Carpal Tunnel Syndrome Part I—The Problem

By Edward D. Dionne

When early Stone Age Man began chip-chip-chipping away while using ill-designed tools and poor job techniques to perform a repetitive task, he may have become the first victim of *Carpal Tunnel Syndrome* (CTS.)

Eons later, Carpal Tunnel Syndrome is still with us, and may be increasing for those same three basic reasons: Ill-designed tools, poor job techniques, and repetitive work processes involving the hands.

The carpal tunnel is a canal bordered on the bottom and sides by bone, and covered with a fibrous sheath called the *flexor retinaculum.* This canal leads from the forearm to the hand; the median nerve passes through it—well-protected under normal conditions, but still vulnerable to damage. One result can be CTS.

As explained for the layman by David Hinkamp, M.D., of the Division of Occupational Medicine at Chicago's Cook County Hospital:

CTS is a disorder caused by injury of the median nerve where it passes through the wrist on its way from the forearm to the hand. Injury to this nerve can cause impaired function. This condition is Carpal Tunnel Syndrome, which usually begins with a tingling, or numbness in the hand and fingers, and may progress to a loss of feeling, loss of grip, and, finally, a loss of some hand functions.

Down through the years, CTS's ramifications have extended into such varied trades and crafts as stone-cutting, weaving, garment-cutting, hand-sewing, meat and poultry processing, electronics assembly work, riveting, word processing, and the piloting of helicopters, to name but a very few affected occupations.

Indeed, the condition can affect virtually anyone involved with repetitive motions of the wrist area, whether one is performing a simple, direct hands-on work process, such as sorting and flipping mail, or whether one is holding a tool—customarily a pair of pliers, cutters, or screw driver, but keep in mind that for some workers the tool may be a control button, a pencil, a telephone, or an assembly part.

More than a century ago—in 1865—the first description of Carpal Tunnel Syndrome appeared in medical literature when Sir James Paget, in his surgical pathology lectures, described a condition where compression of the median nerve occurred following fracture of the wrist.[1]

Although early known to the medical profession, CTS only comparatively recently has attracted the attention of NIOSH, the insurance business, ergonomics engineers, tool manufacturers, and even the work glove industry. All are especially interested in CTS because its effects on employees can disrupt work schedules, affect production, and increase Workers' Compensation costs, in addition to causing personal suffering and disability.

Dr. Hinkamp further explains:

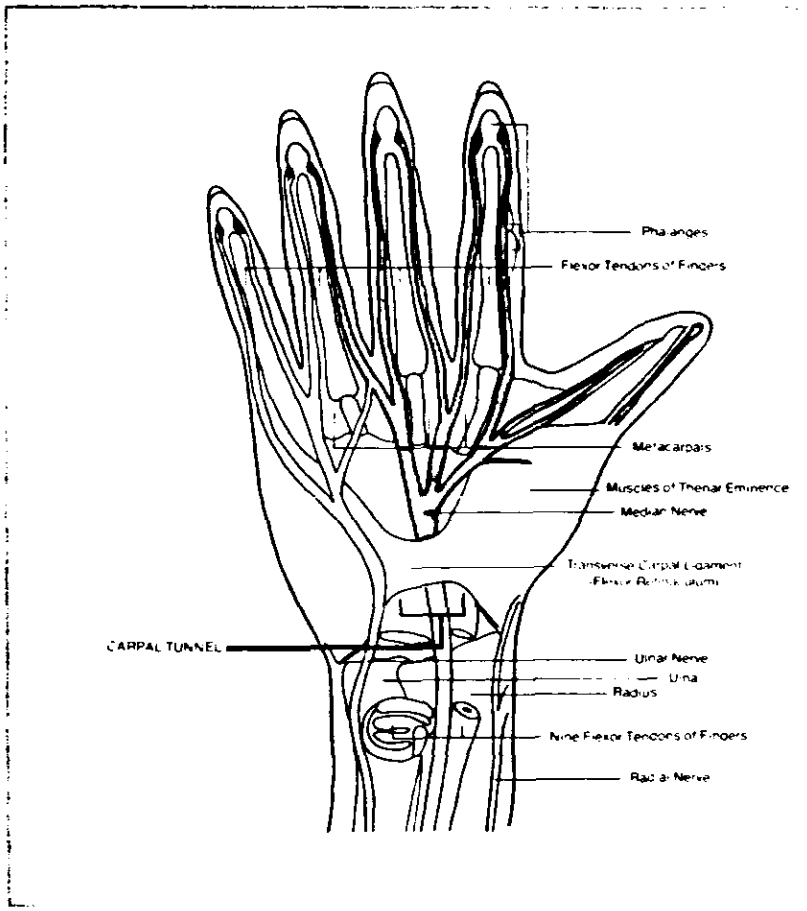
A person may first notice CTS as a tingling, numb, pins-and-needles sensation, usually occurring some hours after work or during sleep. This happens to everyone, occasionally, but it persists in the individual with CTS. The affected person may awaken regularly and have to shake his or her hand to help regain normal feeling. Then, as the syndrome progresses, this sensation becomes more frequent, eventually occurring in the daytime, too. Eventually, clumsiness and weakness also become evident.

