Cumulative trauma disorders: Their recognition and ergonomics measures to avoid them

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Cumulative Trauma Disorders, CTD, are the summary results of many microtrauma. Though known since the early 1800s, they have become a matter of urgent ergonomics concern in the 1980s. They are usually caused by repeated and/or forceful exertions, often in the hand-arm-shoulder region. They predominantly occur to soft tissues, such as tendons and ligaments, and to nerves and blood vessels. They are commonly associated with certain occupational and leisure activities. Many CTD can be avoided by a set of fairly simple and straightforward ergonomics procedures.

Keywords: Cumulative trauma, occupational activities, tell tales, ergonomic countermeasures

Background
One commonly distinguishes between single-event injuries, called acute or traumatic injuries, and those that are sustained through often repeated actions whose cumulative effects finally result in an injury. The distinction is somewhat hazy: are three motions per week, per day, per hour or per minute likely to result in an injury? How many repetitive microtrauma have to occur to result in injury?

Cumulative injuries occur often in connective soft tissues, particularly to tendons and their sheaths. They may irritate or damage nerves and impede the blood flow through arteries and veins. They are frequent in the hand-wrist-forearm area, (for example, the ‘carpal tunnel syndrome’) and in shoulder and neck. Repetitive loadings may even damage bone, such as the vertebral column.

Injuries due to repetitive stresses are not a new phenomenon. According to Tichauer (1973), Bernardino Ramazzini reported in 1813 that this condition occurred among clerks and scribes. He believed that their injuries, usually in the hand region, were due to repetitive movements, constrained postures and general mental stress. By the middle of the twentieth century, injuries, particularly to tendons and their surroundings were generally recognised and traced to repetitive efforts (Tichauer, 1973). In 1960, the International Labour Office recognised repetition strain injury as an occupational disease (ILO, 1960). Peres (1961), Ferguson (1971), Feldman et al (1983) and Putz-Anderson (1988) described a wide variety of health complaints in the musculo-skeletal apparatus of people while Chatterjee (1987) provided a review of the developing recognition of repetitive strain injuries.

Definition
An operational definition is as follows: Cumulative Trauma Disorders, CTD, is a collective term for syndromes characterised by discomfort, impairment, disability or persistent pain in joints, muscles, tendons and other soft tissues, with or without physical manifestations. It is caused or aggravated by repetitive motions including vibrations, sustained or constrained postures, and forceful movements at work or leisure. Many different terms have been used to describe the observed events. For example, the syndrome has also been called over-use injury, cervicobrachial disorder, cumulative trauma injury, repetition strain injury, repetitive motion injury, rheumatic disease, osteoarthrosis (Putz-Anderson, 1988).

Of course, such general terms do not provide exact anatomical or pathological specifications, nor do they indicate the conditions that lead to CTD. Clearly, repetitive strains may occur from many different occupational activities, such as in assembly, manufacturing, and meat processing, sewing, packing and other manipulations. CTD are found among cashiers in supermarkets and among keyboard operators. Also, these injuries are quite often associated with leisure and sports activities; the “tennis elbow” is one of the better known examples.

Risks and causes
There are many possible causes of CTD. The risks may be related to occupation or due to private activities. Among the non-occupational factors are (according to Chatterjee, 1987) age, gender, acute trauma, chronic disease, use of birth control pills, circumstances of pregnancy, menopause, etc. Some individuals could be pre-disposed. Among the occupational factors, repetitive and forceful activities, static muscle load, body posture, mechanical stress, vibration and cold appear to be most prevalent (Chatterjee, 1987).

Repetitive and forceful exertions, particularly if combined are generally thought to be responsible for a large portion of the CTD. While there is no definitive statement about what constitutes high repetitiveness and/or exertion of force, Silverstein (1985) proposed that repetitiveness may be defined as a cycle
time of less than 30 s, or as more than 50% of the cycle time spent performing the same fundamental motion. Silverstein also suggests that high force by itself (for hand force, more than 45N) may be considered a causative factor. Posture may be highly important. For example, a dorsiflexed wrist generates a condition likely to cause a specific CTD, the carpal tunnel syndrome. Among the postural effects, maintained isometric contraction of muscles needed to keep the body or its part in position, is often associated with a CTD condition. If muscles must remain contracted as more than about 15 to 20% of their maximal capability, circulation is impaired which can result in tissue ischemia and delayed dissipation of metabolites, which constitutes a general physiological strain. For hand, arm, shoulder and neck CTD, repeated muscle contractions and tendon movements are regarded as common causative factors. Also, inward or outward rotation of the forearm with a bent wrist, deviation of the wrist from the neutral position, and the pinch grip can be stressful (Chatterjee, 1987).

