Management of Upper Extremity Cumulative Trauma Disorders

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Cumulative trauma disorders (CTDs) is an umbrella term describing specific diagnoses of the musculoskeletal system with a common etiology. The specific diagnoses involve damage to the tendons, tendon sheaths, muscles, joints, blood vessels, and peripheral nerves of the upper extremities (Mandel, 1987; Putz-Anderson, 1988; Travers, 1988) (Table 1). Other terms used to describe these disorders include "repetitive motion syndrome," "repetitive strain injury," and "overuse syndrome." These other terms imply that repetitive work is the sole etiology.

Vibrating tools, forceful motions, and motions in awkward or extreme postures are three other important ergonomic hazards proven to cause these disorders (Armstrong, 1982; Arndt, 1987; Blair, 1987; Punnett, 1985; Rothflesch, 1978; Silverstein, 1986; Stock, 1991). Because of these other ergonomic hazards, the authors' preferred term is CTDs.

The most effective means of preventing CTDs, and the primary focus of any ergonomic program, is the development of engineering controls for identified ergonomic hazards. In some instances, however, the application of engineering controls is not feasible due to economic considerations. When engineering controls are not feasible, or until proven effective controls can be installed, other aspects of an ergonomic program—administrative and medical management controls—need implementation. This article focuses on the medical management of CTDs.

The most effective means of preventing CTDs is the development of engineering controls for identified ergonomic hazards.

The medical management of CTDs is not simply the recognition, evaluation, and treatment of CTDs. Other elements critical to a successful medical management program include CTD surveillance, conditioning and rehabilitation programs, and familiarity with OSHA recordkeeping requirements. This article is a practical guideline to assist health and safety professionals, employers, and union health and safety representatives to develop, assess, or modify their medical management program for CTDs.

HEALTH CARE PROVIDERS

The medical management program should be supervised by an occupational health nurse or occupational medicine physician. These individuals should have training in early recognition, evaluation, treatment, rehabilitation, and prevention of CTDs, in addition to the principles of ergonomics, and OSHA recordkeeping requirements. Health care providers (HCPs) working with the medical or nursing director also should be knowledgeable in these topics and be available on site during all shifts. Where such personnel are not employed full time, the part time employment of appropriately trained HCPs is recommended.

COMPONENTS OF A MEDICAL MANAGEMENT PROGRAM

Workplace Walkthrough

The health care provider should conduct a workplace walkthrough every month or whenever a particular job task changes. This walkthrough accomplishes many things. It allows the HCP to: maintain close contact with employees; identify potential light duty jobs; observe individual

work practices; and remain knowledgeable about operations described to them by employees.

Ergonomic Classification of Jobs

The employee health department should have a list describing the various ergonomic hazards found on each job within the facility. This list can be used to identify jobs for employees with upper extremity CTDs requiring restricted or light duty, and can assist in the development of a job rotation program. The personnel in the employee health department are valuable assets in the development of this job classification because they have contact with symptomatic workers and information generated from the walkthrough and symptoms survey (see next section). This list is reviewed and revised periodically to reflect any changes in ergonomic hazards of any particular job.

CTD Surveillance

Engineering controls that reduce or eliminate ergonomic hazards are needed to prevent CTDs. Identifying and prioritizing areas for intervention are critical. The personnel in the employee health department can assist in this effort by using passive or active surveillance systems to identify high risk departments, production lines, or jobs.

Passive surveillance systems use existing data sources, such as the OSHA 200 logs, and workers' compensation claims to find high risk areas. High risk areas are not simply the areas with the most cases of CTDs, but rather the areas with the highest incidence rate of CTDs. The incidence rate is the number of CTD cases (numerator) over the number of people at risk for a given time period (denominator).

Using the OSHA 200 logs as an example, the numerator is the number of "7f" cases (disorders due to repeated trauma) for a given time period. The denominator is the number of employees in that particular department or job for the same time period. This method can identify high risk departments, production lines, or jobs, and is usually expressed as cases per 100 or 10,000 full time workers per year (U.S. Department of Labor, 1986).

Although attractive due to their low cost, passive surveillance programs have limitations that can hamper identification of high risk areas. These include underreporting; disease misclassification; and exposure misclassification. Underreporting can result from any of the following: symptomatic employees not seeking first aid care (macho workers, ignorance that the condition could be work related, or fear of employer retaliation); restricted or no access to first aid or employee health departments; or differing interpretation about when a CTD case is to be recorded on the OSHA 200 log.

Disease misclassification occurs when a CTD is recorded as an injury rather than as a "disorder due to repeated trauma." Exposure misclassification can occur when employees use a general term to describe their job title. For example, an employee in the meatpacking industry may report the job title "cutter" in a plant with 20 distinct cutting positions. Each one of these cutting jobs may be associated with very different ergonomic hazards, and to identify high risk jobs the HCP must know, specifically, at which cutting position the employee is working.

Because of the problems with passive surveillance systems, the HCP should consider conducting *active surveillance*, a symptom survey of all employees. The symptom survey questionnaire should be short and clear and use body diagrams to identify symptomatic areas (see Figure 1). The symptom survey should be anonymous unless the HCP can assure employees of strict confidentiality.

The primary purpose of the symptom survey is to identify high risk jobs for intervention. However, the information can be used for other purposes, including: monitoring the effectiveness of ergonomic interventions; finding unrecognized ergonomic hazards; and, if conducted in a confidential manner, serving a triage function for employees needing health care evaluations.

If the symptom survey is conducted anonymously, groups of employees can be identified for evaluations. This point deserves emphasis.

TABLE 1
Specific Diagnoses Referred to as Cumulative Trauma Disorders (CTDs)

Tendon Related Disorders

Tendonitis
Tenosynovitis
Stenosing tenosynovitis of the fingers (trigger finger)
Stenosing tenosynovitis of the thumb (DeQuervain's)
Peritendonitis (strain)
Ganglion cyst
Lateral epicondylitis (tennis elbow)
Medial epicondylitis (golfer's elbow)
Bicipital tendonitis
Rotator cuff tendonitis

Peripheral Nerve Entrapment

Carpal tunnel syndrome
Guyon tunnel syndrome
Radial tunnel syndrome
Pronator teres syndrome
Cubital tunnel syndrome

Vascular

Hand-arm vibration syndrome (Raynaud's phenomena)
Ulnar artery thrombosis

Neurovascular

Thoracic outlet syndrome

Muscular

Focal dystonia
Fibromyositis
Tension neck syndrome
Myositis

Joint/Joint Capsule

Osteoarthritis
Bursitis
Synovitis

Symptoms Survey: *Ergonomics Program*

DATE____/____/____

_____ Plant _____ Dept # _____ Job # _____ Job Name

_____ Shift _____ Supervisor _____ Hours worked/week ____years____months Time on THIS job

Other jobs you have done in the last year (for more than 2 weeks)

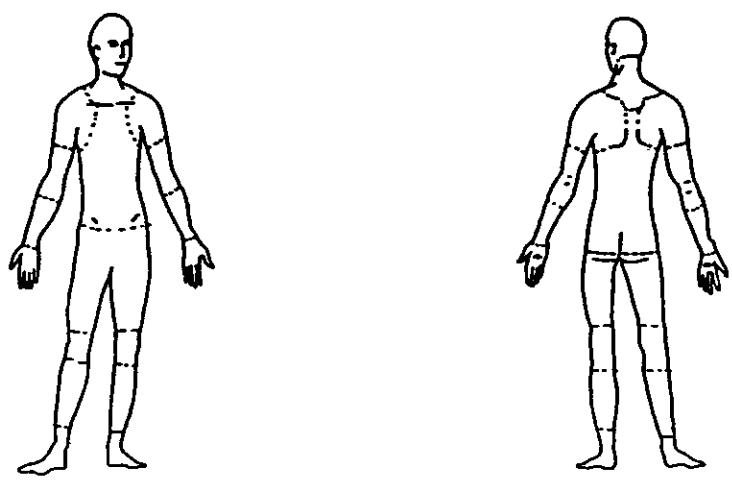
_____ Plant _____ Dept # _____ Job # _____ Job Name ____months____weeks Time on THIS job

_____ Plant _____ Dept # _____ Job # _____ Job Name ____months____weeks Time on THIS job

(If more than 2 jobs, include those you worked on the most)

Have you had any pain or discomfort during the last year?
❑ Yes ❑ No (If NO, stop here)

If YES, carefully shade in the area of the drawing which bothers you the MOST.