A lot of people who have CTS attribute the numbness and tingling to arthritis or aging. And some people think that when they go to work, their hands will hurt, and that's just the way it is.[2]

Carpal Tunnel Syndrome disrupts work scheduling, affects production, increases compensation costs.

But, while numbness, tingling, and loss of function in the hands also can be caused by arthritis, diabetes, or other ailments, researchers also are finding many times that a person's work or hobby may involve repetitive activities that eventually can cause CTS, Dr. Hinkamp points out. Before coming to Cook County Hospital, he worked at the Universi-

EDITOR'S NOTE: This is Part I of a two-part article on Carpal Tunnel Syndrome. *Part II, "The Solution," will appear in the April issue of NSNEWS.*



Graphic illustrates palm view of the right hand, showing relationship of carpal tunnel, nerves, ligaments, tendons, muscles, and bones.

ty of Michigan with others early involved in such research.

One of those researchers is Thomas J. Armstrong, Ph.D., Associate Professor, Department of Environment and Industrial Health at the University of Michigan at Ann Arbor. A paper he recently authored,[3] when studied in conjunction with the accompanying illustrations, helps the industrial hygienist and safety specialist to understand further CTS.

Armstrong explains that CTS "is a disorder of the hand caused by injury to the median nerve inside the wrist. The median nerve is one of three major nerves of the upper extremity that contains motor, sensory, and autonomic fibers. Injury of the median nerve results in impaired or lost nervous function in the first three and one-half digits and the thenar eminance at the base of the thumb. Motor nerve impairment results in reduced muscle control and ultimately muscle atrophy; thenar atrophy is a common symptom in advanced cases of carpal tunnel syndrome."

Again speaking to the layman, Dr. Hinkamp states:

"There are a lot of things we don't know about this syndrome, such as how many repeated twists of the wrist may cause how much damage to each individual. We know that a majority of the people suffering from these work-related injuries are women. In one Michigan study, for instance, just 49 per cent of those in the study were female, but 73 per cent with the disease were women.

"We don't precisely know if there is something about women that makes them more likely to get the disease, or if women just tend to be assigned to jobs that tend to cause it."

Some sources state that CTS "occurs most often in patients between the ages of 30 and 60 years of age, and is three to five times more frequent in women than in men."[1]

A *Health Hazard Evaluation Report*[4] issued by NIOSH presents information currently of interest to those studying CTS. The report states that CTS occurs from three to 10 times more often in women than in men, and it may be associated with a host of other diseases and conditions. Some of these predisposing conditions—including wrist fracture, arthritis, cysts, and acromegaly—can be explained on a purely mechanical basis, "because the tunnel becomes smaller or the contents become larger and compression of the tunnel contents occurs."

The NIOSH report adds that other related disease states or conditions, including diabetes, hypothyroidism, dialysis, pregnancy, oral contraceptive use, menopause, and perhaps Vitamin B6 deficiency, appear to predispose individuals to the development of CTS through complex nutritional, vascular, biochemical, and anatomical factors.

Carpal tunnel syndrome is frequently seen in pregnancy due to retained fluid (edema); it is usually self-limiting, with the symptoms disappearing after birth. And because patients with CTS are women at or near menopause, hormonal changes may be playing some causative role, it is believed by some investigators.

CTS also has been linked prominently to ergonomic factors, NIOSH states. There have been several important biomechanical experiments that demonstrated pressure increases within the carpal tunnel when both the wrist and the fingers are flexed. In several cases it was noted that occupations involving considerable use of the hands appeared to predispose individuals to CTS.

Examples within one study included persons who performed milking, ladling, and spray painting, with the index finger and middle fingers compressing a trigger, NIOSH states.

In a medical record review of 250 consecutive cases of CTS, the NIOSH report points out, it was demonstrated that the dominant hand is affected more often and more severely, suggesting that more frequent and more intense hand use plays a role in the development of CTS.

In two workplace case control studies cited in the NIOSH report, ergonomic factors were among identified risk factors. These included frequent

deviation from neutral wrist position, frequent use of the 'pinch' grasping hand position, and repetitive wrist and hand movements. Gynecologic surgery with oophorectomy (surgical removal of one or both ovaries) was also a risk factor. Despite limitations in these studies, they provide suggestive and supportive evidence for ergonomic (as well as hormonal) risk factors.

Armstrong suggests that because there is not sufficient evidence to use endocrinological factors for selecting or placing workers, employers should concentrate on controlling work factors.

The NIOSH report continues:

"Although CTS is by no means a purely and specifically 'occupational' disease, there is little question that hand and tool usage, alone or in combination with other factors, may lead to the development of a compression neuropathy of the median nerve."

