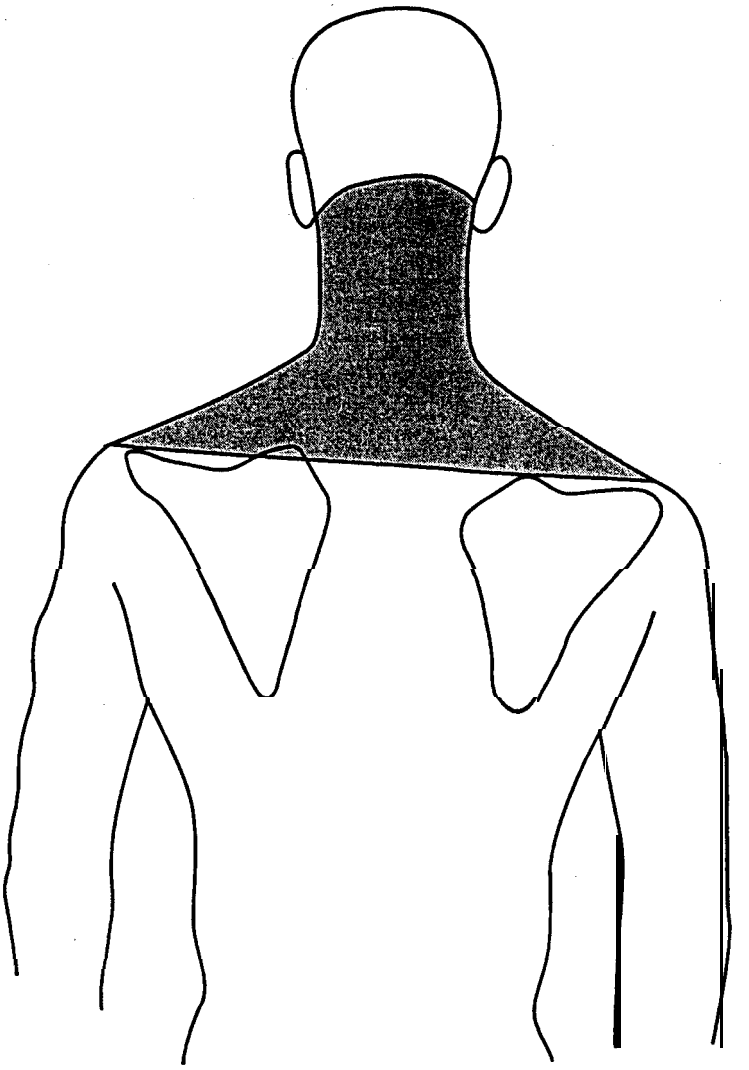


Figure 2 Area in which pain may be felt in cervical syndrome

syndrome is due to a cervical rib but some authors consider that the syndrome may occur due to compression by scalene muscles hypertrophied in response to occupation.

According to Cyriax, the symptoms are wholly distal and consist of pins and needles and numbness in median or ulnar distribution, more often the latter. The symptoms may be worse when carrying heavy objects or after working with the arms abducted above the level of the shoulder.

Viikari-Juntura felt that pain radiating to an upper extremity is the minimum symptom for diagnosis. The signs included a positive elevated arm stress test (pins and needles occurring in the median or ulnar nerve distribution with the arm elevated above the level of the shoulder), a positive Morley's sign (tenderness in the supraclavicular fossa), a positive Adson's test (diminution of the pulse with the patients; arm dependent and the patient's head turned towards the affected side whilst performing a Valsalva manoeuvre), and finally drooping shoulders.

Silverstein required the symptoms of paraesthesiae in the ulnar distribution, a positive hyper-abduction test and decreased grip strength.

Dalton and Hazelman (in Hunter's 1987) required pain, paraesthesiae and motor weakness in the distribution of the C8/T1 nerve roots.

Dawson noted that typical symptoms are pins and needles on the medial aspect of the arm especially on shoulder abduction. Signs included weakness of the intrinsic muscles of the hand and forearm and a diminution in the radial pulse volume on abduction of the arm, although he mentions that this is found in 15% of the normal population.

Ohlsson required pain radiating to the upper extremity in the distribution of the ulnar nerve and a positive Roos' test (three minutes of abduction and external rotation of the shoulder causing pain, fatigue and paraesthesiae in the ulnar nerve distribution). Ohlsson also required a positive Morley's sign and the exclusion of tension neck syndrome and cervical syndrome.

Nashel (ii Klippel and Dieppe) mentions that patients usually experience sensory symptoms as the first manifestation and says that this may be the only feature of the condition. Later signs are clumsiness of the hands, wasting of the thenar, hypothenar and intrinsic muscles of the hand and a small number have vasomotor disturbances particularly coldness, blanching and cyanosis of the fingers.

Hall (in Hadler, 1987) mentions that the predominant symptoms are in the ulnar and the median nerve distribution. Adson's manoeuvre is considered to be unreliable and unspecific. Furthermore, investigations such as electrophysiology, are not as reliable as in carpal tunnel syndrome, partly because diagnosis depends on F wave detection. This viewpoint is supported by Nashel, 1994.

Roos (1976) believes that diminution of radial pulse in response to manoeuvres around the shoulder is of low sensitivity and specificity and that if the patient is operated on for this sign only then improvement does not occur. He described Roos' sign and states that the test is positive if there is early fatigue and heaviness, gradual onset of paraesthesiae, crescendo of distress and a sudden dropping of the arm, irrespective of any change in pulses.

Hadler (1993) cast some doubt on the umbrella term of thoracic outlet syndrome, but conceded that there are two genuine presentations of this condition, the vascular and the neural. The vascular is associated with extremes of usage of the shoulder, such as in professional baseball pitchers where occlusion of the brachial artery and/or vein can occur. The neural consists of compression of the lowest part of the brachial plexus leading to weakness and atrophy in the median nerve (thenar eminence) followed by muscles in the ulnar nerve (small muscles of the hand) together with (usually) ulnar sensory loss with median sparing.

Iu summary, whatever the pathology, thoracic outlet syndrome is a recognised condition in which only symptoms may occur initially, these being confined to the inner aspect of the arm and of a **neurogenic** nature, ie: pain paraesthesiae and numbness. Physical signs are of neural dysfunction, particularly in the ulnar nerve distribution. A number of provocative tests have been proposed but figures for sensitivity and specificity are not available. Investigative procedures are often inconclusive and unhelpful.

In accordance with the preceding discussion, the following are **minimal features** required for diagnosis:-

a) A pattern of occupational use consistent with this syndrome (usually overhead work) and an appropriate temporal relationship.

b) Neurogenic symptoms on the inner aspect of the arm in ulnar nerve distribution or distally in the ulnar or median nerve distribution

c) No evidence of distal nerve entrapment electrophysiologically.

Shoulder disorders

Anatomically, three muscles provide what is collectively termed the 'rotator cuff: supraspinatous, infraspinatus and sub-scapularis. If a painful arc (a painful phase during active elevation of the shoulder) is present a disorder of the rotator cuff is likely. Most authors, however, specifically identify the muscle tendon involved. A fourth tendinitis occurs at the shoulder: bicipital tendinitis of the long head of biceps. The only other commonly described condition at the shoulder is the 'frozen' shoulder, or capsulitis, where there is thickening and inflammation of the shoulder joint (gleno-humeral)capsule. Pain in the shoulder may be referred from the neck, but if tenderness and

limitation of movement is found in the shoulder then at least some of the pain will be due to shoulder disease.

Cyriax developed a system for examining the shoulder, the clinical signs derived enabling a clear diagnosis of the condition (see Table 5). The system requires an examination of active, passive and resisted movements (generally divided into abduction, external rotation and internal rotation). Diagnostic confusion may exist if more than one condition exists at a time.

Viikari-Juntura identifies only supraspinatous tendinitis (pain in the shoulder with local tenderness and pain on abduction) and bicipital tendinitis (pain in the shoulder with tenderness anteriorly and pain at that site on resisted supination of the forearm with the elbow flexed at 90°). Capsulitis is diagnosed with progressive pain and shoulder stiffness during the previous 3-4 months, together with signs of limited active and passive external rotation.

Silverstein requires pain in the deltoid area with nocturnal exacerbation and a 'catch' on movement. Signs included diffuse tenderness, a painful arc and pain on resisted movement.

McCormack et al identify an impingement syndrome (see below) and specific tendon lesions.

Leffert (in Millender) for the diagnosis of shoulder tendinitis requires pain in the shoulder with a painful arc on abduction and relief of pain on the administration of local anaesthetic into the subacromial area. He advises that X-ray occasionally reveals cystic changes and flattening in the greater tuberosity.

Ranney describes pain in the de!toid area or the front of the shoulder increased by gleno-humeral movement with tenderness in the rotator cuff.

Neer described his impingement test for supraspinatus tendinitis: with the patient seated the observer stands behind the patient and elevates the arm forward while keeping the scapular fixed.