Front Back

(Continued)

Figure 1: Symptoms survey checklist.

(Complete a separate page for each area that bothers you)

Check Area: ☐ Neck ☐ Shoulder ☐ Elbow/Forearm ☐ Hand/Wrist ☐ Fingers
☐ Upper Back ☐ Low Back ☐ Thigh/Knee ☐ Low Leg ☐ Ankle/Foot

1. Please put a check by the word(s) that best describe your problem

☐ Aching
☐ Burning
☐ Cramping
☐ Loss of Color
☐ Numbness (asleep)
☐ Pain
☐ Swelling
☐ Stiffness
☐ Tingling
☐ Weakness
☐ Other

2. When did you first notice the problem? _____(month) _____(year)

3. How long does each episode last? (Mark an X along the line)

_____/_____/_____/_____/_____
1 hour 1 day 1 week 1 month 6 months

4. How many separate episodes have you had in the last year?_____

5. What do you think caused the problem?_____

_____

6. Have you had this problem in the last 7 days? ☐ Yes ☐ No

7. How would you rate this problem (mark an X on the line)
NOW

_____
None Unbearable

When it was the WORST

_____
None Unbearable

8. Have you had medical treatment for this problem? ☐ Yes ☐ No

8a. If NO, why not_____

8b. If YES, where did you receive treament?_____

1. Company Medical ☐ Times in past year_____
2. Personal doctor ☐ Times in past year_____
3. Other ☐ Times in past year_____

8c. If YES, did the treatment help? ☐ Yes ☐ No

9. How much time have you lost in the last year because of this problem?_____days

10. How many days in the last year were you on restricted or light duty because of this problem?
_____days

11. Please comment on what you think would improve your symptoms

_____

_____

_____

_____

Unless the HCP can assure employees of strict confidentiality, the survey should be anonymous. Any real or perceived violation of this ethical code can render the information invalid.

CTD Evaluation

The main objective of CTD surveillance is to identify jobs needing intervention to eliminate the ergonomic hazards. The purpose of CTD evaluation, on the other hand, is to identify individuals with mild CTDs, allowing early treatment to limit the severity of the condition.

Frequency. The HCP should perform a CTD evaluation of employees assigned to jobs with known ergonomic hazards or areas found to have CTD problems by the surveillance system. These evaluations should occur: prior to starting a high risk job (preplacement or baseline evaluation); following the conditioning period (post-conditioning evaluation); and periodically (approximately every 3 years).

Preplacement or Baseline Evaluation: The purpose of a preplacement upper extremity musculoskeletal evaluation is to establish a base against which changes in an individual's health status can be measured. It is not to be used as a preemployment screening program precluding certain individuals from employment. Not only would such determinations be discriminatory, but no screening tests or examinations have been validated as predictive procedures for determining which workers will develop CTDs.

Post-conditioning Period Evaluation: New and transferred employees performing jobs with known ergonomic hazards should be given a 4 to 6 week break-in period to condition their muscle-tendon groups. This means working at reduced speed with more frequent breaks, and is also known as "work hardening" (Flinn-Wagner, 1990). Following this work hardening or conditioning period the employees should have a health evaluation to determine if conditioning of the muscle-tendon groups has been successful.

Employees typically report transient soreness or fatigue during the conditioning period. However, these symptoms should resolve within a few weeks, consistent with normal adaptation to the job. If the symptoms persist they may represent the early stages of a CTD. Work hardening programs of shorter duration also should be available to employees returning to work from a vacation lasting for more than 1 week.

Periodic Evaluation: Employees working on jobs with ergonomic hazards should have a CTD evaluation approximately every 3 years. The purpose of this periodic evaluation is to identify employees with CTDs who, for whatever reason, do not report their symptoms to the employee health department.

Content. The CTD evaluation should consist of a medical and occupational history and a brief noninvasive physical examination (inspection, palpation, range of motion testing, and various maneuvers).

The *history* should elicit the location, duration, frequency, intensity, and onset of discomfort (pain, swelling, aching, tingling, numbness, burning, or stiffness). Note if the symptoms started before or after employment at that facility, if the symptoms are exacerbated by job tasks, if any previous injuries or fractures to that joint area occurred, if any recreational activities or hobbies exacerbate the condition, and if any medical conditions known to be associated with carpal tunnel syndrome are present (Table 2).

The *physical examination* of the upper extremities includes inspection for signs of inflammation (redness, swelling), ganglion cysts, or deformities. Palpation can identify areas of discomfort, as well as warmth, the third sign of inflammation. Passive, active, and resisted range of motion maneuvers can again elicit areas of discomfort in addition to crepitus and stenosis.

Other maneuvers include Tinel's test of the median and ulnar nerves, Phalen's test, and Finkelstein's test.

TABLE 2
Conditions Associated with Carpal Tunnel Syndrome*

Endocrine Disorders
Diabetes mellitus, pregnancy, use of estrogens or oral contraceptives, acromegaly, myxedema

Rheumatic Disorders
Rheumatoid arthritis, systemic lupus erythematosus, scleroderma, polymyalgia rheumatica, eosinophilic fasciitis, gout, osteoarthritis

Cardiac Disorders
Congestive heart failure, vascular shunts

Blood Disorders
Amyloidosis, hemophilia

Renal Disorders
Uremia

Infectious Disorders
Tuberculosis

Traumatic Disorders
Previous fracture of the carpal bones

Tumors: Benign
Gangliomas, lipomas

Tumors: Malignant
Multiple myeloma

**Adapted from Leach, 1968; Spinner, 1989*

Remember that CTDs can exist without external manifestations of inflammation (Wigley, 1990).

Tinel's test of the median nerve consists of tapping the median nerve as it passes through the carpal canal (Mossman, 1987). A positive response is pain, or paresthesia in digits two and three (Katz, 1990). Tinel's test of the ulnar nerve consists of tapping the ulnar nerve as it passes through Guyon's canal. A positive response is pain or paresthesia in digits 4 or 5.

Phalen's test is flexing both wrists 90° with the dorsal aspect of the hands held in apposition for 60 sec-

onds (Phalen, 1966). A positive response is pain or paresthesia in digits 2 and 3 (Katz, 1990; Phalen, 1966).

Finkelstein's test is ulnar deviation of the hand with the thumb flexed against the palm and the fingers flexed over the thumb (Finkelstein, 1930). A positive response is severe pain at the radial styloid due to stretching of the abductor pollicis longus and extensor pollicis brevis (Finkelstein, 1930; Labidus, 1953). Trigger finger is the locking of a finger in flexion or a palpable tendon sheath ganglion (Labidus, 1953).

Collecting and recording this information in a uniform manner is imperative. Figure 2 provides one example of such a recording form.

Evaluation of Symptomatic Employees

Individuals presenting to the employee health department with upper extremity symptoms, or identified as having problems by the confidential symptom survey, also should have a CTD evaluation. The content of this evaluation obviously will be dictated by the intensity and location of the symptoms. However, the physical examination described above (Figure 2) could be used as a framework.

