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Occupational Cumulative Trauma Disorders: Prevention and Treatment

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OCCUPATIONAL CUMULATIVE TRAUMA DISORDERS:

PREVENTION AND TREATMENT

by

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This Independent Study, submitted by Michelle S. Uyeno in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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ABSTRACT

Cumulative Trauma Disorders (CTDs) consist of a group of musculoskeletal injuries caused by overuse or repetitive strain. The purpose of this Independent Study was to review the literature concerning occupational CTDs, the methods of prevention, and treatment as it related to physical therapy. The most beneficial means of controlling CTDs appear to be taking preventative measures with jobsite analysis and employee education. Treatment is varied and dependent upon the actual diagnosis and causative factor. Therapists may attempt heat or cold modalities, work hardening programs, or manual therapy such as strain-counterstrain. An important aspect to treatment is early intervention. Due to the high prevalence of CTDs, it is important for therapists to become aware of its presence, learn to effectively determine the mode of injury, and appropriately treat the injured patient.

CHAPTER ONE

INTRODUCTION

Cumulative trauma disorders (CTDs) have been referred to as "a fact of life"[1], "the industrial injury of the Information Age"[2], and "the epidemic of the 1990s'"[2]. Other synonyms for CTDs are "repetitive strain injuries, repetitive motion disorders, overuse syndromes, occupational rheumatic disease or occupational musculoskeletal disorders".[2] CTDs consist of a group of musculoskeletal injuries which are caused by numerous repeated motions.[2-5] The overuse of muscles produces inflammation, pain and swelling, resulting in possible peripheral nerve entrapment.[2,4] Some examples include carpal tunnel syndrome, epicondylitis, tendonitis, and tenosynovitis.[5-6]

The high prevalence of CTDs has been seen in workers who participate in high-speed and high force repetitive activities for lengthy, uninterrupted periods such as keyboard operators, meat cutters, manufacturing assemblers, and textile mill workers.[2-4,7] These jobs usually necessitate prolonged static posturing in awkward positions or other sustained loading leading to injury, muscle stress and fatigue.[3-5,8]

CTDs may affect a variety of body sites, however, a common location is the upper extremity.[3] This is believed to be a result of the increasing number of jobs requiring "paced or work-driven execution of a limited number of relatively fine motor movements of the hands and arms"[4] and to changes in the business industry attributed to technological progress. CTDs were the quickest growing occupational injury in the 1980s, climbing from 18 percent in 1981 to over 50 percent in 1989.[9] Diagnosis and management of upper extremity pain in the work place had become a nationwide priority by the mid-1980s.[10] Between 1985 and 1989, the number of reported CTDs among workers had risen almost fourfold.[11]

The Occupational Safety and Health Act of 1970 established the Occupational Safety and Health Administration (OSHA) in the Department of Labor and the National Institute for Occupational Safety and Health (NIOSH) in the Department of Health and Human Services. OSHA was created to enforce the act, to "(1) encourage employers and employees to reduce hazards in the workplace and to implement new or improved safety and health programs; (2) develop mandatory job safety and health standards and enforce them effectively; (3) establish 'separate but dependent responsibilities and rights' for employers and employees for the achievement of better safety and health conditions; (4) establish reporting and recordkeeping procedures to monitor job-related injuries and illnesses; and (5) encourage states to assume the fullest responsibility for establishing and administering their own occupational and health programs, which must be at least as effective as the federal program."[8]

NIOSH is in charge of directing research in the prevention of occupational disease and injury. The top two priority research topics listed by NIOSH are occupational lung diseases and musculoskeletal disorders resulting from repetitive motion. NIOSH investigates workplaces upon request and identifies any hazardous conditions. Unlike OSHA, NIOSH cannot give citations or fines if any violations are discovered. It can and will, however, warn the employers and employees, recommend methods to prevent or control the problems, and notify the Department of Labor. NIOSH also conducts health surveillance to ascertain the number of employees subjected to specific hazards, the industries they work in, and the type of work they participate in.[8,12]

The purpose of this independent study is to review the literature concerning occupational cumulative trauma disorders, the methods of prevention, and treatment as it relates to physical therapy. The questions which will be considered are as listed.

1. What are cumulative trauma disorders?
2. What are the pathophysiological mechanisms of cumulative trauma disorders?

3. How are cumulative trauma disorders diagnosed?
4. How can cumulative trauma disorders be prevented?
5. What are the current techniques used in treating cumulative trauma disorders?

As companies become more aware of the actions they may take to improve conditions at the work site, there will be an increased need for therapists in many areas of ergonomics. Ergonomics examines the relations between man, work, and the work environment. It includes the physiological and physical engineering principles to bring about safe and efficient functional movements at work.

This independent study combines the two topics of ergonomics and CTDs. It intends to serve as a guide, giving therapists a comprehensive review in the hopes of decreasing the high prevalence of CTDs by prevention with changes in body mechanics or at the work site. It also intends to improve patient care with early recognition, correct diagnosis, and appropriate treatment.

CHAPTER TWO

PATHOPHYSIOLOGY

Idler[3] describes the pathophysiology of tissue injury in CTDs as multifactorial. Although the living tissue is remarkable in its capacity to heal, there are limits to its functioning properties. The first mechanism of tissue injury relates to the rate of repair. If the rate of repair is faster than the rate of tissue breakdown, injury is avoided.

The second mechanism pertains to nutrition. All tissues are dependent upon nutrition for survival. The transfer of nutrients to tissues occurs by diffusion or vascular perfusion. With sustained compression or tension on a tissue, the supply of nutrients may be compromised. The prolonged pressure could lead to ischemia and to tissue damage.[3]

The third mechanism involves friction. Tendons, at certain locations, are subjected to shifts in direction along pulley systems or bony eminences. In some instances, there may be a greater amount of tension in these areas. Injury occurs when there is a disruption in the tissues that normally control the smooth motion of the tendons.[3]

Since there are differing types of CTDs and causes on a more cellular level, only strain will be discussed specifically. In 1989, Jacobson[13] published an article regarding shoulder pain due to repetitive strain injuries. Strain can be defined as "trauma to the muscle or the musculotendinous unit from violent contraction or excessive forcible stretch."[14] It may be also due to overuse, presenting with a history of progressive aggravation to an area. Strains can develop in conjunction with injuries such as a hit to the back, a "tearing sensation while lifting"[15], or other types of traumatic events. Jacobson[13] explained that while the muscle and tendon of the supraspinatus are utilized often, not enough time is allowed for rest. This leads to mechanical strain and, later, the development of edema and inflammation. Injury, however, is not limited to the supraspinatus. Microtrauma to this site causes the contraction of antagonistic muscles. These muscles react by immobilizing the joint. Due to the sustained contraction, the antagonistic muscles will eventually also undergo injury.