Although the precise mechanism whereby hand use results in CTS is not known, proposed mechanisms include:

1) Repetitive increases in the intra-tunnel pressure, with consequent trauma to the nerve directly;

2) Activity levels that exceed the lubricating capacity of the flexor sheath, resulting in friction, mild inflammation of the flexor sheath, and swelling, with secondary compression of the nerve;

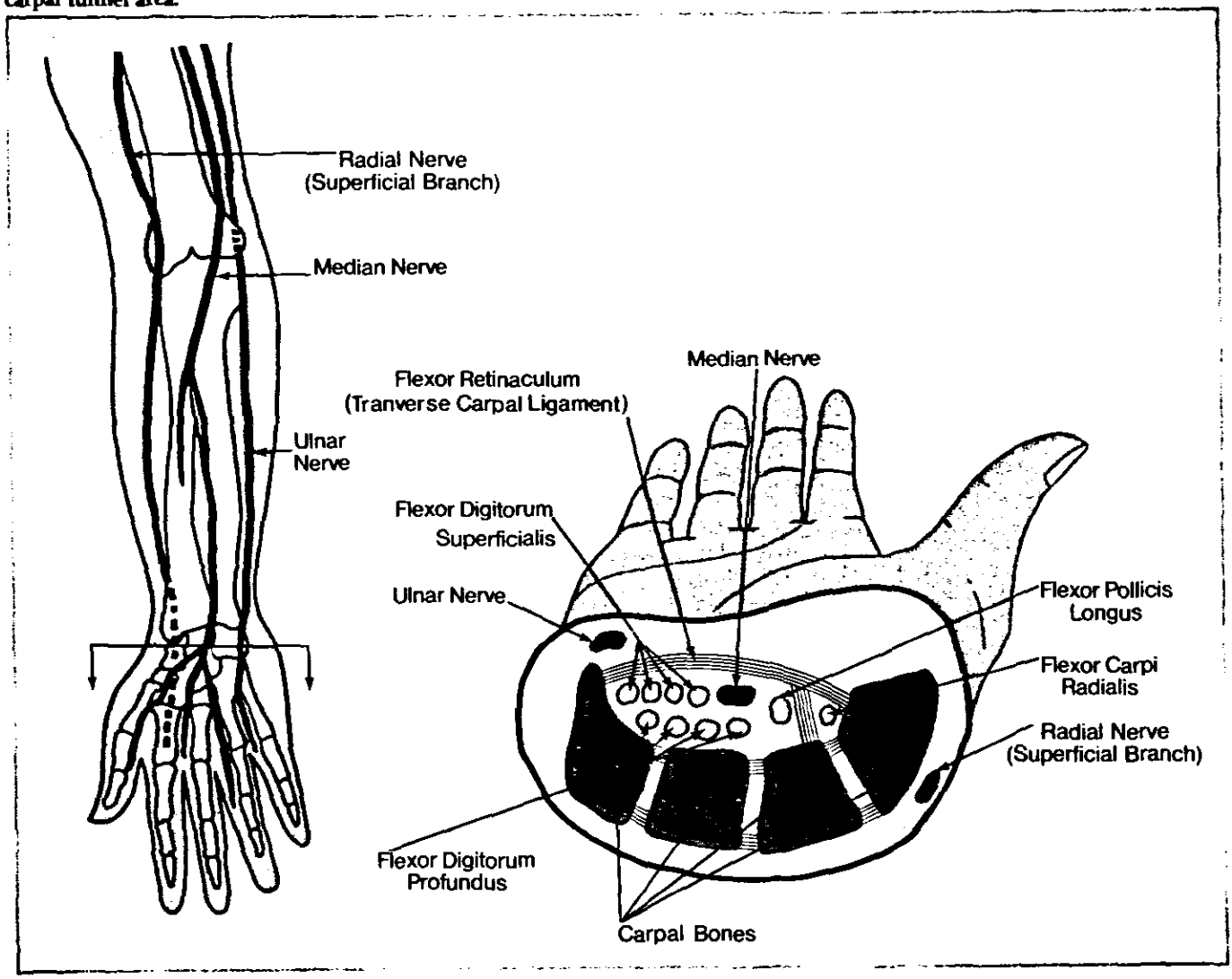
3) Some combination of the two.

Armstrong reports[3] the overall incidence rate and prevalence of Carpal Tunnel Syndrome in the work force is not yet known. Although the available data vary considerably from site to site and job to job, they show that Carpal Tunnel Syndrome and related illnesses are a major problem in some settings.