Treatment of CTDs

After performing the above evaluation, the HCP must now use the information to make an assessment and to formulate a treatment plan. Figure 3 provides the HCP with a CTD medical management algorithm. This algorithm is not meant to dictate practice, but rather to outline a therapeutic approach based on the history and physical examination.

The main message from this algorithm is not its specifics. Rather, symptomatic employees need follow up to determine the effectiveness of the prescribed treatments; employees with severe symptoms, positive physical findings, or disorders resistant to treatment need to be referred to a physician for further evaluation; and conservative therapy deserves an adequate trial before surgical intervention is contemplated (in most cases this should be at least 6 months).

Conservative therapy involves: 1) the application of heat or cold, 2) non-steroidal antiinflammatory agents, 3) physical therapy, and 4) splints.

Cold is used to treat tendon and joint related disorders for pain relief, and swelling reduction (Simon, 1986). Cold decreases the inflammation of CTDs even if no external signs of inflammation are present (redness, swelling, warmth). *Heat* can be used for muscle related disorders (tension neck syndrome or muscle spasms). Heat is inappropriate for employees with tendon related disorders, and cold is inappropriate for employees with vascular related CTDs such as hand-arm vibration syndrome (Nanneman, 1991; Putz-Anderson, 1988).

Non-steroidal antiinflammatory agents may be helpful in reducing soft tissue inflammation; however, their gastrointestinal and renal side effects limit their usefulness (Simon, 1980).

Physical therapy may be a useful component to a CTD treatment or rehabilitation program (King, 1990). Stretching exercises should be performed under the supervision of an occupational health nurse or physical therapist to insure the exercises are performed properly and do not aggravate the condition. Once the employee can perform these exercises properly, supervision is needed only intermittently.

In-plant stretching exercises two or three times a day have been suggested as a method of preventing CTDs in asymptomatic employees (Allers, 1989). The effectiveness of such a program is questionable for three reasons. Exercises that involve stressful or extreme range of motions can exacerbate conditions in individuals who have not reported their CTDs to the employee health department. These exercises typically will reduce the rest periods allowed employees. A controlled study found these stretching programs to be ineffective (Silverstein, 1988).

Off the job or night *splints* may be helpful for hand and wrist CTDs. These splints should maintain the joint in a neutral posture and will discourage employees from performing activities that exacerbate their CTDs (Kessler, 1986; Spinner, 1989). The use of splints on the job should be discouraged unless the occupational health nurse or ergonomist has determined the job does not require wrist bending. Employees who struggle to perform a task requiring wrist deviation with a splint designed to prevent wrist deviation can exacerbate symptoms in the wrist due to the increased force needed to overcome the splint. It also may cause other joint areas (elbows or shoulders) to become symptomatic as technique is altered (Kessler, 1986; Putz-Anderson, 1988).

The effectiveness of hot wax treatments and constrictive wrist wraps has not been established. Effectiveness of vitamin B6 to treat or prevent carpal tunnel syndrome has been disproven and may actually be neurotoxic in prescribed doses (Amadio, 1987).

If initial treatment of the CTD does not result in improvement or resolution of the symptoms, employees must be taken off the jobs causing the problem. They can be transferred to a restricted or light duty job, or if such a job is not available, they should receive time off work. The intent of light duty work is to provide the worker with an alternate job that has minimum exposure to known risk factors for CTDs.

Only after an adequate trial of conservative therapy and time away from the job causing the problem should surgical intervention be considered. In most cases this should involve at least 6 months of conservative therapy. Surgical intervention can be appropriate for carpal tunnel syndrome and trigger finger.

While carpal tunnel release surgery has been reported to be 80% to 90% effective in decreasing or relieving the pain, its effectiveness in re-

Name: _____ Current Job: _____
Examiner: _____ Date: ___/___/___

Discomfort Scale: 1=no discomfort, 2=mild, 3=moderate, 4=severe, 5=worst ever

NECK:
Inspection: Inflammation (red, swollen, warm) ___Yes ___No
Palpation: Right Left
Trapezius Trigger Point ___ ___
Trapezius Spasm ___ ___
Manevuers:
Resisted Flexion ___ ___
Resisted Extension ___ ___
Resisted Rotation ___ ___

SHOULDER
Inspection: Acromium Inflammation? ___Yes(R or L) ___No
Maneuvers: Right Left
Passive Abduction ___ ___
Active Abduction ___ ___
Resisted Abduction ___ ___
Deltoid Palpation ___ ___

ELBOW
Inspection: Olecranon Inflammation: ___Yes(R or L) ___No
Palpation: Right Left
Medial Epicondyle ___ ___
Lateral Epicondyle ___ ___

FOREARM
Inspection: Forearm Inflammation? ___Yes(R or L) ___No
Maneuvers: Right Left
Passive Wrist Flexion ___ ___
Passive Wrist Extension ___ ___
Resisted Wrist Flexion ___ ___
Resisted Wrist Extention ___ ___
Resisted Finger Flexion ___ ___
Resisted Finger Extention ___ ___
3rd digit resisted Extention ___ ___

WRIST
Inspection: Inflammation ___Yes(R or L) ___No
Extensor ganglion cyst ___Yes(R or L) ___No
Flexor ganglion cyst ___Yes(R or L) ___No
Maneuvers: Right Left
Guyon Tinel's ___ ___
Carpal Tinel's ___ ___
Phalen's ___ ___

HANDS AND FINGERS
Inspection: Inflammation ___Yes(R or L) ___No
Maneuvers: Right Left
Trigger Finger ___ ___
Finkelstein's ___ ___

Figure 2: Physical examination recording form for health care providers.