When pain is present, it may be accompanied by muscle guarding and spasm. Unless this is controlled, a cycle may occur whereby pain and muscle spasm are constantly present. As the muscle spasms, circulation is compromised. Waste products accumulate which the nerve interprets as pain causing the muscle to remain tight. Inflammation occurs due to the persistent guarding or chronic stress.[15]

Jones[16] theorizes that the primary ending in a muscle spindle is responsible for the muscular dysfunction. The primary ending monitors both velocity and length (joint motion and joint position). He visualizes a joint in which one muscle spindle is stretched while the opposing muscle spindle is shortened. The shortened side receives little to no proprioceptive input. Reciprocal inhibition occurs on the stretched side with low firing of impulses. Strain causes the body to respond to an overstretch by forcefully straightening the corresponding joint. This results in further shortening of the already shortened muscle and its proprioceptors. The proprioceptors begin "to report strain even before"[16] reaching normal length. The body interprets the action as strain although there is none and the inappropriate message cannot be extinguished without treatment.

Spindle discharges are affected by intrafusal muscle fibers. Contraction of the fibers lengthens the central section where the sensory endings are located and, when stretched, increases spindle firing. Increase in muscle length also produces the same effect: stretching of the muscle causes contraction of the intrafusal muscle fibers and induces a heightened spindle firing than when the fibers are at rest.

The gamma neurons, in turn, influence contraction of the intrafusal fibers. Because of this, it affects the frequency of the spindle firing at a given muscle length and the sensitivity (seen as change in the frequency per millimeter change in length). With increased gamma activity, there is a greater spindle reaction.[17]

Korr[17] explains that if discharges of the gamma motorneurons are maintained at high frequencies, the intrafusal fibers of the muscle will be in a constant shortened state. This causes the discharge frequencies of the muscle spindles and their frequency change per millimeter to be exaggerated. He believes the high-frequency gamma firing may be induced with a "strong centrally ordered contraction during a movement when the muscular attachments (for example two vertebrae) have been closely and abruptly approximated by forces or factors that have not been centrally ordered."[17] These factors may be due to external forces or impact or by an unexpected easing of a load resisting a strong isometric contraction. With the abrupt yielding, the spindles would be also quieted as quickly.

> In calling (or continuing to call) on the slackened, silent muscle for strong contraction via the alpha motoneurons, the CNS, receiving no feedback, would also greatly increase the gamma discharge to the intrafusal fibers until the spindles resumed their reporting.
>
> On recoil (or reflex recovery) of the body from the forced motion, return of the attachments (for example, the vertebrae) to their resting relationship would be opposed -- but not

> necessarily prevented -- by the now (reflexly) resistant muscle.[17]

Due to the effect of gravitational forces, antagonists, and postural reflexes, the spindle would be constantly firing and directing the muscle to oppose. With increased stretch, there is even greater resistance. The greater the resistance (contractile tension), the more the joint surfaces would be pressed together and their frictional resistance increased.

It is thought that if the CNS fails to increase the gamma firing when the spindle is quieted secondary to the significant shortening of the muscle, this results in the nonreporting of the spindles, making the muscle indifferent to length changes. The combining factors of strong contraction and slack-induced spindle-silence could act to increase the spindle gain. The spindles would incorrectly convey messages to the spinal cord that the muscle which was actually in a shortened state, was extended to almost its total length.[17]

The theories help explain proprioceptor and somatic dysfunction and support the strain-counterstrain technique to treat the dysfunction. The technique will be discussed briefly in Chapter 5.

CHAPTER THREE

DIAGNOSIS

There are three general stages of CTD development. In the first stage, the patient experiences fatigue characterized by a greater amount of aching and tiredness during the work shift. The symptoms abate with overnight rest and days off from work. There is no significant loss noted in work productivity and no physical indications. Stage one may last from a few weeks to months, however, it is reversible. It is during this stage that the signs should be recognized as a warning to protect the body site from potential injury.[4,5]

The symptoms do not abate with overnight rest in stage two and often persist to the next day. Onset of fatigue in the work day occurs earlier than in stage one. Sleep may be interrupted. It is during this stage that the injury is actually developing. The employee may demonstrate a reduced capacity to perform repetitive work, and there may be physical signs of the injury. Immediate steps are necessary to reduce the strain at the affected site by resting more often or avoiding the motion causing the strain with changes in the work procedure.[4,5]

In the last stage, the aching, tiredness, and weakness persist regardless of rest. The symptoms are considered chronic. Pain continues to plague the employee even during nonwork activities. Physical signs are present, and the employee may be at this stage for months to years.[4,5]

Before determining if an injury is work-related, the following concerns must be addressed: "1) If a diagnosis can be made, is the problem a recognized cumulative trauma disorder? 2) Do the patient's symptoms occur while performing the job or did the onset of symptoms correlate with a change in the patient's work pattern? 3) Are other workers at the same job having similar problems? 4) Have contributing non-occupational factors been eliminated as a source of this patient's symptoms?"[3]

Obtaining a diagnosis can be difficult, because the onset of CTDs are subjective and gradual.[4] The terms CTD and repetitive strain injuries (RSI) are catchphrases for injuries caused by repetitious activities.[3] The terms are not diagnoses but "statements of causation, and of causation only".[13] Although the terms are needed for a full diagnosis, it is not enough. An identification of the injured tissue must take place, followed by the nature of the pathology, and the cause. Take, for instance, carpal tunnel syndrome. It may occur from a number of reasons such as pregnancy, rheumatoid arthritis, sports activities, and work. Using task analysis and elimination, the cause of carpal tunnel syndrome affecting a patient may be ascertained. By correctly identifying the specific cause of a diagnosis, the appropriate treatment and prevention from further injury can be implemented.