Table 5. Tendinitis of the shoulder (after Cyriax 1987)

A/C joint: acromio-clavicular joint
SST: supraspinatus tendinitis
IFT: infraspinatus tendinitis
SSCT: subscapularis tendinitis
biceps: bicipital tendinitis
sub-deltoid: sub-deltoid bursitis

MOVEMENTS	capsulitis	A/C joint	SST	IFT	SSCT	biceps	sub-deltoid
passive abduction	30 deg.	+	-	-	-	-	-
passive ext. rotation	60 deg.	+	-	-	-	-	-
passive int. rotation	5 deg.	+	-	-	-	-	-
resisted abduction	-	-	++	-	-	-	-
resisted ext. rotation	-	-	-	++	-	-	-
resisted int. rotation	-	-	-	-	++	-	-
resisted elbow flexion	-	-	-	-	-	+	-
painful arc	-	-	+	+	+	-	+

If pain is produced in the shoulder and is relieved by 10 mls of 1% xylocaine beneath the anterior edge of the acromium then the test is regarded as positive.

Murray-Leslie and Wright (1976) specified the loss of movement necessary to diagnose capsulitis as either passive glenohumeral abduction less than 90degrees *or* passive internal rotation less than 45degrees *or* passive external rotation less than 45degrees.

In summary, the diagnostic alogarithm for tendinitis and capsulitis around the shoulder is clear-cut. Some authors recommend appropriately placed local anaesthetic injections to confirm the diagnosis, although this may be impractical in some settings.

Elbow disorders

The elbow disorders discussed here are the lateral and medial epicondylitis and the cubital tunnel syndrome. Lateral epicondylitis (tennis elbow) is an enthesopathy of the common extensor tendon which inserts into the lateral epicondyle. Medial epicondylitis (golfers elbow) is an enthesopathy of the common flexor tendon at the medial epicondyle. Cubital tunnel syndrome is entrapment of the ulnar nerve at the elbow, either as it wraps around the medial epicondyle or as it pierces the fascia of the forearm just distal to the elbow.

All authors agree that **lateral epicondylitis** presents with pain localised to the lateral aspect of the elbow and the pain is made worse by resisted extension of the wrist with the arm in a fully extended position. Similar signs occur for the **medial epicondyle** save that resisted flexion of the wrist reproduces the patient's symptoms. Cyriax and Ranney both accept that pain may be felt over a distance distal to the epicondyle but Cyriax alone suggests that, in some cases, the lateral

epicondyle is not the source of the problem which may occur at the upper extent of the muscle belly **level** with the neck of the radius or at the supracondylar origin of the extensor carpi radialis longus. It could be argued that this should therefore not be classified as lateral epicondylitis. Some authors require pain and/or weakness in gripping to be present for the diagnosis of lateral epicondylitis (see Ohlsson).

In summary, the clinical diagnosis of epicondylitis at the elbow appears straightforward and agreed upon by all authors. Recently, typical investigative findings have been described (Patten, 1995). On MRI scanning oedema may be seen at the insertion of the tendon. The gold standard in epicondylitis must be the response to treatment yet this is often unsatisfactory, particularly when the patient continues the aggravating movement. Diagnostic injections with a local anaesthetic remain an immediate diagnostic aid, although there is nothing in the literature to support this.

The **cubital tunnel syndrome** is due to entrapment of the ulnar nerve at the elbow. Typical symptoms include: pain, paraesthesia or numbness in the 4th and 5th fingers of the hand, and tenderness to palpation at the cubital tunnel. Later sensory signs are diminished sensation in the 4th and 5th fingers of the hand. Motor signs include weakness of the interossei, a positive Froment's sign (wasting of the 1st dorsal interosseous muscle and inability to maintain adduction of the thumb so that hyperflexion of the inter-phalangeal joint occurs while pinching between the thumb and 1st finger) and a positive Wartenberg's sign (inability to abduct the little finger). A positive Tinel's sign (percussion over the cubital tunnel causing shooting symptoms in the distribution of the ulnar nerve) may be present.

Unlike median nerve entrapment at the wrist, specific diagnostic criteria in terms of sensory loss and neurophysiology are not available. Hypaesthesia on testing with vibration, monofilaments or 2 point discrimination would be expected in the lateral aspect of the 4th and 5th finger of the hand. Suggested electrophysiological criteria are nerve conduction velocity less than 35m/sec for the ulnar nerve across the elbow (Miller, 1979). Patten has also described perineural oedema around the ulnar nerve in the cubital tunnel syndrome.

Entrapment neuropathies of the forearm

Entrapments of the median and radial nerves have been described in the forearm.

The anterior interosseous nerve syndrome occurs where the anterior interosseous branch of the median nerve leaves the main trunk and passes under the pronator teres in the upper forearm. Viikari-Juntura identify a more proximal site of entrapment such that, in addition to pain in the volar aspect of the forearm, and pain and paraesthesiae on the volar side of the forearm, there are also symptoms and signs of median nerve entrapment in the hand.

Simmons and Wyman (in Millender) describe pain in the antero-medial forearm infrequently and weakness of the hand more frequently. The specific muscles involved are: pronator quadratus, flexor pollicis longus and/or flexor digitorum profundus to the index finger. Sometimes the patient is unable to make an '0' sign by pinching the thumb and index finger together.

The **pronator teres syndrome** is described by Simmons and Wyman as predominantly sensory changes in the hand with minimal motor changes. Signs include a positive Tinel's sign when percussing the nerve in the forearm, and increased pain with antagonism of either the pronator teres

or the middle finger flexor digitorum superficialis. They mention that electrical studies are negative in about 80% of cases of the pronator teres syndrome.

Silverstein's criteria include sensory symptoms in the forearm and the median nerve distribution with signs that include an increase of forearm pain on resisted pronation with a clenched fist (Mill's test) and sensory impairment over the thenar eminence.

Ohlsson defines the pronator syndrome as pain in the medial part of the forearm with local tenderness over the edge of the pronator teres muscle. Signs included pain and decreased strength of pronation, decreased flexion strength of the wrist and/or of the distal phalanges of the fingers.

Nashel (in Klippel and Dieppe) says that the anterior interosseous nerve syndrome is not associated with sensory complaints since this is purely a motor nerve. The typical pattern is loss of distal flexion of thumb and index finger (as described above) and weakness of pronator quadratus. He accepts that the patient may note a dull aching pain on the volar aspect of the proximal forearm.

Nashel describes the pronator teres syndrome with the principal symptom as aching in the proximal forearm associated with activities which require use of the elbow and require pronation and grasping. Sensory and motor signs may be similar to the carpal tunnel syndrome although nocturnal paraesthesiae are less frequent in pronator teres syndrome. He concedes that a provocative test is reproduction of pain on resisted pronation of the forearm and he confirms that electrophysiological testing is often inconclusive.

Posterior interosseous nerve entrapment is described by Viikari-Juntura as pain in the elbow during rest radiating down or upwards together with tenderness at the edge of the superficial portion of the supinator muscle at the arcade of Frohse; once the condition is established weakness of extension of the middle finger may occur.

...

Simmons and Wyman (in Millender) state that symptoms depend on which branch of the nerve is more compromised during its passage through the arcade of Frohse. If the entrapment involves the sensory branch **(radial tunnel syndrome)** there is no weakness or sensory loss but pain and tenderness at the site of entrapment occur. If entrapment involves the posterior interosseous branch the patients may present with pain at the site of entrapment and weakness of the digital, particularly the middle, extensors.

Ohlsson defines radial tunnel syndrome as pain in the elbow during rest with some tenderness about 5-7 cm. distally to the lateral epicondyle. Signs include pain at this site and weakness on supination and decreased strength of ulnar deviation of the wrist.

In **summary,** entrapment neuropathies of the forearm are uncommon. Median and radial nerve entrapment may occur with symptoms and signs depending on which branch of the nerve is involved. Diagnosis is often based clinically since electrophysiological tests are often inconclusive. Nevertheless, these conditions should be considered, particularly since the radial tunnel syndrome can mimic lateral epicondylitis and is known as the 'resistant tennis elbow' (see Simmons and Wyman) particularly since resisted extension of the fingers can be positive in both conditions. It is possible that some of the resistant cases of Cyriax were due to entrapment of the posterior interosseous nerve.

Disorders of the wrist

At the wrist, the main conditions are tenosynovitis (in particular de Quervain's) and the entrapment neuropathies of carpal tunnel syndrome and the less frequent ulnar nerve entrapment in Guyon's canal. Ganglia may also occur.

Cyriax describes tenosynovitis of the abductor pollicis longus and extensor pollicis brevis to the thumb **as de Quervain's** tenosynovitis. The movements likely to cause this problem are pinching or grasping while the wrist is involved in radial and ulnar deviation movements. There is pain on resisted extension and abduction of the thumb. In some cases, swelling, redness warmth and crepitus may be seen along the line of the tendon due to inflammation within the tendon sheath. Finkelstein's test consists of forced ulnar deviation of the wrist with the thumb adducted across the palm: a positive test elicits pain along the line of the aforementioned tendons.

Minimal criteria given by Ranney for de Quervain's tenosynovitis are pain on the radial aspect of the wrist and tenderness over the 1 st tendon compartment with a positive Finkelstein's test.

Tenosynovitis may occur in any of the extensor tendon sheaths in the wrist, there being 6 compartments through which the tendons pass. Viikari-Juntura requires symptoms of local ache or pain during movement and tenderness along the course of the tendon or muscle-tendon junction.

Silverstein uses the following criteria: localised pain and swelling over the muscle and tendon with exacerbation of pain and appearance of crepitus on resisted movement.