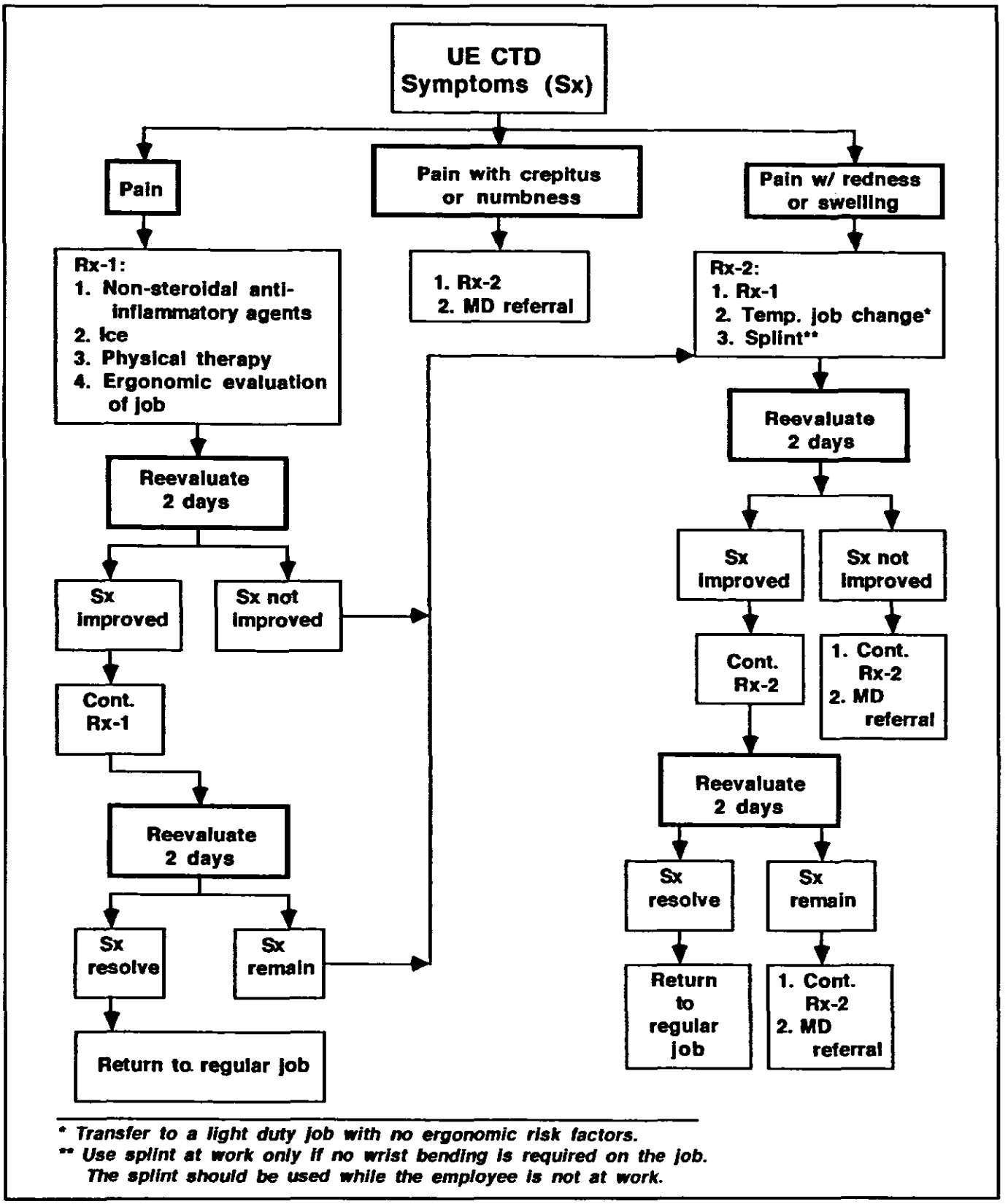


Figure 3: Upper extremity cumulative trauma disorders algorithm.

turning employees to their original jobs is 40% to 50% at best (Jaeger, S.H., personal communication, 1990). All employees scheduled for carpal tunnel release surgery should have: 1) their treatment program reviewed to assure that conservative therapy has failed, and 2) a second opinion to corroborate the need for surgery.

Employee Education

Detection of CTDs prior to the development of a severe, disabling condition should lead to a rapid and complete recovery. To facilitate the early evaluation of CTDs, all employees, including supervisors and other plant management personnel, should be educated on the causes and the early symptoms and signs of CTDs. Encouraging employees to report symptoms to their supervisor with subsequent referral to the employee health department allows for timely and appropriate evaluation and treatment.

It is important to avoid any potential disincentives for employee reporting, such as limits on the number of visits to the health unit, monetary bonuses for not reporting to the health unit, or fear of discrimination or reprisal by employers against employees who report symptoms. This education process should occur during the orientation or training period and be reinforced periodically.

OSHA Form 200 Recording

The Department of Labor has issued guidelines that provide official interpretations for recording and reporting occupational injuries and illnesses (U.S. Department of Labor, 1986). These guidelines provide supplemental instructions for the OSHA recordkeeping forms (OSHA Forms 200, 101, and 200-S) and should be available in every employee health department. HCPs should be responsible for entering the appropriate information onto the OSHA forms; therefore, they should be aware of OSHA's recordkeeping requirements.

Occupational Illnesses. All work related illnesses must be recorded on the OSHA 200 form, even if the condition is in an early stage of development. Diagnosis of these conditions may be made by a physician, registered nurse, or by a person who, by training or experience, is capable of making such a determination.

If the condition is "diagnosed or recognized" as work related, the case must be entered on the OSHA 200 form within 6 work days after detection. CTDs should be recorded on the OSHA 200 form as an occupational illness under the "7f" column ("disorders associated with repeated trauma"). These are disorders caused, aggravated, or precipitated by repeated motion, vibration, or pressure. To be recordable a CTD must be diagnosed, and the CTD must be work related.

CTD Diagnosis: A CTD is diagnosed when there are a) objective findings on physical examination, *or* b) subjective symptoms with resulting action.

Examples of positive physical findings include positive maneuvers (Tinel's, Phalen's, or Finkelstein's tests); or signs of inflammation (swelling, or redness); or joint deformity; or loss of motion.

Examples of subjective symptoms include pain, numbness, tingling, aching, stiffness, or burning. Resulting action includes at least one of the following:

- Medical treatment (including self administered treatment when made available to employees by their employer); or
- Lost workdays (includes restricted work activity); or
- Transfer/rotation to another job.

Work Related: The CTD is work related if the exposure at work either caused or contributed to the onset of symptoms or aggravated existing symptoms to the point that they meet OSHA recordability criteria. Examples of work tasks or working conditions that are likely to elicit a work related CTD include:

- Repetitive and/or prolonged physical activities.
- Forceful exertions, usually with the hands (including tools requiring pinching or gripping).
- Awkward postures of the upper body, including reaching above the shoulders or behind the back, and angulation of the wrists to perform tasks.
- Localized contact areas between the work or work station and the worker's body; i.e., contact with surfaces or edges.
- Excessive vibration from power tools.
- Cold temperatures.

Other Considerations: A case is considered to be complete once signs and symptoms resolve completely. If signs or symptoms recur, a new case is established and thus must be recorded as a new case on the OSHA 200 form. Furthermore, failure of the worker to return for care after 30 days indicates symptom resolution. Any visit to an HCP for similar complaints after the 30 day interval implies reinjury and represents a new case.

It is essential that required data, including job identification, be consistently, fully, and accurately recorded on the OSHA 200 form. "Job identification" will include the appropriate job title for "Occupation" and the appropriate organizational unit for "Department" on the OSHA 200.

Health care providers and others should contact the OSHA area or regional office, or state occupational safety and health agency serving their area with questions about OSHA recordkeeping.

Program Evaluation

The nursing or medical director responsible for the CTD medical management program should review the program periodically to evaluate the effectiveness of the various components. Ineffective components should be modified to achieve their stated objective.

CONCLUSION

CTDs are painful conditions with the potential to result in crippling disorders. The direct costs (medical and workers' compensation) and indirect costs (lost productivity and expense incurred training new workers) can be staggering to employers. The medical management program described in this article should prevent and/or limit the severity of these disorders, resulting in a healthier, more productive workplace.

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Upper Extremity CTDs IN SUMMARY

Management of Upper Extremity Cumulative Trauma Disorders. Hales, T.R., & Bertsche, P.K. *AAOHN Journal* 1992; 40(3):118-128.

1. Elements critical to a successful medical management program include cumulative trauma disorder (CTD) surveillance, conditioning and rehabilitation programs, and familiarity with OSHA recordkeeping requirements, in addition to recognition, evaluation, and treatment.

2. Occupational health care providers (HCPs) can identify high risk departments, production lines, or jobs through the passive and/or active surveillance systems.

3. The HCP should perform a CTD evaluation of employees assigned to jobs with known ergonomic hazards or areas found to have CTD problems by the surveillance system. These evaluations should consist of a medical and occupational history, and a physical examination of the upper extremities.

4. The treatment algorithm emphasizes that a) symptomatic employees need follow up to determine the effectiveness of the prescribed treatments, b) employees with severe symptoms, positive physical findings, or disorders resistant to treatment need to be referred to a physician for further evaluation, and c) conservative therapy deserves an adequate trial before surgical intervention is contemplated.

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Preventing Illness and Injury in the Workplace

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ERGONOMICS AND PREVENTION OF MUSCULOSKELETAL INJURIES

Ergonomic principles can be applied to prevent both overt and cumulative traumas. An example in the overt category is the risk of falling from a ladder, which can be reduced by considering the sizes and mobility of people when deciding how far apart to place a ladder's rungs (250). Cumulative traumas are not the result of single events or stresses; they stem from the repeated performance of certain tasks. Back problems are by far the most common cumulative trauma injuries. Evaluation and redesign of tasks to prevent back injuries is discussed later in this chapter.