As in all medical situations, obtaining information through a history and physical examination is necessary.[3] The history portion should include a description of all previous jobs held, work exposures, timing of symptoms, epidemiology of symptoms or illness among other workers, and nonwork exposures and other factors.[3,18] A helpful technique to determine an appropriate diagnosis is to have the patient demonstrate the activities they perform at work. This will give the therapist an idea of what body parts are involved and how they may be exposed to repetitive strain.[4] All employees who participate in jobs which require postures involving elevated arms are at risk for developing CTDs of the upper extremity.[12]

During the physical examination, the most proximal pathology that may be responsible for the patient's symptoms must be determined. One way is to localize the site of tenderness.[3] By palpation[3,13], the tender area is found. When pressure is applied to the area, the patient is asked to move against resistance. Pain will be provoked if there is a muscle strain. The tendon may be inflamed by friction but usually will not illicit pain.[13] Other things to look for include swelling, redness, crepitance, triggering, decreased sensation, muscle weakness or atrophy, and loss of joint range of motion.[3,13]

COMMON CUMULATIVE TRAUMA DISORDERS OF THE UPPER EXTREMITY

Shoulder

Thoracic Outlet Syndrome (TOS)

TOS occurs when the brachial plexus and brachial artery (and its components) are squeezed between the neck and shoulder muscles. This leads to symptoms of "numbness, ischemia, and pain"[4] down the arm, primarily when the "shoulders are thrown back and the hand is raised."[4]

TOS is common in jobs that demand routine reaching above the shoulder level, carrying moderately heavy loads for long periods of time at the side of the body, wearing a backpack or other straps around the shoulder, or carrying objects in a fixed position at waist level. Diagnosis may be determined by clinical testing using the Adson's maneuver. The test is considered positive if the symptoms are reproduced and the pulse is weakened.[4,19]

Supraspinatus Tendonitis (Rotator Cuff Tendonitis)

Tendonitis is defined as an inflammation of a tendon. It is linked with "repeated tension, motion, bending, being in contact with a hard surface, vibration."[4,19] The tendon surface gets thick, bumpy, and unnatural. The fibers may be split or frayed. Calcification may also occur in tendons without sheaths, such as in the area of the shoulder or elbow.

The supraspinatus muscle initiates abduction of the arm. It is one of four muscles fused over the shoulder joint which forms the rotator cuff. The tendons of the cuff travel through a small passage between the humerus and the acromion. When the arm is lifted, the supraspinatus tendon is pressed against the acromion. If the tendon is inflamed, pain results with elevation.

The condition is found among employees who must sustain their shoulder in abduction with the elbow extended under loaded situations. Painters, construction workers, and welders are examples of employees at risk. A typical diagnostic feature is pain with elevation of the humerus from 70 to 100 degrees.[4,19]

Bicipital Tendonitis

This condition is often found simultaneously with supraspinatus tendonitis, although it may occur alone. It is similar to supraspinatus tendonitis in that it is identified with pain caused by movement of the glenohumeral joint. The biceps tendon passes over the bicipital groove and under the acromion. The mechanism of injury is the same as the previous condition.

Bicipital tendonitis is seen frequently in workers who must reach overhead. Examples of workers at risk are window washers, stockroom clerks, and construction workers.[4,19]

Elbow

Epicondylitis

Tennis elbow (lateral epicondylitis) and golfer's elbow (medial epicondylitis) are caused by irritation of the extensor and flexor tendons, respectively. Epicondylitis results from compressing or jerky throwing movements, repetitive supination and pronation, and vigorous extension/flexion of the wrist. Tennis elbow is seven to ten times more common than golfer's elbow. The symptoms include severe pain and tenderness over the epicondyle with increased discomfort when motion is resisted.[2,4,19]

The injury is thought to be due to small rips or microfibrillar breakdown at the tendinous origins. The rips are caused by an overload on the aging fibers. This results in inflammation and the development of granulation tissue.[2] The condition is common in employees such as small parts assemblers (turning screws), musicians, and woodworkers.[2,4,19]

Cubital Tunnel Syndrome

Cubital Tunnel syndrome involves the entrapment of the ulnar nerve at the medial surface of the elbow. The symptoms experienced are medial elbow pain, tingling and numbness radiating to the ring and little fingers, and weakness of the hand. The onset occurs with repetitive activity of flexion and extension of the elbow against resistance. It may be seen in employees who rest their proximal forearm on a firm surface or sharp edge or those who must reach over an obstruction.

A diagnosis can be made with a corresponding history and physical findings. Usually present is a Tinel's sign, tingling on percussion, over the ulnar nerve.[2,19]

Forearm

Pronator (Teres) Syndrome

Pronator syndrome results from the compression of the median nerve in the forearm. Pain develops on the volar surface and gets worse with activity. There may also be paresthesias and dysesthesias of the fingers innervated by the median nerve but should dissipate when the upper extremity is at rest.

The syndrome is common with strenuous flexion of the elbow and wrist. If a patient is seen during the painful episode, weakness of the thumb and index finger flexion may be exhibited. Confirmation of the clinical diagnosis is made with the results of electrodiagnostic studies. Typical job duties at risk include polishing, soldering, buffing and grinding.[2,19]

Radial Tunnel Syndrome

The syndrome is caused by the entrapment of the radial nerve in the forearm. Symptoms include a deep, aching pain in the forearm (radiating both proximally over the lateral arm and distally over the dorsolateral portions of the forearm), paresthesias, and dysesthesias.

The symptoms are brought about by repetitive resisted wrist extension and supination of the forearm. It may be alleviated with rest but reoccur when the offending activity is resumed. Often, the syndrome is mistakened for lateral epicondylitis. A differential diagnosis may be made by noting tenderness in the extensor muscles rather than at the lateral epicondyle.[2]

Wrist

de Quervain's Disease (or Syndrome)

de Quervain's disease is the most common type of stenosing tenosynovitis. In general, tenosynovitis occurs to the tendons within synovial sheaths. There is swelling in the sheath which hampers tendon movement. Stenosing synovitis occurs when the sheath presses into the tendon.

de Quervain's disease involves the abductor and extensor tendons of the thumb where they share a mutual sheath. The condition includes inflammation and effusion of the sheath. It is frequently seen in employees who perform repeated radial and ulnar motion.