Kurppa et al (1991) requires swelling or crepitus and pain on palpation (or active movement) along the tendon or its sheath.

Ranney emphasises that tears of tendon or musculo-tendon junction may occur and may be identified by pain and tenderness along the course of that tendon, together with pain occurring on

resisted and passive movements. Away from the area of the tendon sheath this may be called peritendiitis. He does however state that such symptoms and signs must be associated with a specific movement employed in the occupation.

In summary, obvious cases of tenosynovitis around the wrist provide little difficulty in diagnosis: there is pain, loss of function (ie: grip or pinch) and signs including swelling, crepitus, warmth and tenderness. **Minimal criteria** are: (a) pain appropriate to occupational use (b) pain and tenderness along the appropriate tendon (c) pain on resisted movement of the muscle-tendon complex.

A ganglion is a cystic swelling associated with a joint. Ganglions commonly occur about the wrist, and may be associated with occupation, but provide little problem in diagnosis.

Ulnar nerve entrapment at the wrist may occur in Guyon's canal. According to Viikari-Juntura the symptoms are pain, paraesthesiae and numbness in the lateral aspect of the ring and little finger in the hand, together with weakness of the little finger. There may be tenderness to palpation at the Guyon's tunnel and a positive Tinel's sign at this site. Signs include diminished sensation and weakness on abduction of the 5th finger. These symptoms and signs mimic those of the cubital tunnel syndrome at the elbow. Diagnostic confirmation may be made electrophysiologically (see Terrono, in Millender).

The **hypothenar hammer syndrome** is a condition of vascular damage due to repeated trauma to the superficial palmar arch, usually during occupational use. The superficial palmar arch passes over the pisifonn bone and may be damaged when the heel of the hand is used to jam against

objects (Butch and Janes, 1963). Symptoms are blanching, pins-and-needles, coldness and pain, especially on exposure to cold, and these may mimic Raynaud's phenomenon.

The diagnostic sign is **Allen's test.** The fist is clenched to blanch the skin, the observer occludes a radial artery at the wrist manually and then the fist is unclenched. If the blood is slow to return to the skin of the hand this test is said to be positive. This syndrome is mentioned in Millender but not by any of the other texts listed at the start of this section. It is uncommon in occurrence.

Disorders of the hand

Stenosing tenosvnovitis (trigger finger)

Stenosing tenosynovitis occurs where free passage of the tendon through its sheath is obstructed either by narrowing of the sheath lumen or by expansion of the tendon diameter.

Cyriax describes the symptoms as pain and loss of movement with a sudden snapping on finger extension (triggering), particularly in the early morning. A palpable nodule, just proximal to the metacarpophalangeal joint may be felt in the palm: the triggering may be erratic but is usually reproducible during the course of examination.

Ranney reports minimal criteria as clicking or catching of the affected digit on movement. Occasionally, a lump in the palm may be found. Signs are demonstrable triggering and tenderness anterior to the metacarpal of the affected digit.

Simmons and Koris (in Millender) report that the stenosis is usually at the base of the digit, associated with the first pulley through which the flexor tendons pass.

Osteoarthritis

Osteoarthritis represents joint failure with loss of cartilage, and new bone (osteophyte) formation. A number of classification systems exist for osteoarthritis but the diagnostic criteria used clinically are generally less stringent.

Viiari-Juntura accepts that osteoarthritis of the distal interphalangeal joints is present when Heberden's nodes (bony swelling at either side of the joint) are found. Osteoarthritis of the carpo-metacarpal joint of the thumb, the other commonly affected joint in the hand, is diagnosed by the presence of pain on palpation and movement of the joint. Dalton and Hazelman (in Hunter's) are also willing to accept these minimal features at the carpo-metacarpal joint.

Silverstein used the following criteria to diagnose osteoarthritis. Symptoms of pain, loss of movement and early morning stiffness less than 30min. Signs include loss of movement and bony enlargement. Lack of joint tenderness is required to make the diagnosis, a rather strict criterion since some slight tenderness is often found in osteoarthritic finger joints.

Dieppe (in Klippel and Dieppe) notes that symptoms of osteoarthritis in the hand are pain, swelling, deformity and loss of function. He lists signs as Heberden's nodes, Bouchard's nodes (similar bony swellings associated with the proximal interphalangeal joint), mucinous cysts (small cystic swellings associated with the aforementioned joints which may occasionally discharge a jelly-lie material), instability and lack of movement. Radiological criteria are loss of joint space, osteophytes, sub-chondral sclerosis and cyst formation; occasionally erosions (loss of cortical integrity over the surface of the joint) may be seen.

Although severe osteoarthritis is obvious clinically, early osteoarthritis may manifest as only pain and radiological examination may be normal at this stage. The pain may be due to capsular strain

or ligamentous injury. However, it seems untenable to diagnose osteoarthritis clinically without the characteristic swelling and deformity.

Dupuytren's contracture consists of painless thickening of the palmar fascia and may be related to occupational use (Simmons and Koris, in Millender). Signs can vary from the finding of a small nodule at the base of the ring finger at the level of the distal palmar crease, to extensive palmar thickening and tethering of thefingers, particularly the little finger, in fill flexion.

NON SPECIFIC UPPER LIMB DISORDER

In the following section, diagnostic criteria for non-specific pain will be reviewed under 5 headings:

- Authors who say the condition does not exist
- Symptoms
- Signs
- Psychological factors
- Investigations

Generally the evidence will be reviewed in chronological fashion, with a summary to conclude each section. Note that in many articles non-specific WRULD is called 'repetitive strain disorder' and this will be abbreviated as RSI in the following discussion.

Does it exist?

Some textbooks make no mention of WRULD nor any other term that has been used for these conditions. Among these are Duffy and Bentley's 'Orthopaedic Surgery' (1983), and Kelly et al, 'Textbook of Rheumatology' (1989).

In some textbooks only specific soft tissue conditions are recognised as associated with occupation, the question of non-specific pain being avoided. These include Putz-Anderson, 'Cumulative Trauma Disorders' (1988), and Waldron, 'Lecture Notes on Occupational Medicine' (1990). Bullock, in 'Ergonomics: The Physiotherapist in the Workplace' (1990), refers to the problem of diagnostic uncertainty but indicates other texts for help in this matter.

A number of textbooks and articles make it clear that non-specific arm pain is not a diagnosis. Among these are Awerbuch (1985), writing during the Australian epidemic, saying that as a medical condition RSI does not exist, that it can only occur in such large numbers because the medical profession colludes and that the medical motives in this matter are founded on ignorance or avarice, or both.

Ireland (1988) points out that it behoves the medical profession to differentiate well-defined medical conditions from occupational neuroses and he suggests that RSI should be classified as a socio-political phenomenon rather than a medical condition.

Barton (1989) writing in the British Medical Journal says that the only way to diagnose RSI is when a specific soft tissue lesion is beyond doubt, and as an example he gives peritendonitis crepitans, described as a tender swelling, fusiform in shape, 4-12cms proximal to the radial styloid on the back of the forearm. He believes that pain without objective signs should not be called RSI since these are diseases without a pathology. The question of the absence of pathology was raised during the High Court judgement of Mughal vs Reuters, during which an expert witness for the

defense was quoted as saying "RSI is not a disease but a label used to describe a complex phenomenon with social, psychological and economic facets in which claims for compensation for injury at work occur in epidemics" (Brahams, 1993).

Fiily, Tyrer, writing in The Journal of Psychosomatic Research, in 1994, said that if RSI is a disease it should have characteristic symptoms and signs associated with a defined pathology: since this is not the case, this is not a disease, although he does concede that there is evidence of prolonged affective stimulation.

In summary, there is a substantial literature denying the existence of non-specific WRULD, largely because of the absence of tissue pathology. In general terms, therefore, if the medical model of injury (damage, followed by repair, healing and, finally, cure) is invoked then non-specific WRULD cannot be identified as a disease. There are, however, other models of illness and an analogy can be drawn with low back pain in which it is thought that the bio-psycho-social model of disease is more appropriate (Waddell, 1987). This will be discussed in a later section.

It is appropriate to mention at this point the work of Hadler who has written a number of publications on soft tissue disorders in which he makes the distinction between the person with a predicament and the patient with an illness. The two may be identical in terms of symptoms and signs but the process of consultation encourages everyday (and possibly normal) symptoms to become illnesses. He owes these concepts to Taylor (1979) who identified the components of sickness as (a) diseases, which are substantial physical realities with pathological changes, (b) illnesses which are a social manifestation of the disease- and are valid without discoverable disease and (c) predicaments, situations in which the person is placed and which have psycho-social

ramifications. Hadler uses the medical literature to support his thesis with some skill. Interestingly, within the literature of WRULD there is some supporting evidence. Hocking (1987), surveyed 90,000 employees of Telecom Australia at the height of the Australian epidemic and could find no evidence of a dose/response relationship between exposure and symptoms.

Symptoms of non-specific WRULD

Higgs et al (1993) have suggested that there are age-related differences in measures of upper extremity impairment, such that any objective findings related to workplace factors must be put in the context of the patient's age (and gender for measures such as grip strength).

Symptoms in this disorder polarise around muscles (and associated tendons) and nerves.

Maeda et al (1980) described muscular symptoms mainly. These consisted of tiredness, pain tremor, cramp and stiffness.