Repetitive motion disorders are a type of cumulative trauma associated with repeated, often forceful movements, usually involving the wrist or elbow. Some 20 million workers on assembly lines and in other jobs that require repetitive, strain-producing motions are at increased risk of developing such disorders. Redesigning work stations, equipment, and handtools can significantly reduce the awkward, forceful movements common to many jobs on assembly lines, in food processing, in the garment industry, and in offices. Carpal tunnel syndrome, one of this class of disorders, illustrates the potential for prevention offered by the integration of ergonomics, medical surveillance, and treatment.

Carpal Tunnel Syndrome

A wide variety of workers (see table 7-1), from aircraft assemblers to upholsterers, are among those at risk for carpal tunnel syndrome (CTS), a progressively disabling and painful condition of the hand. Because the musculoskeletal strain from repeatedly flexing the wrist or applying arm-wrist-finger force does not cause observable injuries, it often takes months or years for workers to detect damage.

Table 7-1.—Occupations and Activities Associated With Carpal Tunnel Syndrome

Aircraft assembly	Inspecting
Automobile assembly	Meat processing
Buffing	Metal fabricating
Coke making	Musicians
Electronic assembly	Packaging
Fabric cutting/sewing	Postal workers
Fruit packing	Textile workers
Gardening	Tire and rubber workers
Hay making	Typing
Waitressing	Upholstering
Housekeeping	

SOURCE: (60)

The incidence and prevalence of CTS in the work force is not known. The National Institute for Occupational Safety and Health (567) reports that 15 to 20 percent of workers employed in construction, food preparation, clerical work, production fabrication, and mining are at risk for cumulative trauma disorders. The Bureau of Labor Statistics (603) reports 23,000 occupationally related repetitive motion disorders in 1980, although the number of CTS cases is not specified.

CTS is undoubtedly underreported in aggregate statistics. Research in particular high-risk plants provides some insight into the extent of the problem. In a study at an athletic products plant, 35.8 percent of workers had a compensable repetitive trauma disorder. In some jobs within the plant,

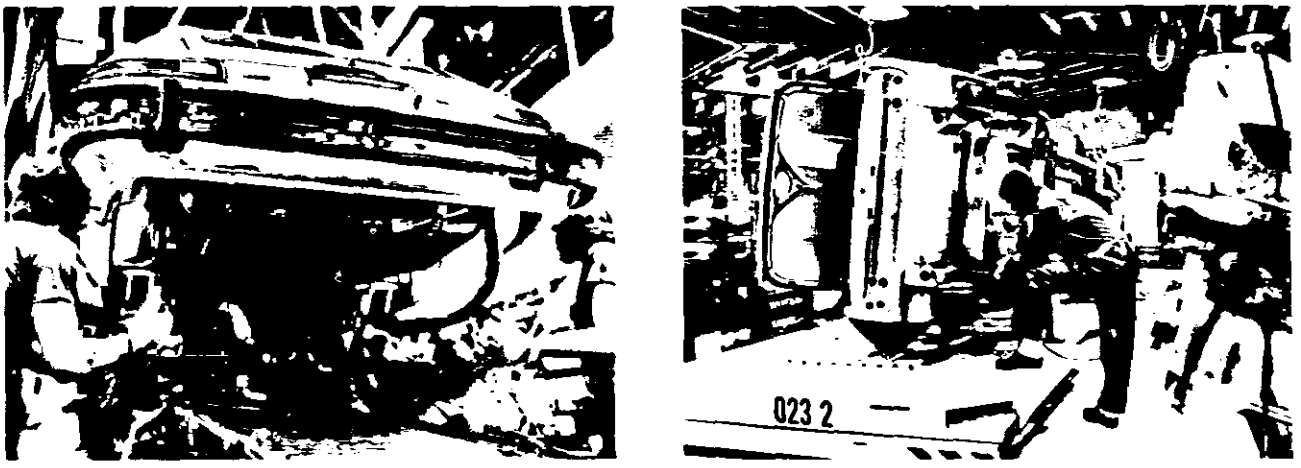


Photo credit: OSHA, Office of Information and Consumer Affairs

Work on an automobile assembly line can involve cramped working positions. A Volvo assembly plant in Kalmar, Sweden, uses "tipper trolleys." These trolleys hold the automobile bodies and can be tipped 90 degrees to allow work on the underside of the car

the rate was as high as 44.1 percent, and carpal tunnel syndrome occurred in 3.4 percent of the workers (21,23). Many industries claim that the incidence of CTS is increasing and is one of their most disabling and costly medical problems (60).

Symptoms

The onset of symptoms of CTS is usually insidious. Frequently, the first complaint is of attacks of painful tingling in one or both hands at night, sufficient to wake the sufferer after a few hours of sleep. Accompanying this is a subjective feeling of uselessness in the fingers, which are sometimes described as feeling swollen. Yet little or no swelling is apparent. As symptoms increase, attacks of tingling may develop during the day, but the associated pain in the arm is much less common than at night. Patients may detect changes in sensation and power to squeeze things but some people suffer severe attacks of pain for many years without developing abnormal neurological signs. Ultimately, in advanced cases, the thenar muscle at the base of the thumb atrophies, and strength is lost.

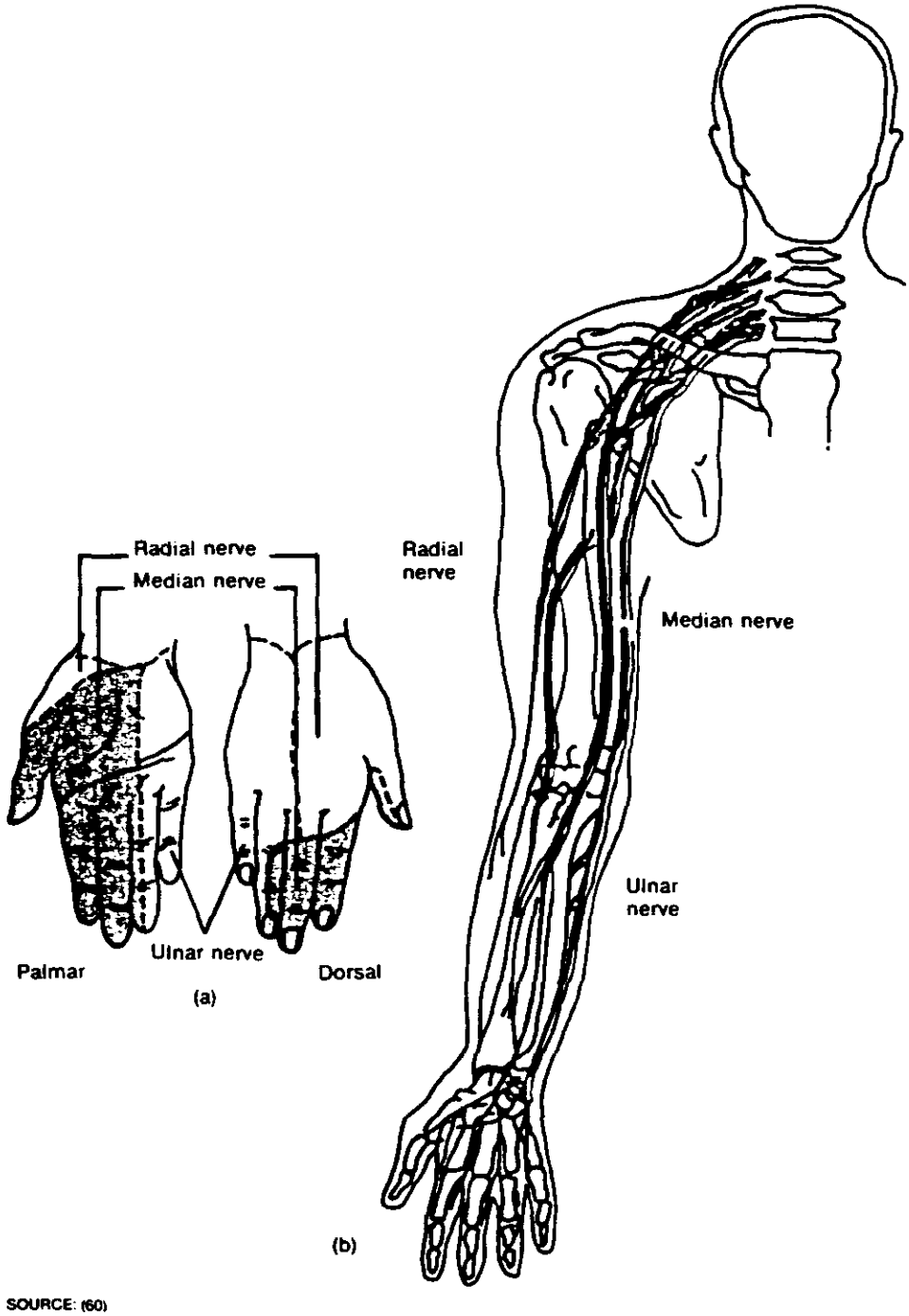
Compression of the median nerve is the immediate cause of CTS. The median nerve comes down the arm, through the wrist, then branches in the hand, supplying the thumb, forefinger, middle finger, and half the ring finger with nerves (fig. 7-3). The carpal tunnel itself, located in the wrist, is formed by the concave arch of the carpal bones and is roofed by the transverse carpal ligament (fig. 7-4). These structures form a rigid compartment through which nine finger tendons and the median nerve must pass. Any compromise of this unyielding space usually compresses the median nerve.