Armstrong then cites these frequently reported non-occupational factors of Carpal Tunnel Syndrome:

- *Systemic diseases*—Such as rheumatoid arthritis, acromegaly, gout, diabetes, myxoedema, ganglion formation, and certain forms of cancer.
- *Congenital defects*—Including bony protrusions into the carpal tunnel, anomalous muscles extending into or originating in the carpal tunnel, and the shape of the median nerve.
- *Wrist size*—Although recent stud-

Graphic illustrates nerves of the right arm descending to the wrist and hand; the view is of the palm side of the hand. The adjacent graphic presents a sectional view of the right wrist at the carpal tunnel area.



ies of CTS patients made with the use of computerized axial tomography (CAT scanner) suggest that there is an association between a very small carpal tunnel and idiopathic carpal tunnel syndrome, Armstrong and Chaffin, in a study[5] of personal factors, were unable to find any association between hand and wrist size and occupational carpal tunnel syndrome.

• *Acute trauma*—Median nerve injury inside the carpal tunnel can be produced by a blow to the wrist, laceration, burn, or other acute wrist trauma.

• *Pregnancy, oral contraceptives, menopause, and gynecological surgery*—All have been reported as factors of carpal tunnel syndrome. Because all are uniquely female problems, they may, in some cases, contribute to a disproportionately high incidence rate of the syndrome in females.

Armstrong's *An Ergonomics Guide to Carpal Tunnel Syndrome* continues with this advice:

"Non-occupational factors may suggest the need for medical screening, but so far there are no reliable pre-employment indicators of worker predisposition to Carpal Tunnel Syndrome. As a practical matter, employers probably will find it easier to exercise control over the design of jobs than over the selection of workers."

Although to date there has been no major industry-wide, all-employee study of the presence or the extent of CTS, a search of the literature reveals many limited and controlled studies conducted or sponsored by individual companies, medical schools, universities, NIOSH, and insurance companies. The interested NSNEWS reader would do well to study the "Bibliography" accompanying this two-part article for specific, detailed information.

As Armstrong and Hinkamp recommend, evaluation of CTS and related cumulative trauma illnesses includes analysis of health data to identify jobs in which there is an elevated incidence of Carpal Tunnel Syndrome, together with an analysis of work methods to identify the risk factors previously described.

Sources of health data suggested by Armstrong and Hinkamp include:

- First aid logs;
- Medical visit logs;
- Medical reports;
- Workers' Compensation reports;
- OSHA logs;
- Personnel benefit records.

It is recommended that these records be reviewed for CTS and all other related illnesses, such as tenosynovitis and strains, because experience has shown that these other illnesses sometimes are associated with CTS, and they often are a result of the same kinds of stresses as is Carpal Tunnel Syndrome.

Incidence rates should be computed for each job classification or department to identify those areas where the risk of developing repetitive trauma disorders is considered "unacceptable."

The incidence rates for CTS in job groups without hand-intensive work, such as supervisors and managers, can be used as a reasonable goal for hand-intensive jobs. Once the problem areas have been identified, the jobs should be systematically analyzed for occupational factors of CTS, Armstrong advises, and such factors eliminated or minimized where possible. Traditional time-and-motion study procedures, in which a job is divided into a sequence of acts or elements for the right and left hand, can be used to describe what the worker does.

Bernard[1] cites two modes of treatment for CTS, *i.e.*, conservative and surgical. If mild symptoms have been present for less than two months, conservative treatment may be given with resulting relief, Bernard states.

Conservative treatment might include resting the hands, or changing the occupation of the patient who has had a recent onset of symptoms after doing manual labor. Other conservative methods include: proper control of diseases associated with CTS, wrist splinting, anti-inflammation medicine, and injection of hydrocortisone into the carpal tunnel.

Conservative therapy can be slow, but it is very important, Dr. Hinkamp points out.

When signs and symptoms are persistent and progressive, and CTS is advanced or rapidly progressing, then surgery may be necessary. The surgical treatment involves the division of the entire transverse carpal ligament (flexor retinaculum).

Post surgical recurrences of CTS can occur, but this is not frequent. The causes of the recurrence can be due to incomplete division of the transverse carpal ligament, post-surgical fibrous proliferation, or recurring tenosynovitis.

Now that the problem of Carpal Tunnel Syndrome has been well-identified by the medical world, NIOSH, and others, answers are slowly forthcoming. Currently contributing their expertise in solving the problem are labor unions, the insurance industry, ergonomics engineers, tool makers, and the work glove manufacturers.

It appears that the problem of Carpal Tunnel Syndrome currently is in good hands. Ω

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EDITOR'S NOTE: Part II, dealing with possible answers to The Problem of Carpal Tunnel Syndrome, will include Acknowledgments and a comprehensive Bibliography.

Carpal Tunnel Syndrome— Part II: Some Answers

By Edward D. Dionne

Two modes of treatment—termed conservative and surgical—have been proposed in dealing with the problems of CTS.*

The conservative method applies human factor engineering principles to analyze repetitive motion jobs to identify those considered stressful, and applies these same principles to reduce such stress. The simplest solution is to provide employee rotation within the working group to minimize stressful exposure. For instance, in an assembly line process, the total job may encompass 20 sub-tasks. When the sub-tasks are analyzed, the analysis may show that two or three are stressful. It may be possible to rotate line employees between these sub-tasks on two-hour intervals.