Kuorinka and Viikari-Juntura (1982) categorised these problems into a new classification, as follows:-

a) Temporary symptoms of over-use such as fatigue or soreness in the muscles after exercise

b) Conditions in which there is persistent pain and pathological changes with functional loss, eg: tenosynovitis

c) Primary fibromyalgia as defined by Wolfe et al. (1990)

d) Generalised rheumatic diagnoses, eg: osteoarthritis

e) A psychogenic component in which symptoms are thought to be of psychological origin, eg: arm pain in a depressed patient.

Armstrong et al (1982), investigating workers in a poultry processing plant, divided complaints into three main categories:

a) Nerve disorders, such as carpal tunnel syndrome

b) Tendon disorders such as tenosynovitis

c) A non-specific category with complaints of aching, soreness, swelling and 'knots' in the muscles.

Ferguson (1984) described RSI as a diffuse disorder of muscles, the symptoms of which are aching, weakness and tenderness.

Brown et al (1984), representing the Occupational Repetition Strain Injuries Advisory Committee of the Division of Occupational Health in the New South Wales Government Department of Industrial Relations, defines RSI as "musculo-tendinous injuries of the upper limbs, shoulder girdles and neck, caused by over-load of the particular muscle groups from repeated use or by constrained postures which result in pain, fatigue and decline in work performance". They point out that very few objective features are found. These sentiments were echoed by the Australian National Occupational Health and Safety Commission which defined symptoms in muscles, tendons and other soft tissues in the absence of physical manifestations, but with the associated work factors, such as repetition, sustained or constrained postures.

Kuorinka et al (1987) attempted to standardise a screening questionnaire for musculo-skeletal health in occupational situations which replied on symptoms of pain, cramping and numbness. They made some attempt to check the reliability of this questionnaire (test, re-test) and concluded that 0-23% gave non -identical answers. An attempt was also made to assess the validity of the questionnaire by comparing the responses to those obtained by interview.

The Health and Safety Executive, in guidance published in 1990, identified symptoms as pain, loss of movement, swelling and sensory abnormality, as well as a number of well defined disorders.

Bird and Hill (1992), in a study of 13 workers, attempted to define the natural history of the condition, commenting that initially pain and weakness may improve with rest but may become more permanent with further exposure to occupational activities.

Huskisson (1992), in his monograph entitled "Repetitive Strain Injury: the Keyboard Disease", defined RSI as a condition characterised by pain, usually in the hand and forearm, as a result of repetitive muscle activity. Interestingly, Huskisson specifically excluded carpal tunnel syndrome, lateral epicondylitis and tenosynovitis in his definition.

Helliwell et al (1992) defined WRULD as pain in the hand, wrist or arm related to work without requiring the presence of physical signs.

Franzblau et al (1993), used a screening questionnaire which contained nine symptoms: burning, stiffness, pain, cramping, tightness, aching, soreness, tingling, numbness, any one of which identified in an appropriate location, provided a positive response.

McCarty and Koopman (1993) defined RSI as vague regional symptoms in people whose occupations require fixed positions and repetitive movements. They describe symptoms of muscular fatigue (stiffness and aching), together with weakness, paraesthesiae and incoordination in their definition.

Ranney (1993) suggests it is possible to identify the tissue, its pathology, and the cause, from the history and examination, but it must be remembered that his diagnoses are largely based on muscular or tendon injury, and hypoxia and compression of nerve tissue.

Cherniack, writing in Rosenstock and Cullen's 'Textbook of Clinical Occupational and Environmental Medicine' (1994), reiterates that cumulative trauma disorders are anatomically and

pathologically elusive and gives the following defenition: absence of a precipitating event, pain with repetitive use, work incapacity, and no plausible anatomical focus. He also adds that treatment is often ineffective.

The Arthritis and Rheumatism Council of Great Britain provides a number of informative articles for general distribution. The article on work-related syndromes written by Bird (1995) identifies specific syndromes but mentions that non-specific syndromes are in the majority. Symptoms are identified as diffise aching, stiffness, and tiredness of muscle and joints, related to work.

Finally, Harris and Birch, in 'Clinical Orthopaedics' (1995), defined RSI as arm pain which does not conform to any identifiable anatomical or pathological pattern in individuals with jobs involving highly repetitive activities.

In **summary,** it is possible to divide non-specific symptoms into those attributable to muscles and those attributable to nerves. Muscle symptoms include aching, tiredness, cramp, weakness, tremor and loss of function (eg: grip); nerve symptoms include numbness, paraesthesiae (pins and needles), allodynia, subjective swelling, burning and incoordination.

Signs

Not surprisingly, in contrast to symptoms, there are few references to physical signs in non-specific WRULD.

Fergusson notes that tenderness of the muscles may be present and, sometimes, induration with swelling and heat.

The Health and Safety Executive (1990) stated that muscle tenderness may be present as a physical sign in non-specific WRULD.

Bird and Hill (1992) in their study of a small number of workers in a packing factory, found that one of the first signs of RSI was a decrease in grip strength to almost 50% of normal. However, the magnitude of grip depends on several factors including muscle quantity and quality. Furthermore, ifgripping elicits pain then reflex mechanisms will inhibit the true grip potential. Bird (1995) also mentioned other signs such as non-specific muscle tenderness, a decreased range of movement of joints and psychological factors such as anxiety and depression.

The Health and Safety Executive (1996) define occupational cramp as the inability to carry out a sequence of what were previously well coordinated movements.

Wigley, author of 'Overuse Syndromes' (1995), describes a form of focal dystonia in non-specific WRULD. This is demonstrated by asking the patient to successively touch each finger tip with the ipsilateral thumb: this is normally a simple manoevre but he says that in WRULD this may take the patient some time (personal communication).

In summary, there may be a paucity of physical signs in non-specific WRULD. Muscle tenderness is the principal sign. Loss of grip and pinch strength is an early sign and offers further possibility for study such as quantitative and spectral electromyography Nerve dysfunction may cause incoordination but this is hard to quantify objectively. There have been no sensory abnormalities recorded in non-specific WRULD.

The symptoms and signs of WRULD are summarised in Table 6.

Psychological factors

Christian, writing in Osler's Principles and Practice of Medicine (1944), in a section entitled 'Functional Diseases of the Nervous System' reported that continuous and excessive use of

Table 6. Non-specific syndrome of work-related upper limb disorder.

Obligatory symptom:	Pain in the arm
Other symptoms which may occur:	weakness, loss of strength, burning, paraesthesiae, cramp, tremor, incoordination
Signs which may be present:	muscle tenderness, incoordination (finger touch test), loss of grip/pinch strength

muscles such as in writers, musicians and telegraph operators, may cause involuntary spasms or cramps. Persons of a nervous disposition were said to be more liable to the disease and that often other problems such as anxiety, obsessions and hysteria were found.

Kuorinka and Viikari-Juntura (1982), in their new classification given above, propose a category of psychogenic pain where symptoms may be purely a sign of illness such as depression.

Fry (1986), noted that symptoms of this condition included pain and a mild fluctuating depression, although in his detailing of signs (localised tenderness in muscles and capsular tenderness in joints) no mention is made of psychological abnormalities.

Wright (1987), writing during the Australian RSI epidemic, suggested that any definition of RSI which does not include psychological features will be inadequate and will also mean that these features are not tackled in a treatment programme.

Pheasant, in his book Ergonomics Work and Health (1991), identified specific work-related syndromes but also a work-related myalgic condition involving pain and dysfunction at multiple sites. The signs identified by Pheasant were tender points in muscles, a strong psychogenic component and occasionally vasomotor signs such as temperature change in the limb.

Millender, in his book 'Occupational Disordersof the Upper Extremity', details four categories of occupationally-related syndromes. Firstly, those cases where there is a clear soft tissue diagnosis and clear treatment. Secondly, those cases where there is a clear diagnosis but unsatisfactory treatment. Thirdly, those cases where there are definite physical problems and non-medical issues (psycho-social issues). Lastly, cases in which there is an unclear diagnosis where the pain may be psychogenic, not a primary musculoskeletal problem.

Helliwell et al (1991) in a cross-sectional study of workers with forearm pain in the packaging industry, found that those workers with pain and a history of sickness absence scored higher on

scales of anxiety, depression and somatisation. These scores remained high after the pain had gone suggesting that these factors may have played a part in the susceptibility to work-related arm pain.

In summary, some authors believe that RSI is purely psychogenic in origin. The more balanced view, in our opinion; is that psychological factors may play a part in the development and continuation of the symptoms in a similar manner to chronic low back pain. If these features are not identified during the assessment procedure, then any physical treatment will result in an unsatisfactory outcome (see Waddell et al. 1984). It would, however, be incorrect to specify psychological features in the diagnostic criteria until the exact role of psycho-social factors has been determined (McDermott, 1986).

Non-specific WRULD as a chronic pain syndrome

Sudek's atrophy (algodystrophy) presents an interesting comparison. Sudek's atrophy is a chronic syndrome of pain, swelling, temperature change and marked radiological osteoporosis which may follow an initial insult/injury; the effects may be mediated by the sympathetic nervous system. Some authors have suggested that WRULD is a mild form of algodystrophy based on the symptoms of pain, swelling, burning and occasionally temperature change, and the lack of obvious soft tissue signs (Hazleman, 1993).