Risk Factors

Repetitive motions, such as those required in many jobs, is one of a number of risk factors for CTS. It is probably the most readily controllable cause, however. Certain diseases, acute trauma, congenital defects, wrist size, pregnancy, oral contraceptive use, and gynecological surgery all may contribute to the likelihood of developing CTS. Overall, the incidence of CTS is higher in women than in men, perhaps because of some of these risk factors.

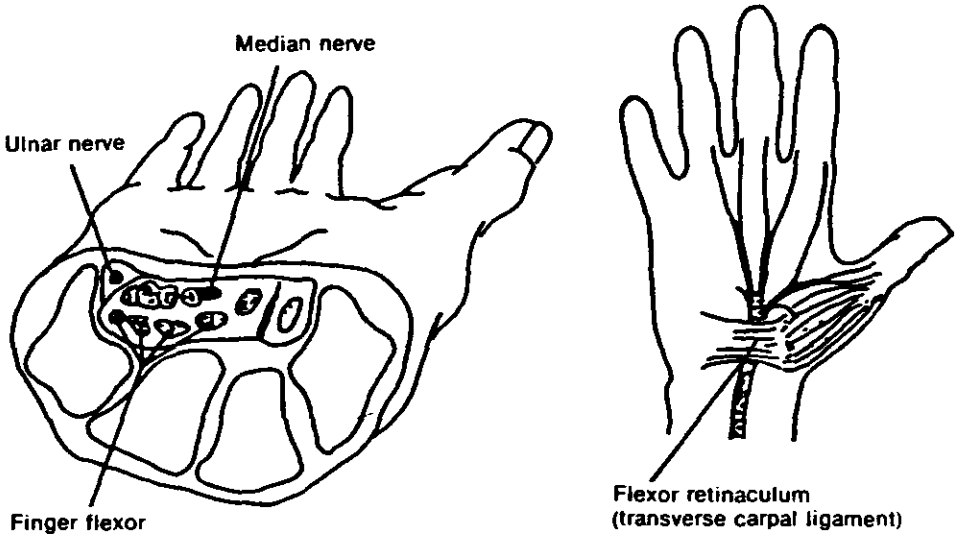
Occupational tasks responsible for the development of CTS include physical exertions with certain hand postures or against certain objects, and exposures to vibration or cold temperatures. Repeated and forceful up-and-down motions of the wrist (flexion and extension) (fig. 7-5), cause the finger tendons to rub on the structures forming the carpal tunnel. This constant rubbing can cause the tendons to swell (tenosynovitis), eventually putting pressure on the median nerve inside the carpal tunnel. The nerve itself is stretched

Figure 7-3.—Major Nerves in the Arm and Hand



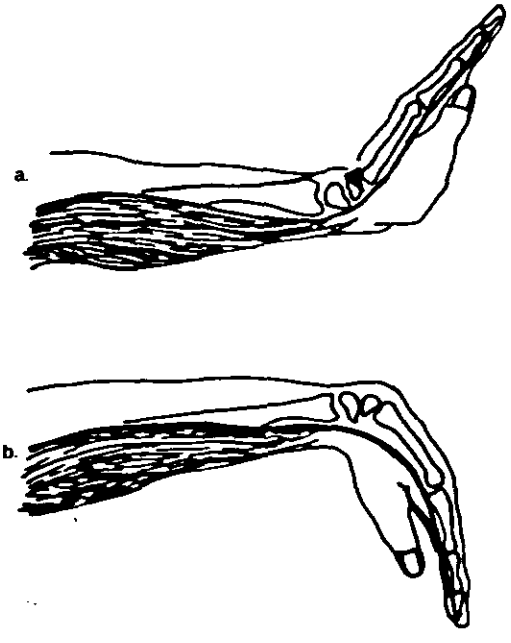
SOURCE: (60)

Figure 7-4.—The Carpal Tunnel



SOURCE: (60)

Figure 7-5.—Flexion and Extension of the Wrist



Bending the wrist causes the finger flexor tendons to rub on adjacent surfaces of the carpal tunnel.

SOURCE: (60).

by repeated exertions, and compressed between the walls of the carpal tunnel.

Forceful movements and the direction of the movement are only two of the underlying causes of tenosynovitis that can lead to CTS. The speed of movements and incorrect posture while working also are important (275). Median nerve compression also can be caused by tasks that require a sustained or repeated stress over the base of the palm (247). Examples include the use of screwdrivers, scrapers, paint brushes, and buffers.

Although the mechanism is not yet understood, low frequency vibration is a recognized risk factor for CTS (405). Vibration exposure may result from air- or motor-powered drills, drivers, saws, sanders, or buffers. Cannon (95) examined medical records at an aircraft company and found a strong association between CTS and use of vibrating tools.

Control of CTS

Control of CTS requires a two-pronged approach. The primary strategy to prevent cases is the use of ergonomic principles to modify handtools and to improve work-station design and

work practices. Even a successful ergonomic program will not prevent all cases of CTS, however. The second important element, therefore, is a medical surveillance program. This is particularly important now when so little is known about the individual factors that cause some people to develop CTS. Thus far, no programs focusing on the medical evaluation of CTS seem to exist (60).

Ways are needed to identify the earliest sign of CTS, to evaluate progression of the disease, and to examine the role of predisposing risk factors. The purpose of such a medical surveillance program is prevention of advanced disease by instituting therapy at early stages.

Although medical surveillance for CTS is still in very early stages, ergonomic interventions have been remarkably successful where they have been instituted. Armstrong (21) describes the steps involved in developing appropriate controls. First, plants and specific departments within plants in which there is a documented high rate of CTS should be identified. Then each job should be systematically analyzed. Traditional time-and-motion studies, in which each movement or act is recorded, can be used. Each element of the job can then be checked against factors known to be associated with CTS development. These include posture of the hand and wrist, strength, stress concentrations over the palm, vibration, cold temperature, and the presence of gloves.