Body components at risk
The human musculo-skeletal system consists primarily of the long bones of the body, joined together in their articulations and moved about by these muscles. While bones (except vertebrae) are not usually injured in the context of CTD, joints, muscles and tendons and their related structures, as well as nerves and blood vessels, are at risk. (For more detail, see Putz-Anderson, 1988.)

Soft tissues
Muscles can generate tension between two (or three) body segments (‘links’ – i.e., bones connected by a joint) either to stabilize their positions (isometric effort) or to move them relative to each other (dynamic effort). Muscles are composed of thousands of fibres, more or less aligned with the long axis of the muscle. Their finest elements, filaments, generate contraction. The contraction is stimulated and controlled by neural signals. The contraction is associated with energy generation and release, supplied by body metabolism. For this, sufficient oxygen supply by blood flow to the working muscle is necessary.

Muscles can sustain three different kinds of CTD. Muscles can be strained or irritated, associated with temporary aching and swelling. A more serious injury is present when a group of fibres is torn apart. If blood or nerve supply is interrupted for an extended time, the muscle atrophies.

Muscles are not attached directly to the bones, but fuse at each end (at the origin and insertion) in tendons which in turn are attached to the bones. Tendons contain collagen fibres which neither stretch nor contract. If overly strained, tendon fibres can be torn. Scar tissue forms which creates chronic tension and is easily re-injured.

Tendons are often surrounded by a sheath which contains a lubricant, synovial fluid. This allows easy gliding of the tendon within its sheath to follow muscle contraction and relaxation. Such movement may be quite large, for example, 5 cm in the hand when the finger is moved from fully extended to completely flexed. The synovial fluid in the tendon sheath may be diminished which causes friction between tendons and its sheath. First signs are feelings of tender- ness, warmth and pain, which may indicate inflammation.

Inflammation of a tendon sheath is a protective response of the body, its purpose being to limit bacterial invasion. The feeling of warmth and swelling stems from the influx of blood. The resulting compression of tissue produces a pain sensation. Also, movement of the tendon within its swollen surroundings is limited. Repeated forced movement may cause the inflammation of additional tissue which, in turn, establishes a permanent (chronic) condition of thickened tendon sheaths which, of course, impede tendon movement.

Ligaments are fibres that connect bones around a joint. When a joint is displaced beyond its regular range, fibres of a ligament may be torn, or pulled from the bone. This is called a ligament sprain, often resulting from a single trauma but also possibly caused by repetitive strains. This can contribute to a permanent joint instability, and hence increases the risk of further injury. Injured ligaments may take weeks or even months to heal because their blood supply is poor.

A bursa is a small, fluid-filled sac lined with synovial membrane. It prevents rubbing between tendons and bone by providing a slippery cushion. An often-used tendon, particularly if it has become roughened, may irritate its adjacent bursa, setting up an inflammatory reaction called bursitis, which is similar to the inflammation in tendon sheaths. Bursitis inhibits the free movement of the tendon, and hence reduces joint mobility.

Nerves and vessels
Nerves can also be affected by repeated or sustained pressure. Such pressure may stem from bones, ligaments, tendons and tendon sheaths within the body, or from sharp edges of tools, equipment and work surfaces. Pressure within the body can occur if the position of the body segment reduces the passage opening through which a nerve runs. Another source of compression, or an added one, may be irritation and swelling of other structures within this opening, often of tendons and tendon sheaths. The carpal tunnel syndrome is a typical case of nerve compression.

There are three different systems of nerve fibres, which serve different functions: motor, sensory and autonomic.

Impairment of motor nerve fibres reduces the ability to transmit signals to the innervated motor units in muscle. Thus, motor nerve impairment impedes the controlled activity of muscles, and hence reduces the ability to generate force or torque to tools, equipment and other external objects.

Sensory nerve impairment reduces the information that can be brought back from sensors to the central nervous system. Sensory feedback is very important for hand activities because it contains information about force and pressure applied, position assumed and motion experienced. Sensory nerve impairment usually brings about sensations of numbness, tingling or even pain. The ability to distinguish hot from cold may be reduced.