This was the approach taken by Harvey E. Foushee, Corporate Human Factors Engineer, AT&T Technologies, Inc., of New York, at a "Blockbuster" session of the 71st National Safety Congress, held last October at Chicago.

As stated by Foushee:

"Industrial companies are finding the application of human factors engineering principles useful in reducing pain and soreness complaints, which contribute to CTS cases in the workplace. When hand force is exerted on tool handles, there will be some compression transmitted to the tendons and their respective tendon sheaths, as well as the nerve bodies. The tool handle length and diameter will be an important consideration to minimize this compressive force. When the compressive force is combined with repetitive motion that requires hand deviation from the straight-line axis, the combination of compression and deviated hand and arm posture may cause inflammation of the nerves, resulting in the loss of sensory feedback mechanisms." (See Figures 1 and 2.)

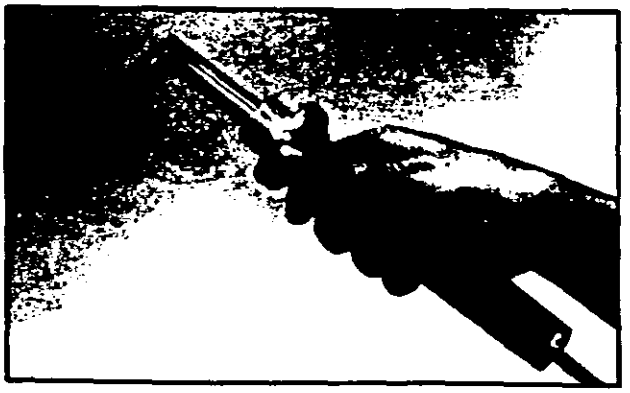
Foushee recommends:

- Provide and orient jigs or fixtures to permit assembly activity to occur within the normal range of arm movement (See Figure 3);
- Provide cushioned arm rests to support the forearm, thus increasing the manipulative ability in the hand (See Figure 3);
- Store parts in containers designed for employee reaches with minimal hand flexion or extension;
- Provide for downward force movements through flanged surfaces on tool handles (See Figure 4);
- Provide for vibration dampening of tools through the use of rubber-backed low-pile carpet on work surfaces;
- Provide radiused (rounded or curved) edges on fixtures to minimize point-source pressure on the

*EDITOR'S NOTE: See "Carpal Tunnel Syndrome: Part I—The Problem," in the March issue of NSNEWS.

Figure 1, an X-ray of the hand holding an ergonomically designed pair of needle-nose pliers, shows the proper axis of thrust for handling such tools. A spring located between the handles facilitates their opening. A flange has been added to the top of the upper handle as a point for the thumb to push against.

Figure 2 shows a soldering iron with the head at right angles to the handle, which has been designed to extend beyond the soft spot of the palm, placing the work force against the muscle of the little finger. The flange also offers the worker security against solder splash.



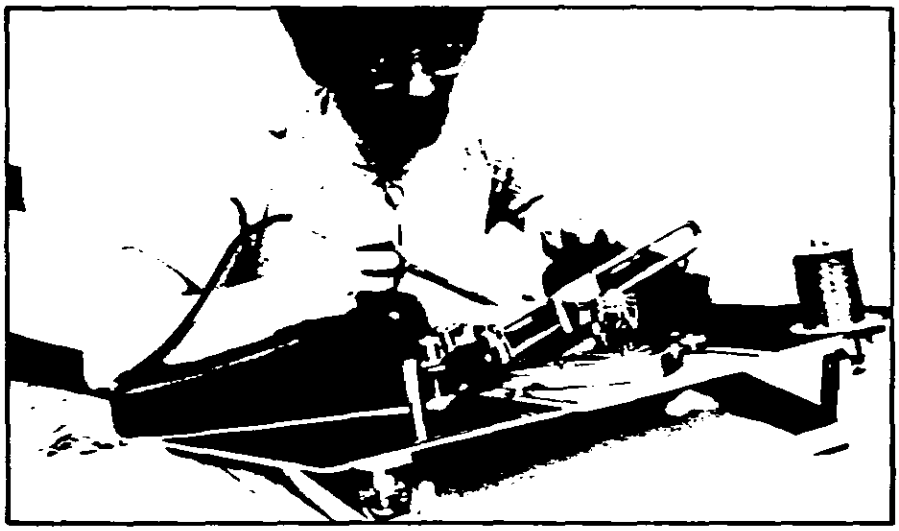


Figure 3 shows a worker doing an exacting soldering task, using a padded fixture instead of resting her arms on the edge of the work table, which cuts into the forearms with resultant problems.

arms (See Figure 5);

- Provide training of employees in correct tool use;
- Select hand tools that spread the stress areas evenly over muscle eminences (See Figure 6);
- Maintain power tools at proper torque requirements;
- Consider power tools that stop when the torque setting is reached—(When this principle is ignored, the G forces transmitted into the hand tissue will increase dramatically);
- Suspend power tools on balancers to support the tool weight; this will minimize the static load on the muscle bodies for lengthy time periods (See Figure 4);
- Select tools that consider hand size variables in workers;
- Select tool handle surfaces to provide control and a relaxed grip force;
- Avoid fluted surfaces that concentrate stress over small point-sources in the hands.