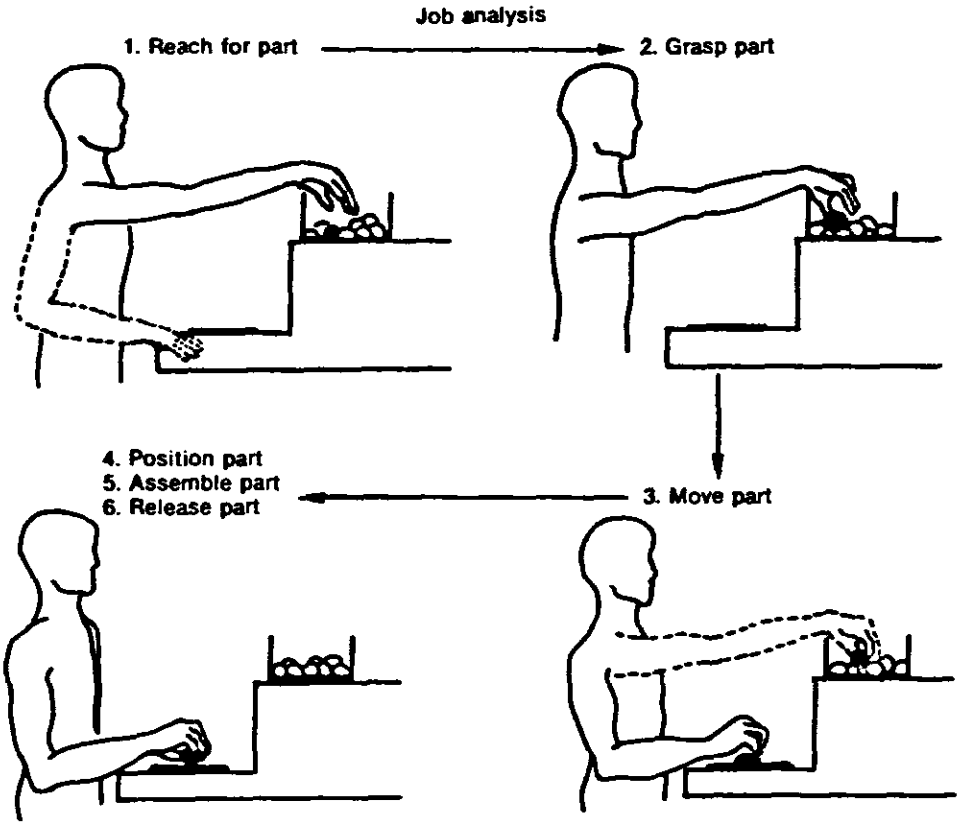
Armstrong presents a typical work task as an example. Figure 7-6 shows a worker taking parts out of a container and placing them on a conveyor. The six elements involved in this task are reach, grasp, move, position, assemble, and release. Reaching into the container involves wrist flexion and pinching, during which the worker's wrist is likely to rub on the edge of the box. The forearm is also likely to rub on the edge of the work bench while the part is positioned. The redesigned work station should reduce stress on the hand and wrist, and eliminate sharp edges. Good and bad designs for the container and the workbench with jig in this hypothetical case are illustrated in figure 7-7.

Powered handtools can also be designed and used to minimize stress. As illustrated in figure 7-8, good designs allow the work to be done with little or no flexion or extension of the wrist.

Armstrong and his colleagues have investigated cumulative trauma disorders in a poultry processing plant using the procedures described above. They discovered that workers in the "thigh boning" section had the highest incidence of cumulative trauma disorders of all departments. Thigh boning involves grabbing the thigh with one hand on a moving overhead conveyor, then making four cuts with the other to separate the meat from the bone. Each worker makes an estimated 15,120 cuts per shift. Ergonomic improvements to the process recommended by Armstrong and colleagues include training workers in the "proper work methods and knife maintenance to minimize the time and, hence, the distance that must be reached and force that must be exerted on the thigh." The work station could be modified to minimize the distance to be reached. The workers wear wire mesh gloves with rubber gloves underneath, which increase the force necessary to grasp the thigh and pull the meat away. Gloves should fit well, and the addition of barbs on the palm of the wire mesh glove might facilitate the hand actions. A new knife handle design, to reduce the force required to hold the knife and make the cuts—e.g., that pictured in figure 7-9—is suggested (22). Such a design would also minimize wrist flexion.

A high incidence of repetitive trauma disorders, including carpal tunnel syndrome, in a telephone assembly plant prompted management to consider how to prevent future cases. McKenzie and colleagues (299) noted the highest rates in areas using vibratory air screwdrivers, and in jobs requiring repetitive grasping, squeezing, or clipping motions. Ergonomic changes recommended included modifying the screwdrivers with sleeve guards and changing work positions to minimize hand and wrist stress. The changes were instituted with almost immediate results: from 2.2 percent annual incidence of repetitive trauma disorders in 1979

Figure 7-6.—Job Analysis: Assembly Tasks

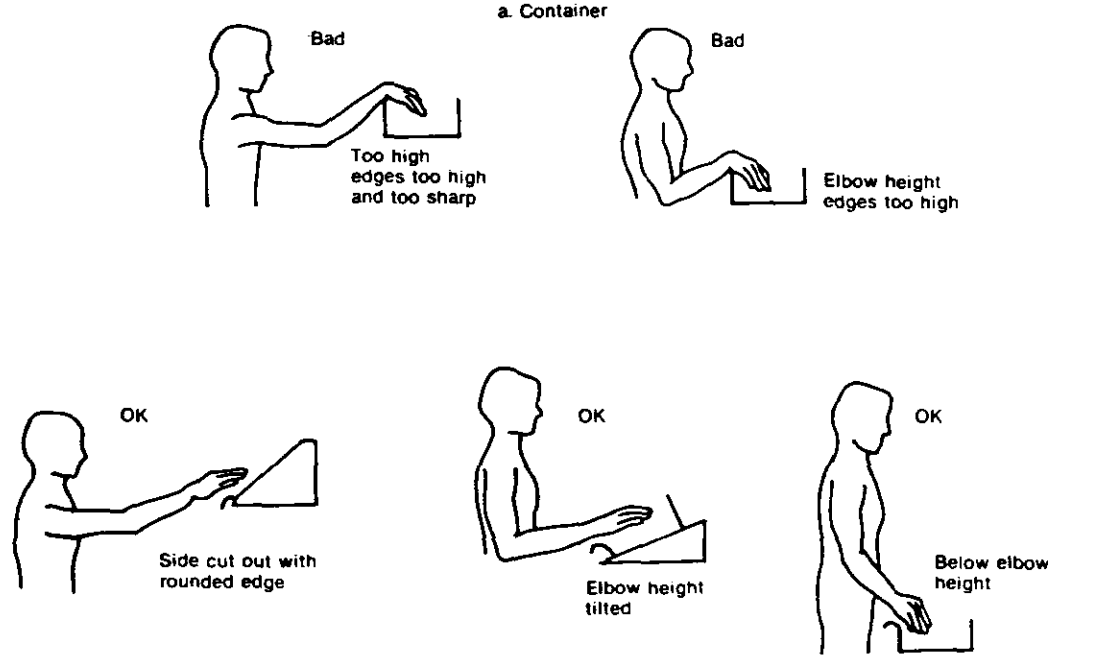


Assembling parts on a moving conveyor can be described by a series of six elements.