Tenderness and pain are felt over the radial styloid process with thumb motions. There may also be a popping sensation when the thumb is flexed and adducted. Diagnosis may be made with a positive Finkelstein's test.

Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) occurs as a result of compression of the median nerve in the carpal tunnel of the wrist. The tunnel contains nine tendons, in addition to the median nerve. If there is an increase in size of one of the tendons' tenosynovium, pressure will be put on the nerve. Symptoms include numbness, tingling, and decreased sensation in the fingers.

The main causes of occupational CTS involve repetitive wrist flexion and extension, firm gripping with ulnar deviation, jolting forces on the palm, and vibrating forces. There may be changes noted in hand dexterity, such as holding objects, driving, and penmanship. Examples of provoking activities include typing, playing musical instruments, and hammering.

A diagnosis is made with several tests. A Tinel's sign may be found over the median nerve. In the Phalen's test, tingling is felt with gravity-maintained wrist flexion. Weakness of the thenar muscles and an increase in spacing for two-point discrimination along the median nerve sensory distribution are other means of confirming CTS.[2,4,19,20]

Hand

Trigger Finger

Trigger finger is a type of tenosynovitis in which the flexor tendons of the finger are constrained within the "fibrous annular pulleys".[2] The tendon becomes almost locked, so that forced movement causes a jerky, snapping motion. Symptoms include pain and tenderness over the pulley area, followed by the afore mentioned locking sensation in flexion.

Employees with this condition usually have a history of activities requiring repetitive gripping. Examples include "operating finger trigger, using hand tools that have sharp edges pressing in the tissue or whose handles are too far apart for the user's hand"[19] so that the distal interphalangeal joints of the fingers are flexed while the proximal interphalangeal joints are extended.

Once a diagnosis has been made, and it has been established that the medical problem is caused by work situations, the following questions are raised: "1) Is that person physically incapable of performing the job? 2) Are there structural or physiological factors that make this person predisposed to developing cumulative trauma disorders? 3) Are improper body mechanics involved in the way that person performs the job? 4) Are the physiological demands of that job excessive for anyone? 5) What are the effects of aging on that person's ability to perform the job?"[3] The answers to these will give the physical therapist, employee, and employer ideas for possible treatment and prevention of reinjury.[2]

CHAPTER FOUR

PREVENTION

The simplest technique of managing CTDs is prevention. Prevention may be achieved by making employees and employers aware of work related health problems, by research on hazards and their control, and by government regulations. Health professionals play a vital role by looking beyond the patient they are treating to consider other employees who may be at risk and then taking appropriate measures to prevent the occurrence.[8]

Methods of preventing CTDs may be placed into one of two categories: methods that primarily affect the workplace and methods that primarily affect the employee. The former category is thought to be more effective in prevention.[8]

Levy[8] describes three methods of prevention which primarily affect the workplace. These methods act to decrease or remove potential hazards in the workplace by altering the workplace environment or work processes. The methods incorporate the goal of a true ergonomic program which aims to make the workplace adaptable to fit the worker.

The first method involves substituting a nonhazardous substance for a hazardous one. Although the substitution seems advantageous, this method is not without its drawbacks. In some situations, the substituted material may not have been sufficiently examined for negative health effects and may be harmful as well. An example is carbon tetrachloride. The substance was to be used as a nonflammable cleaning solution. It was later discovered that the solvent caused problems such as hepatotoxicity.

Another method involves changing work practices. Take for instance the case of working with asbestos. In the process of asbestos removal, it would decrease the risk of hazards if the material was wet rather than dry.

The third method of prevention includes the installation of engineering controls and devices. Examples of these are exhaust systems that eliminate hazardous dusts, soundproofing equipment to decrease loud noise, and enclosures that confine dangerous processes. Obstacles to the implementation of this technique are the cost of installation and the lack of knowledge that such options are available.

Changes may be made to the design of the workstation itself. A well designed workstation has the potential to promote ease and efficiency. If the employee is uncomfortable or procedures are awkward, productivity will be affected by decreases in quality and/or quantity. The employee's well being may also be affected.

There are six general principles regarding the design of a workstation:[21]

1. Plan the ideal, then the practical.
2. Plan the whole, then the detail.
3. Plan the work process and equipment around the system requirements.
4. Plan the workplace layout around the process and equipment.
5. Plan the final enclosure around the workplace layout.
6. Use mockups to evaluate alternative solutions and to check the final design.

There are other facets to the design which must be taken into consideration. These include space for changing body positions as well as suitable body postures, operation of equipment without colliding into objects with elbows and knees, and avoiding excessive forces. Attention should also be given to the operation of tools and controls by hand or foot, seat adjustment, emergency items, and visual and auditory information or communication.[21] The workstation, methods of recognizing risks, and recommended specifications will be discussed in further detail later in this chapter.

Methods of prevention, which primarily affect the employee, act to decrease the damage from potential hazards at the workplace without the actual removal of the problem source. Injuries can be reduced with the use of personal protective equipment. This includes earplugs, gloves, and protective clothing. Gloves, for example, may cut down on vibratory forces, which are a risk factor for CTDs. Problems with this method are seen in noncompliance, inappropriate fit of equipment, and the high cost associated with effective programs.[8]

An important aspect to prevention is education and advice regarding particular work hazards. Employees should be given ample information about the hazards and ways to reduce their risks. A large number of safety tactics require changes in employee behavior which also necessitates education or training. Lack of awareness poses potential risks not only to the employee but also to their co-workers.[8]

Employees should be advised to avoid seven specific conditions to prevent development of CTDs.[19]

1. Job activities with many repetitions.
2. Work that requires prolonged or repetitive exertion of more than about one-third of the operator's static muscular strength available for that activity.

3. Putting body segments in an extreme position, such as severely bending the wrist.
4. Work that makes a person maintain the same body posture for long periods of time.
5. Pressure from tools or work equipment on tissues (muscles, tendons), nerves, or blood vessels.
6. Work in which a tool vibrates the body or part of the body.
7. Exposure of working body segments to cold, including airflow from pneumatic tools.