The conservative approach to CTS also was discussed at a Congress session sponsored by the Council's Labor Division. Speakers were Roger Stephens, Ph.D., an ergonomist at the Washington, DC office of OSHA, and Ed Golonka, Industrial Hygienist, AT&T Technologies, Inc., Hawthorne Station, Chicago.

Stephens presented a comprehensive view of CTS—what it is, its effect upon various industries, and directions the U.S. Department of Labor is taking in the way of research and other methods of remedying CTS and other industrial traumatic conditions, including those resulting from repeated and excessive body movements and machine vibrations.*

Golonka explained how ergonomically and biomechanically designed and engineered hand tools, work area furniture, and procedures helped combat CTS and other diseases at the Hawthorne plant, where the assembly of electronic and telecommunications equipment is conducted.

Golonka stressed that detailed observations of work procedures revealed some basic—but important—principles related to assembly workers:

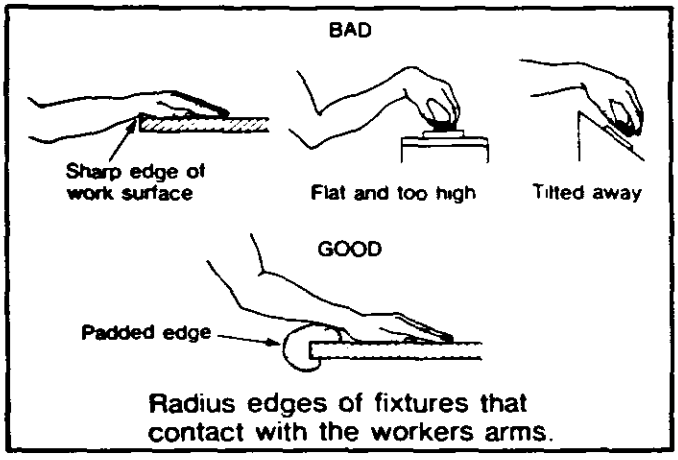
- People can be ambidextrous.
- Much can be learned by paying close attention to skilled, experienced workers as to how they do their jobs; watch them closely for solutions, in addition to those with the problem.
- Experienced workers are resourceful; some were found to orient their bodies relative to the work fixture, and this orientation differed by almost 120 to 140 degrees between right-handed and left-handed employees. One ingenious solution devised by the company's engineering staff is a unique "Vice-Versa Machine," capable of being adapted easily to hold and support the work to fit the employee's own individual hand needs, whether that worker be right-handed or left-handed.

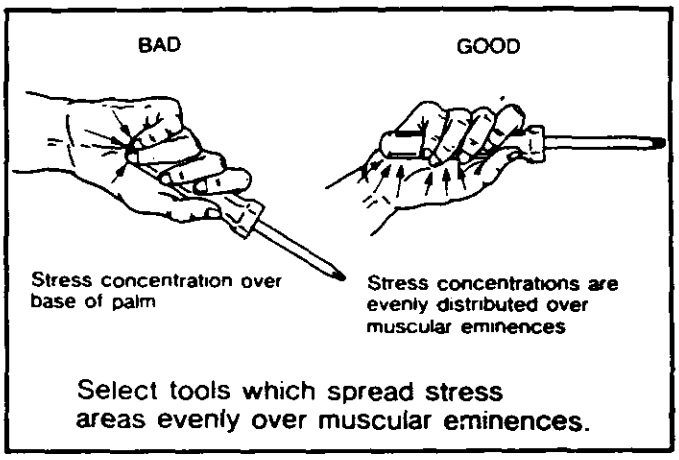
Even a familiar, everyday procedure such as pushing a control button can, in time, set up a traumatic condition, explains David B. Knight, M.P.H., Executive Director of Product Development for CIGNA's Loss Control Services, Inc., at Philadelphia. He says:

"One of the most common elements of work is activation of machinery or equipment by hitting control buttons. It is not uncommon for an operator to activate equipment every four or five seconds. Allowing for rest intervals and other tasks, this may mean the hands must perform the motion pattern more than 5,000 times per day. It becomes imperative, therefore, that consideration be given to both the hand position and the force required to engage the control. Different controls may vary considerably in the amount of force re-

*See also "Positioning Health and Safety in the '80's" February NSNEWS, pp. 40-44.