Impairment of autonomic nerve fibres reduces the ability to control such functions as sweat production in the skin. A common problem with autonomic nerve impairment is dryness and
Stage 2 has symptoms that start early in Stage 1 shows aches and ‘tiredness’ during the working hours, but which usually settle overnight and over days off work. There is usually no reduction in work performance. This condition may persist for weeks or months, and is reversible.

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Stage 3 is characterised by symptoms that persist at rest, pain that occurs with non-repetitive movements, and disturbed sleep. The person is unable to perform even light duties, and experiences difficulties in other tasks. This condition may last for months or years, (Chatterjee, 1987).

Vibrations of body members, particularly the finger-hand system, may result in reduction of the diameter of arteries, even in their complete closure. Of course, this impedes blood flow to the body areas supplied by the vessels, which becomes visible by blanching of the area, known particularly as white finger (or Raynaud’s) phenomenon. Exposure to cold may aggravate the problem because it can trigger vasospasms in the fingers. Associated symptoms include intermittent or continued numbness and tingling in the fingers, with the skin turning pale and cold, and eventually loss of sensation and control in the fingers. The condition is often caused by vibration transmitted from tools like pneumatic hammers, chainsaw, power grinders and power polishers. Frequent operation of keys on keyboards may also constitute a source of vibration strain to the hand-wrist area.

Stages of disorders
The clinical features of CTD are various, variable, and often confusing. Common symptoms are pain, tenderness, weakness, swelling and numbness. The onset of these symptoms can be gradual or variable, and often confusing. Common symptoms are pain, tenderness, weakness, swelling and numbness. The onset of these symptoms can be gradual or variable, and often confusing.

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Like nerves, blood vessels may be compressed. This results in a reduced blood flow in the affected area, which means reduced supply of oxygen and nutrients to such tissues as muscles, tendons and ligaments. Vascular compression hence produces ischemia which particularly limits the possible duration of muscular actions and the recovery of muscles after such activities. Such neurovascular compression is often found in the neck, shoulder and upper arm region. Thoracic outlet (or hyperabduction) syndrome, cervicobrachial disorder, brachial plexus neuritis, and costoclavicular syndrome, describe the exact location of the condition.

Specific repetitive strain disorders
Specific clinical manifestations of CTD have been described by Armstrong (1983), Feldman et al (1983), Chatterjee (1987), and by Putz-Anderson (1988) as follows:

Hand and wrist problems
1. "Tendonitis" (also called tendinitis) is a tendon inflammation associated with a tendon which is repeatedly tensed, moved, bent, in contact with a hard surface, vibrated, or with fibres frayed or torn apart. The tendon becomes thickened, bumpy and irregular. In tendons without sheaths, such as within the shoulder, the injured area may calcify.

2. "Tendosynovitis" occurs to tendons inside synovial sheaths. The sheath produces excessive synovial fluid which accumulates, and the sheath becomes swollen and painful. Movement of the tendon within the sheath is impeded and painful. (Other names for tendosynovitis are tenosynovitis, tendovaginitis and peritendinitis.)

3. A ‘ganglion’ is a swelling of a tendon sheath that is filled with synovial fluid, or a cystic tumour at the tendon sheath or a joint membrane. The affected area swells up and causes a bump under the skin, often on the dorsal or radial side of the wrist.

4. 'Carpal tunnel syndrome' is the result of compression of the median nerve in the carpal tunnel of the wrist. This tunnel is an opening under the carpal ligament on the palmar side of the carpal bones, through which pass the median nerve, finger tendons, and blood vessels (see Fig. 1). Swelling of the tendon sheath reduces the opening of the tunnel and pinches the median nerve (and blood vessels). The opening is also reduced if the wrist is flexed or extended, or sideways (ulnarly or radially) deviated. (Writer's cramp,
occupational neuritis, partial thenar atrophy and median neuritis are other terms which describe this disorder.)

Symptoms of the carpal tunnel syndrome include pain, numbness and tingling of those areas of the hand that are innervated by the median nerve. These areas are, on the palmar side, thumb, index finger, middle finger and the ring finger (with the exclusion of its ulnar side, that is the side towards the little finger), and most of the palm. On the dorsal side, the ulnar side of the thumb, and the upper distal two-thirds of index, middle, and ring fingers are affected (again with the exclusion of the ulnar side of the ring finger). Thus, the specific location of the sensations in these areas indicates the existence of a carpal tunnel syndrome.