Raniere[22] states that close examination of the workplace is necessary to help employers decrease injuries. Levy[8] also advocates screening for early detection of disease. This is the role of ergonomists. There are two recurrent goals of ergonomists. The first is to evaluate the levels and types of stressors that are found in the work place and the methods with which employees deal with these stressors. The second goal is to match the demands of the job to the abilities of the employee or simply, to fit the job to the worker. Both goals may be achieved by analyzing the conditions at work. The ergonomist may view the total work situation and obtain a better perspective on the environment as well as the job requirements. Particular attention should be given to changes implemented by the employee at the worksite such as extra padding to chairs. These types of creative modifications indicate potential ergonomic hazards.[8,22-24]

Analysis may be accomplished with the aid of checklists. Checklists are designed as initial screening tools in hopes of improving conditions at work. There are a number of different checklists which may be used. Some are more general in nature, while others specific in their objective. Included in Appendix A are examples of checklists to help the ergonomist with worksite analysis.[12,24] Other checklists may be located in publications from Eastman-Kodak, the National Safety Council, and OSHA 3123.[23]

Keyserling[24] developed a checklist for "determining the presence of ergonomic risk factors associated with the development of upper extremity cumulative trauma disorders" and evaluated the checklist as part of an ergonomics intervention program. The results gathered from the checklist were compared to analyses completed by health professionals with Masters degrees in occupational ergonomics. The outcome of the study showed that the results from the checklist were generally in accordance with the results of the ergonomists. The checklist was found to be more sensitive in recognizing risk factors. It was also found to be effective as a quick screening tool for recognizing jobs that expose employees to potentially harmful ergonomic stresses. The checklist was limited by its inability to sufficiently identify specific job features which are associated with the ergonomic hazards.

Another method of jobsite analysis is surveillance. Ergonomists may also choose to take a passive route by reviewing records such as insurance claims, safety records, illness, absenteeism, and OSHA 200 logs. Use of this type of information can determine patterns in occupation related health problems.

Passive surveillance discovers high risk areas. It finds the highest incidence rate of CTDs (the number of cases per people at risk for a given time period). Although this method is low in cost, it does have its drawbacks. Limitations such as underreporting, disease misclassification, and exposure misclassification can hinder identification of high risk areas.[6,25]

Underreporting may result from employees who do not seek health care because of ignorance or fear of employer retaliation, no access to employee health departments, or differing interpretation about when a CTD case should be recorded on the OSHA 200 log. Disease misclassification occurs when a CTD case is reported as something other than a "disorder due to repeated trauma." Exposure misclassification occurs when the employee uses a general term to describe their job title. An example of this is an employee in the meatpacking industry. He may report his job title as being a "cutter." The plant may have 20 distinct cutting jobs. Each of these jobs may have its own ergonomic hazards. Without knowing exactly what he does, an ergonomist would be unable to accurately identify high risk jobs.[25]

Because of the problems with passive surveillance, active surveillance should be considered. In this method a survey is given to employees who are thought to be at risk. The survey asks pertinent questions regarding symptoms which are associated with CTDs. These questions should try to determine when and where problems occur and what the employee thinks is responsible for the problem. The survey should be short and understandable, including in it body diagrams to identify symptomatic areas. It should also be anonymous.[6,25]

The main purpose of active surveillance is, like passive surveillance, to identify high risk jobs for intervention. The data gained from the surveys may be used for other purposes such as monitoring the effectiveness of ergonomic interventions, finding unrecognized hazards, and serving a triage function for employees needing health care evaluations.[25]

Rosecrance[26] attempted to develop and employ a multistaged active surveillance program for the management and control of CTDs in the newspaper industry. The program was utilized in three newspaper companies with a total of 1,150 employees. The study integrated the use of symptom and job factor questionnaires, specific anatomical surveys, and clinical detection tests. The results of the study provided the researchers with information to help identify musculoskeletal problems in the workplace and provide suggestions as to possible contributors to the problem. Also, the researchers viewed the program as a cost-effective means to help with managing CTDs in the workplace.

Pictures and video tapes are commonly used in the workplace and can be an invaluable source for analysis. Pictures should be taken of the worksite and the employees at work. A camera and a tape measure can determine heights of tables and chairs and help to identify awkward lifts, postures, and unusual reaches. Videotaping works in the same fashion as the camera, but it allows for the ergonomist to slow down the task sequences and more closely observe the job.[22,27]

Once hazards are identified, changes need to be implemented. The following are ergonomic guidelines for a video display terminal (VDT) worksite. Raniere[22] reported that lateral reaches should be kept under or about 18 inches, and lifts should be limited to between the knees and shoulders. Work station levels should be adjustable for seated and standing work. For seated work, adjustable chairs with footrests are suggested. This includes adjustable seat and backrest. Recommended seat heights are between 20 and 26 inches.

Proper work chairs are an important tool at the jobsite. A seated person who is uncomfortable may or may not be cognizant of their discomfort at all times. Regardless, their concentration spans will be shorter and alertness may be decreased. A well designed chair can positively "affect posture, circulation, the amount of effort required to maintain a position, and the amount of pressure on the spine."[28] Basic ergonomic requirements for work chairs include safety, adaptability, comfort, practicality, durability, and suitability for the job.[29] Zenz[28] gives these recommendations:

1. The seat should adapt to the user, not vice versa.
2. Chairs should be stable and fully and easily adjustable from the seated position.
3. Seat pans and backrests should be upholstered and covered in a material which absorbs perspiration. They should be firm, with a compression of about 20 mm.
4. Seat pan height should be adjustable and should transfer the user's weight through the buttocks, not the thighs.
5. Backrests should adjust up and down and backward and forward for good lumbar support.

6. Where mobility is required, wheels or casters should be fitted to the chair (hard casters for soft floors and soft casters for hard floors). There are exceptions to this--for example, where a slippery floor makes it difficult to keep the chair in the desired position. Where wheels or casters are fitted, seats should preferably have five legs. This offers stability and reduces the risk of tipping over.
7. Seating should provide sufficient clearance for the flesh of the thigh in order to prevent reduction of blood circulation. The front of the seat should be of a "waterfall" design.
8. For tasks requiring frequent lateral movements, seats should swivel.