Figure 4 shows a flange of padded material on a powered screw driver. The flange acts as a structure the employee can push against, giving a feeling of security and eliminating need to grip the tool tightly. Note the suspension system to lessen tool weight.





Figures 5 and 6 illustrate good and bad work practices and tool handling as related to Carpal Tunnel Syndrome.

quired, and this should be given due attention in the selection of different devices. Touch-sensitive controls now available virtually eliminate forces."

Knight also points out that where switches are placed —and their shape—can have a significant effect on the position of the hand and the consequent deviation of the wrist. Other design-related principles presented by Knight include those pertaining to collars added to some tools and machines in an effort to protect the control switch from accidental activation, or from deliberate attempts to defeat two-hand controls. Such devices, designed for safety purposes, may increase stress on tendons, Knight states, and attention should be given to alternative guarding methods when workers are experiencing cumulative trauma disorders.

Additional guidelines for the conservative approach to CTS are offered by Thomas J. Armstrong, Ph.D., Associate Professor at the University of Michigan's Center for Ergonomics, at Ann Arbor:*

- The frequency of work sometimes can be reduced by eliminating wasted motions and minimizing reach distances; however, in many cases it cannot be reduced without reducing the rate of work.
- The force of work often can be reduced by reducing the size of containers or bundles. Force also can be minimized by using only parts that fit properly, and machines that are adjusted properly. Quality control and maintenance people should be consulted for help in this area.
- The effective force can be reduced by gripping objects, rather than pinching them; the body has to work four to five times harder to pinch than to grip.
- The force of work can be reduced by avoiding poorly fitting gloves. Gloves easily can reduce strength by 30 per cent. A variety of glove sizes and styles should be made available so that workers can find the ones that are most comfortable for their particular job.
- The amount of force exerted is related to the feel of the force in the hand. The sense of feel can be reduced and even eliminated by exposure to low temperatures. Hand temperatures should be maintained at temperatures that do not feel cold to the touch of protected areas of the body.
- The position of the wrist is determined by the shape of the object held or manipulated with the hand, and the location and orientation of the work surface. For example, wrist deviation is required to hold and use an in-line nut-runner on a vertical surface at elbow-height. The posture can be controlled by changing the location or orientation of the work surface, or by changing the tool itself. A pistol-shaped nut-runner could be held against a vertical surface at elbow height without excessive postural stress. In another example, wrist flexion is required to hold a pistol-shaped nut-runner on a horizontal bench surface. Again, the posture could be controlled by reorienting or relocating the work surface or by changing tools. In this case, an in-line shaped handle would minimize postural stress.
- Stresses often are produced on the base of the wrist by pressing with the palm or by holding a tool. Forceful exertions with the base of the palm should be avoided. Where this is not possible, protective pads

Figure 7 shows James McClatchey of AT&T Technologies, Inc., holding contoured needle-nose pliers with hand grips designed to minimize repetitive motion disease. On the table are other specially adapted tools, including two models of an air-powered triggerless wire wrap gun, an air-powered screwdriver with cushioned plastic sleeve, and a hatchet-shaped soldering gun.

See also "Carpal Tunnel Syndrome—Part I: The Problem," and "Are Your Work Procedures a Menace?" in the March issue of NSNEWS.

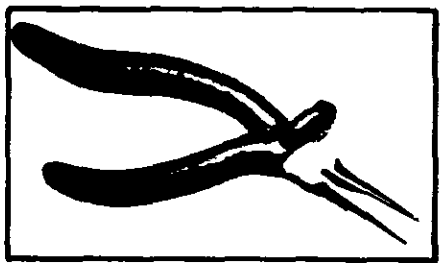


Figure 8 shows a pair of long-nose pliers, specially designed, padded, and with thumb flange to minimize problems of CTS. (Photo: Courtesy Klein Tools, Inc.)

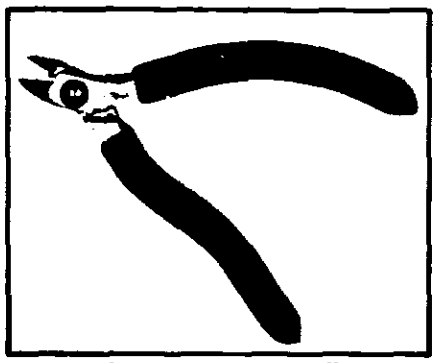


Figure 9 shows an ergonomically designed cutter, with soft foam cushion grips and internal spring. (Photo: Courtesy Erem Corp.)

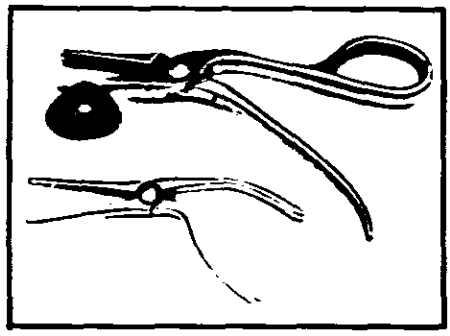


Figure 10 shows two types of ergonomically designed press feeding tools, including one with a vacuum cup attachment. (Photo: Courtesy Osborn Manufacturing Corp.)

should be used. Handles of tools should be long enough to traverse the muscular eminences at the sides of the palm.