5. ‘Guyon tunnel syndrome’ results from entrapment of the ulnar nerve as it passes through the Guyon tunnel in the wrist. It can occur from prolonged flexion and extension of the wrist and repeated pressure on the base of the palm (hypothenar eminence). (This condition is similar to but more superficial and less common than the carpal tunnel syndrome.)

6. “White finger” (also called ‘dead finger’ or Raynaud’s syndrome) stems from insufficient blood supply, seen as blanching. Fingers turn cold, numb, and tingle, and sensation in and control of fingers may be lost. The condition is due to closure of the digits’ arteries caused by vasospasms triggered by vibrations, particularly in the cold. A common cause is continued forceful gripping of vibrating tools such as jack hammers, chain saws or power grinders.

Arm and elbow problems

7. In the elbow (and shoulder) joint, unsheathed tendons are prevalent. The extensor muscles, which attach at the elbow (to be exact: at the epicondyle, a protrusion at the distal end of the humerus bone) control movements of the wrist and hand. When strained or over-used, the tendons become irritated and radiate pain from the elbow down the forearm. Activities that are likely to trigger this condition are impacting or jerky throwing motions, repeated supination and pronation of the forearm, and forceful wrist extension movements. Playing tennis, pitching, extensive hammering or bowling are activities that may lead to this condition, hence the term ‘tennis (pitcher’s, carpenter’s, bowler’s) elbow’. The symptoms are common on the outer side of the elbow (lateral epicondylitis). An irritation of the tendon attachments or the finger flexor muscles on the inside of the elbow is called medial epicondylitis, also known as ‘golfer’s elbow’.

8. ‘Pronator teres syndrome’ is the result of compressing the median nerve where it passes through the two heads of the pronator teres in the forearm. It often occurs in occupations where rapid and forceful pronation of the forearm with wrist flexion are frequent.

9. ‘Radial tunnel syndrome’ is the result of compressing the median nerve which may be due to the pathologi- cal thickening of the supinator muscle. It is often caused by repeated rotatory movements of the forearm, repetitive wrist flexion with pronation, or wrist extension with supination.

10. Extensor tenosynovitis, more common than flexor tenosynovitis, is usually caused by repeated rotatory movements of the forearm.

Shoulder and neck disorders

11. ‘Rotator cuff tendinitis’ is a common shoulder disorder. (It is also called supraspinatus tendinitis, subdeltoid bursitis, subacromial bursitis, or partial tear of the rotator cuff.) The rotator cuff consists of four tendons that fuse over the shoulder joint. They are linked to muscles which pronate and supinate the arm and help to abduct it. The rotator cuff tendons pass through a small bony passage between the humerus and the acromion, with a bursa as cushion.

Rotator cuff disorders are often found with work in which the elbow must be kept in an elevated position, or with other activities that strain the shoulder tendons and bursa. Such work commonly involves reaching or lifting, and continued use of an arm in abduction or flexion.

12. A variety of often poorly defined disorders occur in the neck. Two are fairly common: one is the ‘thoracic outlet syndrome’, a general term for disorders resulting from compression of the nerves and blood vessels between neck and shoulder. The brachial plexus is a collection of nerve fibres. Also at this spot are arteries and veins that channel blood for the arm. If this neurovascular bundle is compressed by the pectoralis minor muscle, an ischemic condition is created which makes the arm numb and limits muscular activities and slows recovery from fatigue. Such condition can result from carrying objects, such as a suitcase, or a rucksack, or repeatedly reaching above shoulder level. (Other names for this condition are neurovascular compression syndrome, brachial plexus neuritis, costoclavicular syndrome.)

13. The other often found disorder is the ‘tension neck syndrome’, usually due to repeated strain (including sustained static tension) of the levator scapulae and trapezius muscle groups of the neck. It commonly occurs after repeated or sustained overhead work, when the neck is kept in a forward-bent posture, or when heavy objects are carried.

Leg and foot problems

14. Nerve entrapments occur to the sciatic nerve in the ischial region, to the peroneal nerve at the fibular head, and to interdigital nerves in the foot. (These conditions are fairly infre-quent.)