In a similar manner, a chronic regional pain syndrome may develop as a result of an initiating event (such as repetitive use) in which the patient may continue to feel pain and dysfunction in the absence of a specific peripheral lesion: these changes may occur centrally at spinal cord and sub-cortical level within the central nervous system.

Cohen et al, (1992) proposed an hypothetical situation in which central nociceptive abnormalities occur due to constant mechano-receptor barrage from peripheral sites (such as occurs in repetitive use or prolonged abnormal postures). In support of their theory they list symptoms of WRULD which may be of central nervous system origin such as burning, the electrical quality of the pain, hypoaesthesia, hyperalgesia, paraesthesia, hyperpathia, vasomotor changes, dermatographia, weakness without wasting, and pseudo-cramp.

Hazleman, writing in Maddison et al, 'Textbook of Rheumatology' (1993), defines RSI as a 'chronic pain syndrome' involving the neck and arm. He also details the role of psychological factors in contributing to the onset of this disorder.

Tindall, writing for the Iron Trades Insurance Company Limited , 1993, identities the chronic features of this condition as stiffness, weakness of grip, swelling, numbness, tingling, paraesthesia and disability.

Littlejohn, writing in Klippel and Dieppe ('Textbook of Rheumatology', 1994) again defined RSI as a chronic pain syndrome involving the whole of the neck and arm in the context of activities requiring either repetition or controlled posture. He lists signs as regionalised pain, altered threshold to pain, allodynia, hypalgesia, stiffness, co-contraction of muscles, dysaesthesia, dermatographia, and vasomotor changes such as palmar erythema and a livedoid rash. Littlejohn also indicated other central features such as sleep disturbance, abnormal stress reactivity, extreme fatigue and personality change. He likened RSI to a localised form of fibromyalgia (see below).

Fibromyalgia is a chronic pain syndrome for which diagnostic criteria are avialable (Wolfe et al, 1991). Required criteria are pain in each of four quadrants for greater than three months together

with specific soft tissue tender points. Clinical findings are often minimal. Psychological abnormalities have been frequently described but may be a consequence of the chronic pain.

Katz and Buchbinder (1995), while discussing proposed classifications for soft tissue syndromes, recommend that a new term 'regional soft tissue pain syndrome' be introduced within which these disorders can be placed.

In summary, some authors have proposed that the lack of specific soft tissue signs in the affected arm may be explained by the development of a regional pain syndrome the mechanism of which is uncertain but may involve neurophysiological changes at spinal cord or sub-cortical level. Other conditions which may have a similar basis are chronic low back pain and fibromyalgia.

Investigations

It will now be clear that the hallmark of non-specific WRULD is a paucity of objective clinical findings. Not surprisingly there are no specific tests available to aid diagnosis. Anecdotal reports in the lay press have suggested that abnormalities of sensation may be recorded but evidence for this is still lacking in the scientific press. It is possible that subtle abnormalities of muscle function may be apparent, building on the work of Bird and Hill (1992). The authors are currently investigating muscle wasting and spectral EMG patterns in patients with this disorder.

If muscles are used vigorously then a specific muscle enzyme, creatine kinase, will leak from muscle cells such that a small rise in serum 'creatine kinase level occurs. Hagberg et al (1982) asked 10 students to spend 15 minutes lifting heavy weights to above shoulder height and found a modest increase in creatine kinase at 24 and 48 hours after the exercise. These workers also looked at industrial employees, measuring creatine kinase on Monday and Thursday mornings. Their work

involved heavy upper arm use: they were compared with a control group of office workers. Again, a small difference in creatine kinase was found. No further reports of this kind have occured and this would suggest that the changes were insufficient to make it useful as a diagnostic test. If a. more sensitive biochemical test for muscle overuse were to appear then this may offer hope of providing a purely objective test of muscle dysfunction. It must be said that there are currently techniques available for looking at muscle metabolism in-vivo (such as nuclear magnetic resonance), but they remain primarily a research tool and would be impractical for use in large scale surveys.

Dennet and Fry (1988) have reported histological changes in muscles of symptomatic subjects but their study has not been replicated and their subjects were not matched for age and sex with the control subjects.

INTERVIEWS

The following people were interviewed, mostly in person, some using the telephone:-

Howard Bird, Professor of Pharmacological Rheumatology, University of Leeds.

Professor Bird has an established interest in repetitive strain disorders and hypermobility syndrome, particularly in musicians, gymnasts, and ballet dancers. He receives referrals from around the country and also is involved in medico-legal work.

Dr Frank Gallagher, Health and Safety Executive in Sheffield.

Dr Gallagher provided helpful discussion at the start of this project and gave some helpful pointers as to who should be interviewed, and sources of literature.

Mr A F Milling, Consultant Orthopaedic Surgeon, Huddersfield NHS Trust.

Mr Milling has a particular interest in hand surgery and is involved in medico-legal work.

Mr Neville Kay, Consultant Orthopaedic Surgeon, Sheffield.

Mr Kay is now employed Ml-time in medico-legal work in cases of work related upper limb disorder.

Dr Raymond Quinlan, Occupational Physician, Zeneca UK Limited Huddersfield.

Dr Quinlan is occupational health physician at a large North of England chemical company with a workforce of 2,500.

Mr J Stothard, Consultant Hand Surgeon, Middlesborough General Hospital.

Mr Stothard has a particular interest in repetitive strain injury and tenosynovitis both clinically and medico-legally. Furthermore, he has recently carried out a survey of interested clinicians in the North East of England (Diwaker and Stothard 1995).

Professor Verna Wright, Emeritus Professor of Rheumatology, University of Leeds.

Professor Wright has considerable medico-legal experience of work related upper limb disorder.

Dr M F Helliwell, General Practitioner, Keighley.

Dr Helliwell is a General Practitioner in a 6-person practice serving a population of 10,000 in a geographical area where there are a number of light industries.

Dr I Pinder, Occupational Health Physician, Pontefract.

Dr Pinder is particularly interested in arm and wrist disorders and has a number of posts in the newspaper industry.

Dr. Kim Burton, Ergonomist and Osteopath, Huddersfield.

Dr. Burton has wide research experience of occupationally related upper limb and back disorders and is on the Professional Register of The Ergonomics Society.

Other people contacted were Dr E C Huskisson (author of 'Repetitive Strain Injury, the Keyboard Disease' and Consultant Rheumatologist at St Bartholomew's Hospital) and Mr J Campbell Semple, Harley Street, London. For a number of reasons it was not possible to discuss WRULD with these people. Mr Semple invited the author to a conference entitled 'RSI at the RSM': this was a semi-informal meeting of medical and legal personnel involved in dealing with WRULD convened in order to clarify the current medical and legal issues. Unfortunately the author was unable to attend this meeting. However, the views of Mr Semple and Dr Huskisson are in print and information has been drawn from their respective publications on this subject.

In general, during these interviews, the main topic was the clinical presentation of WRULD and the symptoms and signs required for diagnosis, particularly in the non-specific category of upper limb disorder. Specific soft tissue diagnoses were discussed where indicated but generally it was accepted that diagnostic criteria for specific disorders and their relationship to occupation are agreed. Our particular approach was to discuss points of controversy and to seek clarification of actual practice.

All the above interviewees are involved with patients with WRULD. The level of involvement varies from first presentation at the work-place through to medico-legal assessment prior to court appearance. Assuming that there is an evolving natural history of this disorder then it is reasonable to assume that the presentation of WRULD will be different at different stages of the condition and this may explain some of the different opinions recorded. Professor Bird emphasises this process of evolution from initial pain relieved by a night's rest to continual pain unaffected by weekend and statutory holiday periods. It is likely that as the condition progresses then work incapacity will also occur; absence from work was proposed as a diagnostic criterion by at least two of the interviewees.

It was also pointed out that, although workplace factors are important, just because someone is exposed to forceful and repetitive movements of the arm, this does not mean that they will develop a work-related arm disorder. This accords with the views of Hadler (1993) who also makes the point that just because someone has an impairment, for example a narrow disc on x-ray, it does not mean to say they will have any disability from this impairment (it may be easier to quantify impairments rather than disabilities, particularly in the case of low back pain).

The criteria required for diagnosis may be a function of the stage at which the condition presents. For example, Dr's Helliwell, Pinder and Quinlan all accepted that non-specific arm pain, without physical signs, if appropriately linked to occupation, may be sufficient for diagnosis. On the other hand, secondary and tertiary care providers stated that definite clinical signs must be apparent before a diagnosis can be made and that if only symptoms are present then a diagnosis cannot be made (a less extreme version of this view was that if there are just symptoms in the arm without any signs, then the pain may be referred from the neck, as suggested by Smythe, 1993). It must be said that not all secondary and tertiary providers took this view point: at least two accepted that pain in the arm together with tenderness in the muscles was sufficient to make a diagnosis of non-specific WRULD. .