Keyboard design and use has been found to play a definite role in generating CTD symptoms. Predictors of medical symptoms may be seen in faulty body positions of prolonged periods of shoulder abduction, ulnar deviation of the wrist (palm down, hand turned out), and wrist extension (palm down, back of hand turned upward). Zenz[28] suggests correction of the positions by repositioning of the keyboard. To correct shoulder abduction, the keyboard should be near the front edge of the table. To correct ulnar deviation, have the keyboard in a movable horizontal plane. To correct wrist pronation and extension, the keyboard should be tilted. Table 4-1 illustrates current work station specifications and offers recommendations for the work station.

Table 4-1[28]

Comparison of Work Station, With Recommended Specifications

FEATURE	PRESENT WORK STATION SPECIFICATIONS	RECOMMENDED SPECIFICATIONS	PROPOSED WORK STATION SPECIFICATIONS
	Workbench		
Head tilt of worker	30-45 degrees	15 degrees maximum	0-10 degrees
Height of work station	34 in	27.5-34.5 in	26.75 in adjustable
Undersurface of work station	32.75 in	25 in minimum	25.75 in
Depth of work surface	28 in	*	31.5-34 in
Depth of surface area after setup	16 in	*	18.6-23.6 in plus cart area
Total surface area available after setup	680 sq in	*	1,680 sq in
Reach	16-24 in	23.3 in	22-29.5 in
	Chair		
Height of chair	24.6 in	13-18 in	17 in
Pan dimensions	16.5 in	15-19 in	17 in
Seat width	17 in	15.7 in minimum	17.5 in
Contour	none	front	front and rear
Backrest	4.5-10.7 in	4.2-9.5 in above seat pan	3.6-5.6 in
Width of backrest	14 in	15 in maximum	11-13 in
Movement	Seat does not swivel	360 degrees	360 degrees
Cushioning	2.5 in	0.75-1.5 in	1.5 in
	Visual aid		
Visual angles re: Character, height, and retinal image	9 min (1 mm) (using prints)	16 min minimum	20.8 min minimum (4 mm) (using microfiche)
Optimal visual zone (on the microfiche viewer)	32-45.9 in	32-45.9 in	33-44.5 in
Noise levels	72 dBA	66-80 dBA	80 dBA maximum
Illumination			
With overhead task lamp on	69 fc	100-150 fc	100-150 fc
With overhead task lamp off	40 fc	100-150 fc	100-150 fc

*Dependent upon the specific user group.

Abbreviations: in = inches; min = minutes; dBA = decibels on the A scale; fc = footcandles.

Injuries will never fully be eliminated in the workplace, however, the rates of incidence and severity can be controlled. It is hoped that the methods of prevention will give the ergonomist an array of ideas to implement with which to limit the occurrence of CTDs.

CHAPTER FIVE

TREATMENT

The treatment of CTDs may include physical therapy, splints, job adjustments, injections, and surgical management. Because the term CTDs encompasses a variety of diagnoses, it must be remembered that the treatment for each case will depend upon the actual type of CTD the patient may have.

Modalities are commonly utilized. Hales and Bertsche[25] recommend the application of cold and heat. Cold is used in treating conditions involving tendon and joint related disorders for decreasing pain and swelling. Cold will also decrease inflammation if no external indications of inflammation are noticeable, such as erythema, swelling, and warmth. Cold is often used in cases of acute trauma because "1) the resulting arteriolar vasoconstriction reduces bleeding, 2) the decrease in metabolism and vasoactive agents (e.g., histamine) reduces inflammation and outward fluid filtration, and 3) elevation of the pain threshold affords the patient more comfort."[30] It may be administered by a number of means. These include cold packs, ice massage, cold baths, and vapocoolant sprays.

Heat is used to treat muscle related disorders such as muscle spasms or tension neck syndrome.[25] It is applied to enhance relaxation, decrease pain, increase blood flow, and aid in altering the viscoelastic qualities of collagen to increase range of motion with stretching. Examples of heat agents are hot packs, ultrasound, and diathermy.[30]

Treatments requiring hands-on therapy are another option. One method which has gained attention in the past few years is strain-counterstrain. This technique, developed by Dr. Lawrence H. Jones, is defined as "a passive positional procedure that places the body in a position of greatest comfort."[16] By correct positioning, the pain is thought to be relieved when inappropriate proprioceptor activity, which sustains somatic dysfunction, is decreased or eliminated.[16] The actual mechanism of how the technique works is unclear, although most texts believe the cause is through a gamma loop neuromuscular effect.

> When a muscle is under strain, the affected muscle's proprioceptors (the muscle spindles) are discharging at an increased frequency. When the muscle is in a shortened, comfortable position, the proprioceptors will cease their abnormal activity.[13]

Comfort is achieved by returning the body to the original position of strain. When the body is placed in a position in which the dysfunctioning muscle is shortened, the abnormal activity of the primary and secondary ending stops. Jones recommends the position to be sustained for a minimum of 90 seconds. The body is then returned to a neutral position very slowly so as not to stimulate the dysfunction again.

The tender points, areas of edema, tenseness and tenderness, are located and monitored to determine changes in tissue tension (i.e. softening, decrease of "bogginess" following treatment). Palpation of the area while positioning the body will ascertain the appropriate posture for correction. If the tender point decreases in tenderness by at least 2/3, it is considered ideal. After 90 seconds, the tender point is rechecked and considered successful if the tenderness has decreased a minimum of 70%.[16] The point may be sore, but the sharp pain should be alleviated. Patients are given home stretching exercises using isometric contractions, and modifications of the work posture should be made.[13] Other options are gentle stretching and massage.

Immobilization is another method of treating CTDs. In the case of CTS, splinting is used to prevent wrist flexion and extension. The splint, according to Schenck[20], decreases the "irritative stimulus from motion." It is suggested that the splints be worn off the job or at night. The splints should hold the joint in a neutral position to deter workers from participating in activities which may exacerbate their CTDs. Splints should not be worn on the job since symptoms may also be exacerbated when the worker attempts to perform their task, using increased force in order to overcome the splint. Other joint areas might be affected as well when the worker changes their technique in performance.[31]

Rempel[32], et al, studied the effect of wearing a flexible splint on carpal tunnel pressure during repetitive hand activities. Patients with CTS have higher carpal tunnel pressure than normal. It was unknown how repetitive motion affected the pressure and whether or not a wrist splint could impact the effect. A comparison was made using carpal tunnel pressure without a wrist splint as the baseline. The participants loaded and unloaded one pound cans from a box at a rate of 20 cans per minute for 5 minutes. The data gathered indicated that median carpal tunnel pressure during activity was the same regardless of splinting. Although the median nerve is exposed to increased pressure within the carpal tunnel during repetitive hand activity, limiting range of motion with the splint had no significant impact on carpal tunnel pressure.[32]

CTDs may also be controlled with the aid of ergonomic equipment as stated in Chapter Four. Table 5-1 illustrates common problems of a worksite and the means to remedy the situation.