Occupational activities and related disorders

Specific activities have been found to be often associated with certain CTD. A list of such associations is presented in Table 1 which has been derived from information provided by Armstrong (1983), Chatterjee (1987), Ferguson (1981), Peres (1961), Silverstein (1985), and from personal experiences. Of course, this list is neither complete nor exclusive, although the literature was thoroughly searched. New occupational activities occur, and several activities may be part of the same job.
<table>
<thead>
<tr>
<th>Disorder</th>
<th>Body activities</th>
<th>Typical job activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal tunnel syndrome</td>
<td>Repeated wrist flexion or extension, rapid wrist rotation, radial or ulnar deviation, pressure with the palm, pinching</td>
<td>Buffing, grinding, polishing, sanding, assembly work, typing, keying, cashiering, playing musical instruments, surgery, packing, housekeeping, cooking, carpentering, brick laying, butchering, hand washing or scrubbing, hammering</td>
</tr>
<tr>
<td>Epicondylitis, tennis elbow</td>
<td>Radial wrist pronation with extension, forceful wrist extension, repeated supination and pronation, jerky throwing or impacting motions, forceful wrist extension with forearm pronation</td>
<td>Turning screws, small parts assembly, hammering, meat cutting, playing musical instruments, playing tennis, bowling</td>
</tr>
<tr>
<td>Neck tension syndrome</td>
<td>Prolonged static posture of neck/shoulder/arm, prolonged carrying of load on shoulder or in the hand</td>
<td>Belt conveyor assembly, typing, keying, small parts assembly, packing, load carrying in hand or on shoulder</td>
</tr>
<tr>
<td>Pronator teres syndrome</td>
<td>Rapid pronation of the forearm, forceful pronation, pronation with wrist flexion</td>
<td>Soldering, buffing, grinding, polishing, sanding</td>
</tr>
<tr>
<td>Radial tunnel syndrome</td>
<td>Repetitive wrist flexion with pronation or supination of the forearm</td>
<td>Use of hand tools</td>
</tr>
<tr>
<td>Shoulder tendonitis, rotator cuff syndrome</td>
<td>Shoulder abduction and flexion, arm extended, abducted, or flexed in the elbow more than 60 degrees, continuous elbow elevation, work with hand above shoulder, load carrying on shoulder, throwing object</td>
<td>Punch press operations, overhead assembly, overhead welding, overhead painting, overhead auto repair, belt conveyor assembly work, packing, storing, construction work, postal ‘letter carrying’, reaching, lifting</td>
</tr>
<tr>
<td>Tendonitis in the wrist</td>
<td>Forceful wrist extension and flexion, forceful ulnar deviation</td>
<td>Punch press operation, assembly work, wiring, packing, core making, use of pliers</td>
</tr>
<tr>
<td>Tendosynovitis, DeQuervain’s syndrome ganglion</td>
<td>Wrist motions, forceful wrist extension and ulnar deviation while pushing or with supination, wrist flexion and extension with pressure at the palmar base, rapid rotations of the wrist</td>
<td>Buffing, grinding, polishing, sanding, punch press operation, sawing, cutting, surgery, butchering, use of pliers, ‘turning’ control such as on a motorcycle, inserting screws in holes, forceful hand wringing</td>
</tr>
<tr>
<td>Trigger finger</td>
<td>Repetitive finger flexion, sustained bending of the distal finger phalanx while more proximal phalanges are straight</td>
<td>Operating finger trigger, using hand tools where the handle opening is too large for the hand</td>
</tr>
<tr>
<td>Ulnar nerve entrapment, Guyon tunnel syndrome</td>
<td>Prolonged flexion and extension of the wrist, pressure on the hypothenar eminence, sustained elbow flexion with pressure on the ulnar groove</td>
<td>Playing musical instruments, carpentering, brick laying, use of pliers, soldering, hammering</td>
</tr>
<tr>
<td>White (or dead) finger syndrome, Raynaud’s syndrome</td>
<td>Gripping of vibrating tool, using hand tool that hinders blood circulation</td>
<td>Chain sawing, jack hammering, use of vibrating tool, sanding, paint scraping, using tool too small for the hand, often in a cold environment</td>
</tr>
</tbody>
</table>
Ergonomics measures to avoid CTD

Avoidance of cumulative trauma injuries, whether by redesign of an existing workstation or by appropriate planning of a new workstation, follows one simple rule: let the operator perform ‘natural activities’ – i.e., those for which the human body is suited; avoid highly repetitive activities and those in which straining force or posture must be maintained over prolonged time.