Psychological features were mentioned by a number of interviewees. However, only one interviewee attempted to quantify these factors using standardised questionnaires. On a number of occasions it was remarked that it is sometimes difficult to decide whether psychological features are a consequence or a cause of the disorder. It was pointed out that WRULD may just be another manifestation of a lifetime of consultation with non-specific disorders (for example: headache and abdominal pain). This emphasises the psycho-social background which may influence the

presentation of these disorders. It is worth remembering, however, that there is no simple test available which can identify and quantify these factors,

A number of respondents commented on the importance of having an appropriate opinion at an early stage. Two interviewees commented on what they described as a lack of expertise in doctors who had previously seen the patients referred to them. They felt that specific diagnoses could have been made earlier and appropriate treatment given, and non-specific diagnoses may not acquire such medical respectability if managed differently from the outset. This is an important point: even within this field there is confusion about the cause, diagnosis and treatment of these conditions and patients have a reasonably wide selection of sources from which they can seek help. It is suggested that patients may develop beliefs about their condition from colleagues and friends and they may seek to confirm these beliefs from the sources of help available. Within this context it is worth remembering that the Australian epidemic may have, in part, occurred as a result of dis-information amongst employees.

Several interviewees noted that there are different diagnostic criteria used in clinical and medico-legal cases. This may be due to several factors. Firstly, in industry minimal symptoms are sufficient to trigger an appropriate response eg. an ergonomic evaluation of the job; it is important to stop the problem progressing. Secondly, only a limited number of musculoskeletal diseases are 'prescribed'; in this setting other conditions, by definition, are 'not important'. Thirdly, at a medico-legal level, and using the medical model of disease, an absence of pathology means the condition doesn't exist (see Prosser judgement, in Brahams, 1993). In this way, although at a clinical level it may be possible to diagnose and treat work related upper limb disorder with only pain in the arm and tenderness in the muscles, from a legal point of view, unless there is frank tenosynovitis or a clear diagnosis of carpal tunnel syndrome with positive neurophysiology and unless an operative

intervention has confirmed the diagnosis and appropriate treatment relieved it, then there is little chance of the case succeeding. Again the difference between clinical and medico-legal practice is highlighted by one orthopaedic surgeon who said that he would be happy to diagnose carpal tunnel syndrome on symptoms and signs alone but only in his clinical practice.

In 1993, just before the Judge Prosser pronouncement, a survey was carried out of medical personnel involved in medicolegal cases of WRULD (Diwaker and Stothard, 1995). Of 203 screening letters sent, 72 were sent a further questionnaire designed to elicit the respondent's views on prescribed diseases A8 (tenosynovitis), A4 (professional cramp), and repetitive strain disorder. 54 replies were obtained: 24 from orthopaedic surgeons, 4 plastic surgeons, 12 rheumatologists, 1 neurologist, 3 accident and emergency consultants, 6 occupational health physicians, 3 anonymous and 1 other. In the results presented here, the clinical findings represent a majority opinion.

Tenosynovitis (A8)

The clinical features agreed upon by the majority of respondents are listed below:-

a) A history of unaccustomed and arduous exercise at work.

b) Symptoms of pain swelling, crepitus and squeaking in the tendon within its sheath.

c) Signs of tenderness longitudinally along the flexor or extensor tendon.

d) Improvement of symptoms when not at work.

Within the broader definition of tenosynovitis the only condition accepted by the majority of respondents was de Quervain's stenosing tenovaginitis (extensor inter-section syndrome, trigger thumb and trigger finger were felt by the majority not to come under this definition).

Professional cramp **(A4)**

This section was only answered by about half the respondents. Several respondents felt that they had not encountered this diagnosis. Clinical features were as follows:-

a) Duration of employment: answers were split between 6 months, 1 year and greater than 2 years.

b) A history of pain inability to move the fingers at the normal speed (for example when operating machinery), poor grip, and dropping things.

c) The demonstration of pain and tenderness in specific muscles or muscle groups.

Repetitive strain disorder

Respondents were asked whether they felt that it was a genuine condition. Of 54 respondents, 23 felt that it was a genuine condition, 27 felt that it wasn't and there were 4 non-responses. The results suggested that orthopaedic surgeons were more likely than rheumatologists and occupational health physicians to disbelieve the existence of RSI.

Further sub-division between specialties was apparent when respondents were asked what they would include within the definition of repetitive strain disorder. Orthopaedic surgeons would not include any of the specific conditions given (tenosynovitis, stenosing tenovaginitis, extensor inter-section syndrome, carpal tunnel syndrome, tennis elbow, golfers elbow, ulnar nerve compression at cubital tunnel, radial nerve compression at ligament of Frohse, supraspinatous tendinitis and brachial neuralgia). For other respondents, the majority felt that tenosynovitis, de Quervain's stenosing tenovaginitis, tennis elbow and golfers elbow, should be included within the definition.

Of those respondents that believed in repetitive strain disorder, the diagnostic criteria used were as follows:-

a) Repetitive hand/finger action (the frequency varied from more than once per second to between once per second and once per minute)

b) Onset of symptoms at work, amelioration of symptoms after work and at weekends.

b) Pain in the arm.

c) Tenderness in the arm.

The authors of this important paper felt that there was continuing confusion about diagnostic criteria for RSI. The point was also made that it is possible for the same expert to give a different interpretation of a patient's condition to solicitors/insurers, in the outpatient clinic and when reporting for the Department of Social Security using their guidelines, The authors conclude that further training is required for medical personnel working in this field, with perhaps the development of a panel of experts who would operate using agreed criteria.

SUMMARY AND CONCLUSIONS

Criteria may be used for diagnosis, classification or epidemiological purposes. The remit of this report was to review the clinical criteria for work related upper limb disorders. Clearly, in the context of the clinical examination, the criteria must include symptoms, physical signs and easily administrated bedside tests (for example: grip strength using a sphygmomanometer). For screening purposes, the criteria must be simple and highly sensitive. The criteria given in Table 1 for specific soft tissue syndromes and the criteria given in Table 6 for the non-specific condition represent minimal criteria from the literature.

All diagnoses use symptoms and simple physical signs but it must be made clear that there are very few data on the ability of diierent physicians to elicit these physical signs in the same patient and further data on this important subject are required. Further, the variability of symptoms from day to day may lower the reliability of symptoms as diagnostic criteria

In medicine, the mathematical science of probability is poorly represented. There are few data relating sensitivity and specificity of clinical symptoms and signs to diseases. This is particularly true for the host of soft tissue syndromes occurring in the arm and neck. Where sensitivity and specificity data are available, such as for carpal tunnel syndrome, the results are poor.

For screening, a test (or clinical symptom or sign) should have high sensitivity, ie: a low false negative rate; some cases who do not have the disease are bound to be included. Specificity represents the true negative rate; high specificity means that the test is virtually never positive in patients who do not have the disease but it may miss a good proportion of those who do have the disease. The play-off between sensitivity and specificity is indicated in Appendix 2. Without confirmatory (and usually pathological) tests, sensitivity and specificity data cannot be generated and diagnoses have to be made and confirmed phenomenologically. As we become more knowledgeable about work related upper limb disorders it may be possible to abandon the phenomenological approach for the scientific.

It will be clear that different sets of criteria are used clinically compared to those used medico-legally. We think this is an important point to make. From the literature review and the discussion with experts it is clear that those people working closer to the workforce use less stringent criteria to those working in secondary or tertiary or medico-legal care. In other words, occupational physicians and primary care physicians are more interested in using sensitive criteria in order to make an early diagnosis. Physicians managing patients when they present are interested in

preventing this disorder progressing and so keep a low threshold for diagnosis. In contrast, doctors working further up the hierarchical chain are interested in highly specific criteria, that is: they don't want to over-diagnose cases and they have a higher threshold for diagnosis.

It might be argued that using high sensitivity criteria may cause other problems, partly by increasing patient expectations but also by influencing patients' beliefs as to the work-relatedness of their symptoms. This is a diicult problem and may only be remedied by healthy and frank employer/worker relations and educational activity in the workplace.

Certain common issues cross the diagnostic boundaries in work related disorders. Firstly, it is clear that a work related disorder cannot be diagnosed without the patient being exposed to an appropriate work situation. Most authors would require the patient to be exposed to an appropriate and specific activity for the soft tissue disorder of which they complain, for example: working overhead in thoracic outlet syndrome, or repeated flexion extension of the wrist in carpal tunnel syndrome. Precise description of the rate, force and cumulative load may provide more informative data on work exposure (see Silverstein, 1985, Helliwell et al, 1991).

Secondly, psycho-social factors are probably important in the presentation and continuation of WRULD. These include cultural and political factors (as was illustrated in the Australian epidemic). Pre-existing beliefs and the likelihood of seeking medical help for any condition are important. Other factors include home, personal and social circumstances, including financial issues.

Thirdly, it is clear that the workplace environment is important, not only from the point of view of prevention (this may be tackled by new Health and Safety Regulations), but by job requirements such as piece-work, conveyor belt work and word processing.

Fourthly, since pain is the main symptom of these disorders, an appropriate method of surveillance and a cooperative rather than an adversarial atmosphere may enable earlier detection of specific problems.

ACKNOWLEDGEMENT

The author would like to acknowledge ‘the considerable help of Mrs. Sylvia Shires in preparing this manuscript.

REFERENCES

Albert D A, Munson R, Resnik M D
Reasoning in medicine: an introduction to clinical inference
Baltimore - The Johns Hopkins Press Ltd, 1988

Armstrong T J, Foulke J A, Joseph B S, Goldstein S A
Investigation of cumulative trauma disorders in a poultry processing plant
Am Ind Hygiene Assoc J, 1982; **43:** 103-116

Awerbuch M
RSI or 'Kangaroo paw'
Med J Austr, 1985; **142:** 237-238

Barton N
Repetitive strain disorder
BMJ, 1989; **299:** 405-406

Bird H A
Work-related syndromes
In: Butler R C, Jayson M I V (Eds) Collected Reports on the Rheumatic Diseases. Chesterfield: Arthritis and Rheumatism Council. 1995.