Although these adaptations are helpful, to obtain the maximal benefits of the equipment education is necessary. Green and Briggs[7], through questionnaires, evaluated 514 keyboard operators with adjustable

Table 5-1[33]

Common Ergonomic Concerns and Corrective Measures

Problems	Recommendations
Chair not adjusted; feet not flat on the floor; inadequate lumbar support.	1) Adjust height and position of chair so that feet are flat on floor, arms are close to the body. 2) Adequate lumbar support by using a rolled towel, pillow, cushion, or lumbar support. 3) Footrest. 4) Employee education on adjusting chair and the importance of assuming varied postures throughout the course of any day.
Keyboard too high, causing wrists and elbows to be in non-neutral positions; reaching motions.	1) Lower keyboard by using desk drawer, articulating shelf, or lowering desk or table; or raise chair and use a footrest. 2) Position keyboard and other input devices to avoid reaching motions. 3) Employee education on reasons for setting up areas to foster neutral body positions. 4) Work practice changes so that no one position is assumed for long periods of time.
Terminal screen too low.	1) Raise terminal by using terminal stand, wooden box, or two leveled stand.
Contact with sharp edges.	1) Pad edge of table or desk with foam rubber, cushion, towel, or wrist support. 2) Employee education on how to set up work area, symptoms, reasons for symptoms, and ways to avoid discomfort.

workstations. Between sufferers and non-sufferers of overuse injury, they found no difference on the basis of adjustability of their equipment. The study did show that suffers tended to be less satisfied with their equipment and there was indication of improper posturing. The results demonstrated the importance of education. Equipment alone cannot alleviate the problem. Training or information on workstation adjustment is necessary for correct usage by operators, and it is suggested the information be delivered verbally rather than in written form.

Ergonomic measures to avoid the motions causing the particular CTD may also be taken. Table 5-2 lists some techniques to avert recurrences of a few previously mentioned CTDs.

Table 5-2[20]

Methods of Avoiding Repetitive Strain Injuries

CTD	Avoid in General	Avoid in Particular
TOS	lifting of arms, carrying	shoulder flexion, arm hyperextension
Rotator Cuff Tendonitis	lifting of arms	arm abduction, elbow elevation
Epicondylitis	"bad backhand"	dorsiflexion, pronation
Pronator Syndrome	forearm pronation	rapid and forceful pronations, strong elbow and wrist flexion
de Quervain's	finger flexion, wrist deviation	ulnar deviation, dorsal and palmar flexion, radial deviation with firm grip
CTS	rapid, often-repeated finger movements, wrist deviations	dorsal and palmar flexion, pinch grip, vibrations between 10 and 60 Hz
Trigger finger	digit flexion	flexion of distal phalanx alone

Generally, workers should participate in the infrequent usage of large muscle groups for short durations when performing activities. The wrists and forearm should be in line with one another. Forearms may be horizontal or slightly declined. Shoulders and upper arms should be relaxed.[20]

Another method of treating the injured worker is through a work hardening program. A work hardening program is defined by the AOTA commission as "an individualized, work-oriented activity process that involves a client in simulated or actual work tasks. These tasks are structured and graded progressively to increase psychological, physical and emotional tolerance and improve endurance and work feasibility."[34] Work hardening functions in the rehabilitation aspect of restoring the injured worker to work.[12] There are a number of different services available, however, the main goal inherent to all work hardening programs is to aid clients in reaching a degree of performance that is sufficient to compete in the job market. Effectiveness of the program depends upon how exact its execution corresponds with expectations. An example of this may be that 80% of the clients within a program will return to work upon finishing the program.[35]

Worker's compensation plays an important role in work hardening. Aside from the insurance carrier, there are a number of other individuals involved: the injured worker, the employer, the physician, attorneys, family, etc.[12] Work hardening serves to benefit all parties. For the injured worker, it allows the employee to return to work safely. Work tolerances are improved. Self-esteem and confidence is increased. The employer benefits by the reduction of medical costs, appropriate job placement, and a quicker return of the employee to work. The insurance carrier also benefits by the quick return to work. The "prompt and effective case resolution provides objective information of physical and functional abilities in relationship to ADL's and job performance."[36]

In order for injured workers to participate in a work hardening program, they must meet guidelines set out by the APTA.[37] (The guidelines do not specify whether or not all the criteria must be met.) The work hardening program can only begin once a work hardening assessment has been completed.

1. Have a targeted job or job plan for return to work at the time of discharge.
2. Have a stated or demonstrated willingness to participate.
3. Have identified physical (systemic neuromusculoskeletal), functional, behavioral, and vocational deficits that interfere with work.
4. Be at the point of resolution of the initial or principal injury at which participation in the work hardening program would not be prohibited.

Due to the numerous amount of external variables which are present, work hardening requires an interdisciplinary approach to healing the injured worker. Work hardening programs focuses on physical, functional, behavioral, and vocational needs.[12,35] This includes pain control, emotional support and stress management during the healing period.[4] In the comprehensive psychophysical model, the team may be comprised of physical therapists, occupational therapists, rehabilitation counselors, social service workers, and psychologists. This model demonstrates how a facility may deal quickly and effectively with any obstacles in treating the worker when the appropriate resources are available. There is a degree of cross-training which occurs, an overlapping to emphasize patient education, and it allows flexibility of schedules, "procedural reliability, and better understanding among the various professionals regarding each other's work."[12]

The importance of early intervention with the injured worker is gaining in attention. Traditionally, work hardening programs had not been initiated until the patient had reached maximal medical progress. It had been shown that the amount of time off work is inversely proportional to the rate of return to work. The more time a patient is off work, the less inclined that patient is to resume work.[12,38] It is estimated that 50% of injured workers can be returned to work on the same day of an initial evaluation with immediate intervention.[12] Programs may incorporate conditioning activities and work simulation at low intensity amounts during the medical treatment phase of recuperation. The goal of early intervention is to keep patients as active as possible, not allowing patients to assume a "sick role", and thereby returning them to work. Care must be given to permit enough time for structures to heal.[39]

Other treatments available to the patients include the use of nonsteroidal anti-inflammatory drugs (NSAIDs) and local infiltration with a corticosteroid preparation. These may ease pain by "local anti-inflammatory action or by acceleration of the microdegeneration of tendon fibers, which reduces tension."[2] Surgery may be necessary when nonoperative treatments have failed.