The overall principle is to fit the job to the person, and not to attempt to fit persons to the job. Thus the general process of work, the particular hand tools to be used, or the parts on which work needs to be performed, should be altered as needed to fit human capabilities. The opposite way – i.e., selecting persons who seem to be especially able to perform work that most people cannot do, or to let several people work at the same workstation alternately so that nobody has to work long periods of time on the same job – are basically inappropriate measures which should be applied only if no other solution can be found.

There are seven conditions that specifically need to be avoided:
1. Job activities with many repetitions. (Silverstein (1985) proposed to describe repetitive activity as work in which each cycle lasts less than 30 s, or as work in which one basic activity element is present during more than 50% of the total cycle time. More specific and better applicable definitions are desired.)
2. Work that requires prolonged or repetitive exertion of more than 30% of the operator's muscle strength available for that activity (Silverstein, 1985).
3. Putting body segments in an extreme position, such as severely bending at the wrist.
4. Work that makes a person maintain the same body posture for long periods of time.
5. Work in which a tool vibrates the body or part of the body.
6. Exposure of working body segments to cold, including air flow from pneumatic tools.
7. Combinations of the conditions just described.

<table>
<thead>
<tr>
<th>CTD</th>
<th>Avoid in general</th>
<th>Avoid in particular</th>
<th>Do</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal tunnel syndrome</td>
<td>Wrist deviation, finger pinch</td>
<td>Dorsal and palmar flexion, pinch grip</td>
<td>Use large muscles but infrequently and for short durations</td>
<td>The work object properly</td>
</tr>
<tr>
<td>Epicondilitis</td>
<td>‘Bad backhand’</td>
<td>Dorsiflexion, pronation</td>
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<tr>
<td>Pronator teres syndrome</td>
<td>Forearm pronation</td>
<td>Rapid and forceful pronation</td>
<td>Let wrists be in line with the forearm</td>
<td></td>
</tr>
<tr>
<td>Shoulder tendonitis, rotator cuff syndrome</td>
<td>Arm elevation</td>
<td>Arm abduction, elbow elevation</td>
<td>Let shoulder and upper arm be relaxed</td>
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<tr>
<td>Tendonitis</td>
<td>Often repeated movements, particularly with force exertion, hard surface in contact with skin, vibrations</td>
<td>Frequent motions of digits, wrists, forearm, shoulder</td>
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<td></td>
</tr>
<tr>
<td>Tendosynovitis, DeQuervain’s syndrome, ganglion</td>
<td>Finger flexion, wrist deviation</td>
<td>Ulnar deviation, dorsal and palmar flexion, radial deviation with firm grip</td>
<td>Let shoulder and upper arm be relaxed</td>
<td>Hand tools properly ('bend tool, not the wrist')</td>
</tr>
<tr>
<td>Thoracic outlet syndrome</td>
<td>Arm elevation, carrying</td>
<td>Shoulder flexion arm hyperextension</td>
<td>Let forearm not be elevated more than horizontal</td>
<td>Round corners, pad</td>
</tr>
<tr>
<td>Trigger finger</td>
<td>Finger flexion</td>
<td>Flexion of distal phalanx alone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar nerve entrapment</td>
<td>Wrist flexion and extension, pressure on hypothenar eminence</td>
<td>Wrist flexion and extension</td>
<td></td>
<td>Place work object properly</td>
</tr>
<tr>
<td>White finger, vibration syndrome</td>
<td>Vibrations, tight grip, cold</td>
<td>Vibrations between 40 and 125 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck tension syndrome</td>
<td>Static head posture</td>
<td>Prolonged static head/neck posture</td>
<td>Alternate head/neck postures</td>
<td></td>
</tr>
</tbody>
</table>
These seven conditions are associated with ‘tell tales’, most of which are easily observable: rapid and often repeated actions; exertion of finger or arm forces; contorted body joints; blurred outlines of the body owing to vibration; and the feeling of cold and the hissing sound of fast flowing air.

Table 2 lists ergonomics measures to avoid most common CTDs. Proper design of the work task and use of suitable work tools can be facilitated by careful design and positioning of the work object. Training in physiologically correct activities, and provision of alternating work (which allows ‘breaks’ in otherwise repetitive or maintained activities) are essential.

References