Bird H A, Hill J
Repetitive strain disorder: towards diagnostic criteria
Ann Rheum Dis, 1992; **51:** 924-977

Boniface S J, Morris I, Macleod A
How does neurophysiological assessment influence the management and outcome of patients with carpal tunnel syndrome?
B J Rheum, 1994; 33: 1169-70

Brahams D
Repetitive strain injury
Lancet, 1993; **342:** 1168

Browne C D, Nolan M B, Faithful D K
Occupational repetition strain injuries - guidelines for diagnosis and management
Med J Austr, 1984; **140:** 329-332

Bullock M I (Ed)
Ergonomics - the physiotherapist in the workplace
Churchill-Livingstone, 1990

Butsch J L, Janes J M
Injuries of the superficial palmar arch
J Trauma, 1963; **3:** 505-516

Cherniak M
Upper extremity disorders
In: Rosenstock L, Cullen M R
Textbook of Clinical Occupational and Environmental Medicine
Philadelphia - W B Saunders, 1994

Christian H A
Osler's Principles and Practice of Medicine
Appleton-Century Co, New York; London. 15th Edn, 1994

Cohen M L, Arroyo J F, Champion G D, Browne C D
In search of the pathogenesis of refractor-y cervicobrachial pain syndrome
Med J Austr, 1992; **156:** 432-436

Cyriax J
Textbook of Orthopaedic Medicine
London: Bailliere Tindall. 7th Edn, 1978

Dalton S, Hazelman B L
Repeated movements and repeated trauma
In: Raffle P A B, Lee W R, McCallum R I, Murray R
Hunter's Diseases of Occupations; London -. Edward Arnold, 1987

Dawson D M
Entrapment neuropathies of the upper extremities
N Engl J Med, 1993; **329:** 2013-2018

Dennett X, Fry H J H
Over-use syndrome: a muscle biopsy study
Lancet. 1988: **1:** 905-908

Dieppe P A
Osteoarthritis: clinical features and diagnostic problems
In: Klippel J H, Dieppe P A. Rheumatology
London: Mosby Year Book Europe Ltd, 1994

Diwaker H N, Stothard J
What do doctors mean by tenosynovitis and repetitive strain injury?
Occup Med, 1995; **45:** 97-104

Durkan J A
A new diagnostic test for carpal tunnel syndrome
J.Bone Jt. Surg., 1991; 73A: 535-538

Duthie R B, Bentley G
Mercer's Orthopaedic Surgery
London: Edward Arnold, 8th Edn, 1983

Fam A G
Wrist and hand
In: Klippel J H, Dieppe P A. Rheumatology
London: Mosby Year Book Europe Ltd, 1994

Feldman R G, Jabre J F
Electrodiagnostic aspects of the carpal tunnel syndrome
In: Hadler N M (Ed), Clinical Concepts in Regional Musculoskeletal Illness.
Orlando: Grune and Stratton, 1987

Ferguson D
The 'new' industrial epidemic
Med. J Aust, 1984; 140: 3 18-3 19

Fine L J, Silverstein B A, Armstrong T J, Anderson C A, Sugano D S
Detection of cumulative trauma disorders of upper extremities in the workplace
J Occup Med, 1986; 28: 674-678

Franzblau A, Blitz S, Flaschner D, Werner R, Albers J W, Armstrong T
Medical screening of office workers for upper extremity cumulative trauma disorders
Arch Environ Health, 1993; 48: 164-170

Fry H J H

limb

Austr N Z J Surg, 1986; 56: 47-49

Gellam H, Gelberman R H, Tan AM, Botte M J
Carpal tunnel syndrome: an evaluation of the provocative diagnostic tests
J. Bone Jt. Surg., 1986; 68A:735-737

Golding D N, Rose D M, Selvarajah K
Clinical tests for carpal tunnel syndrome - an evaluation
B J Rheum, 1986; 25: 388-390

Hadler N M
Industrial rheumatology
Med J Austr, 1986; 144: 191-195

Hadler N M
Occupational musculoskeletal disorders
New York Raven Press Ltd, 1993

Hagberg M, Michaelson G, Ortelius A
Serum creatine kinase as an indicator of local muscular strain in experimental and occupational work
Int Arch Occup Environ Health, 1982; 50: 377-386

Hagberg M, Wegman D H
Prevalence rates and odds ratios of shoulder-neck disease in diierent occupational groups
Brit. J Ind Med, 1987; 44: 602-610

Hall C D
Neurovascular syndromes at the thoracic outlet
In: Hadler N M (Ed), Clinical Concepts in Regional Musculoskeletal Illness.
Orlando: Grune and Stratton, 1987

Harris N H, Birch R
Clinical Orthopaedics
Oxford & Blackwell Science, 2nd Edn, 1995

Hazelman B
Soft tissue rheumatism
In: Maddison P J, Isenberg D A, Woo P, Glass D N
Oxford Textbook of Rheumatology
Oxford: OUP, 1993

Health and Safety Executive
Work related upper limb disorders - a guide to prevention
London: HMSO, 1990

Heberden E
William Heberden: Physician of the age of reason
London: Royal Society of Medicine, 1989

Helliwell P S, Mumford D B, Smeathers J E, Wright V
Work related upper limb disorder: the relationship between pain, cumulative load, disability and psychological factors
Ann Rheum Dis, 1992; 51: 1325-1329

Higgs P E, Edwards D F, Season M K, Feeley C A, Young V L
Age-related differences in measures of upper extremity impairment
J. Gerontology, 1993; 48: M175-M180

Hocking B
Epidemiological aspects of 'repetitive strain injury' in Telecom Australia
Med. J Austr, 1987; 147: 218-222

Huskisson E
Repetitive Strain Injury
London: Charterhouse Conference and Communication Co Ltd, 1992

International Statistical Classification of Diseases and Related Health Problems - ICD- 10
Geneva: WHO, 1992

Ireland D C R
Psychological and physical aspects of occupational arm pain
J Hand Surgery, 1988; **13-B:** 5-10

Jeng O-J, Radwin R G
A gap detection tactility test for sensory deficits associated with carpal tunnel syndrome
Ergonomics, 1995; 38: 2588-2601

Katz J N, Buchbinder R
Soft tissue syndromes
In: Bailliere's Clinical Rheumatology, 1995; 9: 585-598

Katz J N, Larson M G, Fossel A H, Liang M H
Validation of a surveillance case definition of carpal tunnel syndrome
Am. J Pub Health, 1991; 81: 189-193

Kelley W N, Harris E D, Ruddy S, Sledge C B
Textbook of Rheumatology
Philadelphia: W B Saunders, 3rd Edn, 1989

Kimura J
The carpal tunnel syndrome - localisation of conduction abnormality within the distal segment of the median nerve
Brain (1979), 102: 619-635

Kuorinka I, Forcier L
Work Related Musculoskeletal Disorders (WMSD's): a reference book for prevention
London: Taylor and Francis, 1995

Kuorinka I, Viikari-Juntura E
Prevalence of neck and upper limb disorders (NLD) and work based in diierent occupational groups. Problems in classification and diagnosis
J Human Ergol., 1982; **11: 65-72**

Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, Jorgensen K
Standardised Nordic questionnaire for the analysis of musculo-skeletal symptoms
Appl Ergonomics, 1987; 18: 233-237

Kurppa K, Viikari-Juntura E, Kuosma E, Huuskonen M, Kivi P
Incidence of tenosynovitis or peritendonitis and epicondylitis in a meat processing factory
Scand J Work Environ Health, 1991; 17: 32-37

Leading Article.
Repetition strain injury
Lancet, 1987; 2: 316

Leading Article.
Testing for carpal tunnel syndrome
Lancet, 1991; 338: 479-480

Leffert R D
Diseases of the neck and shoulders in workers
In: Occupational Disorders of the Upper Extremity
Ed. Millender L H, Louis D S, Simmons B P
New York: Churchill-Livingstone, 1992

McCarty D J, Koopman W J
Arthritis and Allied Conditions
12th Edn. Philadelphia: Lea and Fabiger, 1993

McCormack RR, Inman R D, Wells A, Bemsten C, Imbus H R
Prevalence of tendonitis and related disorders of the upper extremity in a manufacturing workforce
J Rheum, 1990; 17: 958-964

Littlejohn G 0
Repetitive strain syndrome
In: Klippel J H, Dieppe P A (Eds) Rheumatology
London: Mosby - Year Book Europe Ltd, 1994

McDermott F T
Repetition strain injury: a review of current understanding
Med J Austr, 1986; 144: 196-200

Maeda K, Hunting W, Grandjean E
Localised fatigue in accounting-machine operators
J Occup Med, 1980; 22: 8 10-8 16

Matte T D, Baker E L, Honchar P A
The selection and definition of targeted work-related conditions for surveillance under SENSOR
Am. J Pub Health, 1989; 79: (suppl) 21-25

HEALTH AND SAFETY EXECUTIVE (HSE) - INVITATION TO TESDER FOR CONSULTANCY SERVICES FOR A REVIEW OF DIAGNOSTIC CRITERIA FOR WORK RELATED UPPER LIMB DISORDERS (WRULD)

FURTHER DETAILS AND DESCRIPTION OF THE WORK REQUIRED

1. The HSE is committed to achieving a reduction in the incidence of musculoskeletal disorders which arise in association with occupational activities. A particular target is complaints arising from or attributed to the upper limb. so called work related upper limb disorders (WRULD).