CHAPTER SIX

CONCLUSION

The information included in this paper is merely an overview of the more common CTDs. As one can see, the study of CTDs covers a broad spectrum of disorders and care. It makes it doubly important for physical therapists to effectively diagnose and treat each condition as it pertains to the individual injured worker. Therapists also must look beyond their health facility for patient care. Consider the injury and its specific cause. If, as in the case of CTDs, the injury is work related, therapists may find it necessary to visit the worksite and observe the movements of the worker. It may be necessary to change the work environment to better suit the employee and teach the employee techniques they may adapt. Patient education classes are not often enough. Other factors, such as cramped spaces and obstacles, may make it difficult for employees to incorporate proper positioning and body mechanics.

Many CTDs are already well known to therapists. These include TOS, rotator cuff tendonitis, lateral epicondylitis, and CTS. Therapists, however, may not have realized these disorders fall under a similar heading or have similar predisposing influences of repetitive overuse.

Treatment for these injuries, therefore, will be equally familiar to therapists. Heat, cold, and massage therapy are often used. Another technique which has been gaining attention is strain-counterstrain. This may not work in all cases. For those situations in which it is effective, treatment may be limited to a minimum of one 90 second session. Therapists may find this appealing and beneficial in terms of time management and cost effectiveness. Other methods discussed were work hardening programs frequently seen for the back injured worker and ergonomic adaptations.

Prevention of CTDs are by far the most effective method of treatment. This, again, may be resolved by ergonomic changes, such as adjustable chairs and desks. Employee education is an important option. Employees may be taught to avoid motions which may lead to CTDs and aggravation of pre-existing conditions.

Due to the high prevalence, therapists will be more likely to encounter these cases. CTDs may be present in a variety of professions. The level of physical demand is not a primary factor. CTDs affect not only the heavy manual worker but also key board operators and musicians. Therapists will be expected to recognize the disorders and competently treat the patients. Hopefully, this paper provides the reader with some insight to the growing problems and offers suggestion for the prevention and management of CTDs.

APPENDIX A

WORKPLACE CHECKLIST[23]

Physical Demands

__ Does the task require strenuous two-hand lifting?
__ Lifting at too great a horizontal distance
__ Lifting more than once per minute
__ Lifting over too great a vertical distance

__ Does the task require strenuous one-hand lifting and reaching? (Such as too long a reach feeding parts into a machine)

__ Are lifts awkward because they are near the floor, above the shoulders, or too far from the body?

__ Does the job require twisting while lifting?

__ Must the worker handle difficult-to-grasp items? (Are the items difficult to reach? Is the hand-hold poor?)

__ Does the job require continual manual handling of materials?

__ Does the job require handling of oversized objects?

__ Does the job require two-person lifting?

__ Must force be exerted in an awkward position (for example, to the side, overhead, or at extended reaches)?

__ Is help for heavy lifting or exerting force unavailable?

__ Does the job involve peak loads of muscular effort?

__ How often do peak loads occur?

__ How long do they last?

__ Can the job be designed to alternate periods of exertion and rest?

__ Can the job be designed to alternate periods of static effort and movement?

__ Is the pace of material handling determined by a machine? (Feeding machines, conveyors, etc.)

__ Does the job lack material handling aids such as air hoists or scissor tables?

__ Does the job involve static muscle loading (such as holding or carrying)?

__ Does the job involve the use of hand tools that are difficult to grasp?

__ Is there a high level of hand-tool vibration?

__ Must the worker stand on a hard surface for 45% or more or the work shift?

__ Is there frequent daily stair or ladder climbing?

INDICATORS OF THE NEED FOR TASK REDESIGN[28]

Is the operator required to lift and carry too much weight?

Is the operator required to push or pull carts, boxes, rolls of material, etc., that involve large break-away forces to get started?

Is the operator required to push or pull carts and hand trucks up or down ramps and inclines?

Does the task require the operator to apply pushing, pulling, lifting, or lowering forces while the body is bent, twisted, or stretched out?

Is the work pace rapid and not under the operator's control?

Does the operator's heart rate exceed 120 beats per minutes during task performance?

Do operator's complain that their fatigue allowances are insufficient?

Does the task require that one motion pattern be repetitively performed at a high frequency?

Does the task require the frequent use or manipulation of hand tools?

Does the task require both hands and both feet to continually operate controls or manipulate the work unit?

Is the operator required to maintain the same posture, either sitting or standing, all the time?

Is the operator required to mentally keep track of a changing work situation particularly as it concerns the status of several machines?

Is the rate at which the operator must process information likely to exceed his or her capability?

Does the operator have insufficient time to sense and respond to information signals that occur simultaneously from different machines?

INDICATORS OF THE NEED FOR WORK PLACE REDESIGN[28]

Do operators sit on the front edge of their chairs?

Must the operator assume an unnatural or stretched position to see dials, gauges, or parts of the work unit or to reach controls, materials, or parts of the work unit?

Is the operator required to operate foot pedals while standing?

Does the operation of foot pedals or knee switches prevent the operator from assuming a natural, comfortable posture?

Are foot pedals too small to allow foot position changes?

Is a footrest necessary?

Do operators frequently attempt to modify their work chair by adding cushions or pads?

Are operators required to hold up their arms or hands without the assistance of armrests?

Are dials and equipment controls difficult to operate or poorly labeled?

Do the design and layout of equipment hinder cleaning and maintenance activities?

Does the workplace appear unnecessarily cluttered?

Is the operator required to use a nonadjustable chair?

Can the operator be relieved of static holding work by providing clamps or supports for the work units?

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