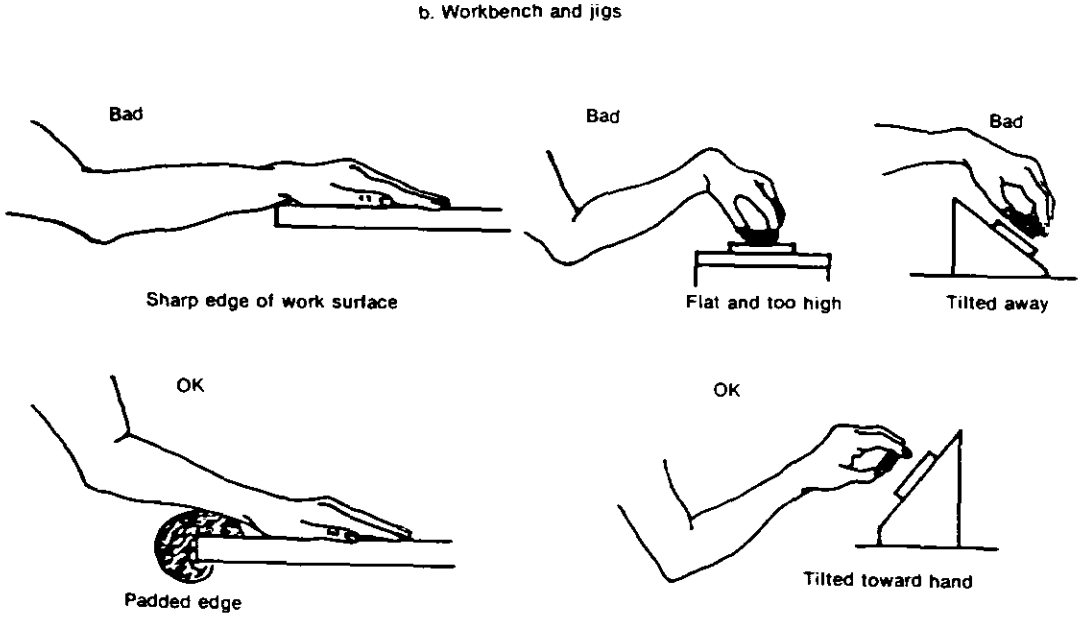
SOURCE: (21)

to 0.79 in 1981. Lost and restricted workdays fell from 5,471 in 1979 to 1,111 in 1981, and further reductions were expected in subsequent years.

Figure 7-7.—Good and Bad Designs for Containers and Workbenches



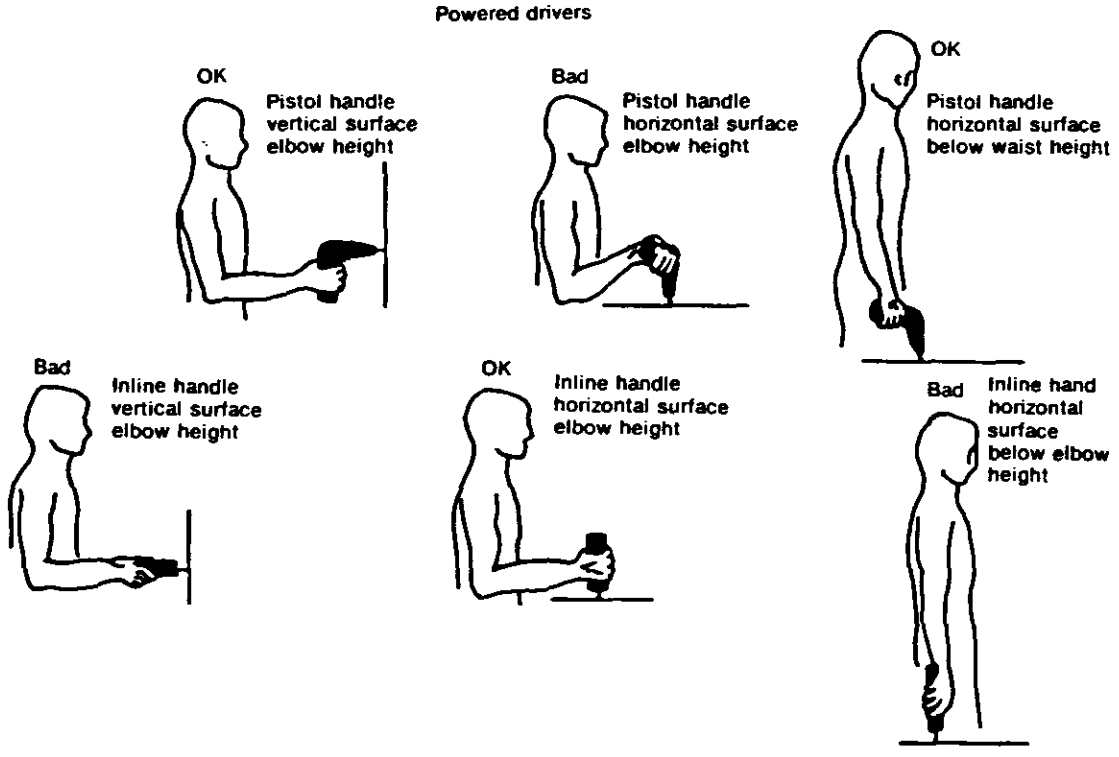
Containers should be designed so that workers can reach all locations without flexing their wrist. All edges that come into contact with the worker should be well rounded.



Jigs should be located and oriented so that parts can be assembled without flexing the wrist.

SOURCE: (21).

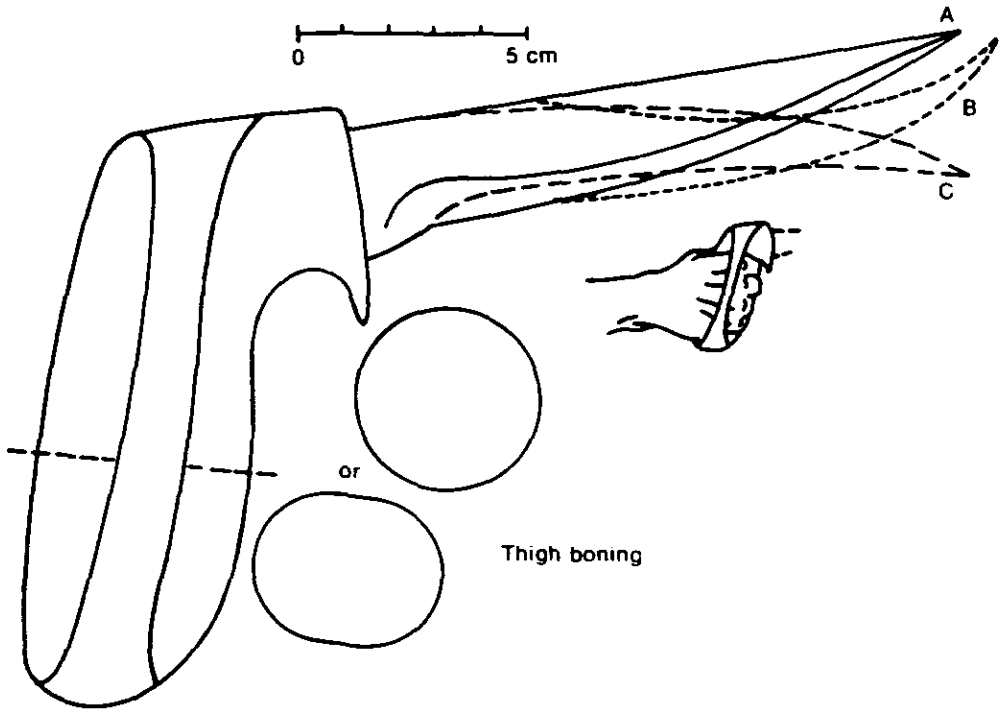
Figure 7-8.—Good and Bad Designs for Powered Drivers



Wrist posture is determined by the elevation and orientation of the work surface with respect to the workers and the shape of the tool.

SOURCE: (21)

Figure 7-9.—A Knife Designed to Reduce Cumulative Trauma Disorders in Poultry Processing



One possible knife handle with three blades for reduced wrist deviations. The handle is designed to reduce the tendency for the knife to fall out of the hand in thigh boning.

SOURCE: (22)

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