2. The HSE is primarily responsible for ensuring that appropriate preventive strategies are put in place by employers and to this end has published a number of guidance documents. It is now apparent, as a result of a closed seminar organised by the HSE, that further progress depends, in part, on achieving agreement regarding diagnostic criteria for the range of conditions in the upper limb which have been attributed to occupation.

3. Such diagnostic criteria will require to be adaptable to a number of functions, such as: clinical assessment, classification for reporting and health surveillance and also for epidemiological use. But rhe prime concern at this time is with clinical assessment. The criteria will also need to find acceptance with those working in both primary and secondary care and also in occupational medicine. It is intended that in due course a working group will be convened to consider this subject, but the organisation of that group is not a part of this project.

4. However, as a preliminary, the HSE wishes to have a review conducted of the diagnostic criteria for these conditions which are in current use in medical practice in the United Kingdom. This review should consider each of the upper limb conditions separately. It should begin by considering the approaches recommended in current textbooks of orthopaedic surgery and medicine, rheumatology, general practice and occupational medicine. It should then review the scientific literature, concentrating on papers published in English and originating from Britain, North America and Scandinavia.

5. The review should be conducted by someone with a medical qualification, or who is supervised by a medical practitioner. The reviewer should have access to practitioners in the various disciplines in order to be able to discuss points of controversy and to seek clarification of actual, as against reported, practice. The report should discuss issues which are common to the diagnosis of these various conditions as well as considering the individual conditions in detail. This section at least should be written for use by a lay audience.

6. HSE will provide initial access to the scientific literature and will require to be updated on progress about halfway through the project. HSE will provide a project officer.

APPEND= 2. Probability theory (adapted from Albert et al. Reasoning in Medicine. 1988)

		DISEASE +	DISEASE -
TEST	+	a	b
	-	c	d

Sensitivity = a / a + c
(true positive rate)

Specificity = d / b + d
(true negative rate)

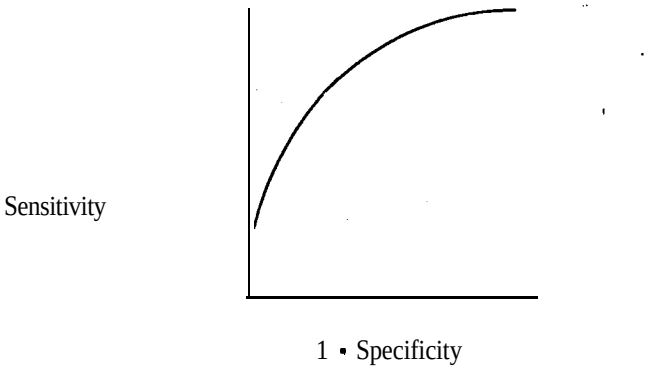
Positive predictive value = a / a + b

Negative predictive value = d / c + d

Accuracy=a+d/a+b+c+d

NB. The predictive value depends in part on the prevalence of the disease in the population so that the higher the prevalence of the disease in the population under study, the higher the probability that the disease is present, given a positive test result.

Figure: receiver operating curve demonstrating relationship between sensitivity and specificity



Millender L H
Occupational disorders of the upper extremity: orthopaedic, psychological and legal implications
In: Millender LH, Louis DS, Simmons BP. Occupational Disorders of the Upper Extremity. New York: Churchill-Livingstone. 1992.

Miller R G
The cubital tunnel syndrome: diagnosis and precise localisation
Ann Neurol, 1979; 6: 56-59

Murray-Leslie C F, Wright V
Carpal tunnel syndrome, humeral epicondylitis, and the cervical spine: a study of clinical and dimensional relations
Br. Med. J., 1976, 1:1439-1442.

Nathan P A, Meadows K D, Doyle L S
Relationship of age and sex to sensory conduction of the median nerve at the carpal tunnel and association of slowed conduction with symptoms
Muscle and Nerve, 1988; 11: 1149-l 153

Nathan P A, Meadows K D, Doyle L S
Sensory segmental latency values of the median nerve for a population of normal individuals
Arch Phys Med Rehabil, 1988; 69: 499-501

Neer C S
Impingent lesions
Clin Orthop Rel Res, 1983; 173: 70-77

Ohlsson K, Attewell R G, Johnsson B, Ahlm A, Skerfving S
An assessment of neck and upper extremity disorders by questionnaire and clinical examination
Ergonomics, 194; 37: 891-897

Patten R M
Over-use syndromes and injuries involving the elbow
Am. J Roentgen, 1995; 164: 1205-1211

Pheasant S T
Ergonomics, Work and Health
London: MacMillan, 199 1

Pheasant S T
Does RSI exist?
Occup Med, 1992; 42: 167-168

Pryse-Phillips W
Validation of a diagnostic sign in carpal tunnel syndrome
J Neurol Neurosurg and Psych, 1984; 47: 870-872

Putz-Anderson V (Ed)
Cumulative Trauma Disorder
London: Taylor and Francis, 1988

Ranney D
Work related chronic injuries of the forearm and hand: their specific diagnosis and management
Ergonomics, 1993; 36: 871-880

Ranney D, Wells R, Moore A
Upper limb musculo-skeletal disorders in highly repetitive industries: precise anatomical physical findings
Ergonomics, 1995; 38: 1408-1423

Riddor 95: A guide to the reporting of injuries, disease and dangerous occurrences regulations, 1995

Roos D B
Congenital anomalies associated with thoracic outlet syndrome
Am J Surgery, 1976 132: 771-778

Schwartz M S, Gordon J A, Swash M
Slowed nerve conduction with wrist flexion in carpal tunnel syndrome
Ann Neurol, 1980; 8: 69-7 1

Semple J C
Tenosynovitis, repetitive strain injury, cumulative trauma disorder, and nerve syndrome, et cetera
J Bone Jnt Surgery, 1991; 73-B: 536-538

Silverstein B A
The prevalence of upper extremity cumulative trauma disorders in industry
PhD thesis: Ann Arbor, Univ of Michigan, 1985

Silverstein B A, Fine L J, Armstrong T J
Hand wrist cumulative trauma disorders in industry
Brit. J Ind Med, 1986; 43: 779-784

Simmons B P, Koris M J
Occupational disorders of the hand and digits
In: Millender LH, Louis DS, Simmons BP. Occupational Disorders of the Upper Extremity. New York: Churchill-Livingstone. 1992.

Simmons B P, Wyman E T
Occupational injuries of the elbow
In: Millender LH, Louis DS, Simmons BP. Occupational Disorders of the Upper Extremity. New York: Churchill-Livingstone. 1992.

J Rheum, 1988; 15: 1604-1608

Stevens J C, Sun M D, Beard C M, O'Fallon W M, Kurland L T
Carpal tunnel syndrome in Rochester, Minnesota, 196 l-1 980
Neurology, 1988; 38: 134-138

Stewart J D, Eisen A
Tinel's sign and the carpal tunnel
BMJ, 1978; 2: 1125-l 126

Taylor D C
The components of sickness: diseases, illnesses and predicaments
Lancet, 1979; 2: 1008-1010

Terrono A L, Millender L H
Evaluation and management of occupational wrist disorders
In: Millender LH, Louis DS, Simmons BP. Occupational Disorders of the Upper Extremity. New York: Churchill-Livingstone. 1992.

Tindall A
Tenosynovitis - a case of mistaken identity
London: Iron Trades Insurance Co Ltd, 1993

Tyrer S
Repetitive strain injury
J Psychosom Res, 1994; 38: 493-498

Viikari-Juntura E
Neck and upper limb disorders among slaughterhouse workers
Scand J Work Environ Health, 1983; 9: 283-290

Viikari-Juntura E
Inter-examiner reliability of observations in physical examinations of the neck
Physical Therapy, 1987; 67: 1526-1532

Waddell G
A new clinical model for the treatment of low back pain
Spine, 1987; 12: 632-644

Waddell G, Main C J, Morris E W, Paola M D, Gray I C M
Chronic low back pain, psychological distress and illness behaviour
Spine, 1984; 9: 209-213

Waldron H A
Lecture Notes on Occupational Medicine
Oxford: Blackwell Scientific Publ, 4th Edn, 1990

Waris P, Kuorinka I, Kurppa K, Luopajarvi T, Virolainen M, Pesonen K, Nummi J, Kukkonen R.
Epidemiologic screening of occupational neck and upper limb disorders.
Scand. J. Work Environ. Health. 1979;5:suppl. 3:25-38.

Wigley RD. Overuse Syndrome. Palmerston North:R D. Wigley. 1995.

Wolfe F, Smythe H A, Yunus M D et al
The American College of Rheumatology, 1990 criteria for the classification of fibromyalgia
Arthr. Rheum, 1990; 33: 19-3 1

Wright G D
The failure of the RSI concept
Med. J Austr, 1987; 147: 233-236