• Vibration exposure can come from the use of power tools, impact tools, grinding and buffing, or holding the steering wheel of vehicles. Equipment suppliers and maintenance persons should be consulted for help in selecting and maintaining equipment for minimum vibration.

Carpal Tunnel Syndrome has become a world-wide industrial problem. Helping to solve that problem is James W. McClatchey, department chief, corporate industrial hygiene and human factors engineering at AT&T Technologies, Inc.'s New York office. (See Figure 7.) In 1982 and 1983 he was a member of a technical exchange team visiting the People's Republic of China, a nation seeking improved worker safety as it gears up for industrialization.

McClatchey offered the Chinese his expertise with Western Electric (now AT&T Technologies, Inc.) a company well-known for its long experience in human factors engineering. McClatchey states:

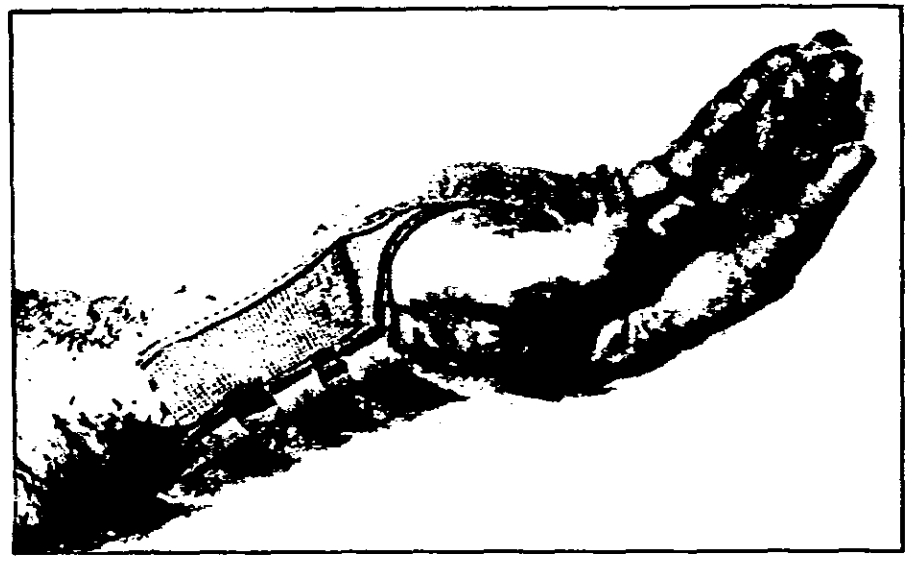
"China's workers are involved in a high degree of repetitive tasks that require significant hand and arm movements. If their tools are awkward to use, the result often is a repetitive motion disease. The solution sometimes can be a simple change in the curvature or shape of a hand tool or a change or redesign of a work station."

Some U.S. tool manufacturers have worked closely with various segments of industry in designing and engineering hand tools to reduce or eliminate carpal tunnel syndrome, tendonitis, and other diseases related to repetitive motions, vibration, and other conditions found in the workplace. (See Figures 8, 9, and 10.)

At East Peoria, IL, an innovative—and somewhat controversial—approach to the problem of hand and wrist diseases has been undertaken by John F. Bennett, Chairman of Bennett Ergonomic Labs. His proposed solution makes use of what he refers to as "the Bennett Bend," or "The Bionic Curve," which incorporates a 19-degree bend in an otherwise customarily straight handle for hammers and other tools, including a line of knives used by workers in the poultry and meat processing industries.* Bennett has extended his theory to the familiar household broom, tennis racquets, and baseball bats.

Still another approach to the problem of CTS is being offered by some manufacturers of work gloves. Although both the Work Glove Manufacturers Association (WGMA) and National Industrial Glove Distributors Association (NIGDA) report there is currently no organized, industry-wide program under way, some individual companies are carrying on their own research and development programs related to repetitive trauma, vibration, and other job-related diseases of the shoulder, arm, wrist, and hand. One glove manufacturer currently has four prototypes for such apparel, designed to "minimize" the problem. He states that his company "has the technical abilities to fabricate, but needs more feedback and suggestions from employers. Such input could refine our efforts toward eliminating the CTS

*See "Are Your Work Procedures a Menace?" in the March issue of NSNEWS.



One medical approach to the treatment of Carpal Tunnel Syndrome is a brace with a steel insert to prevent bending of the wrist.

Photo taken only a few days after surgery was performed illustrates the path of incision selected for this case of Carpal Tunnel Syndrome.

problem." Another work glove manufacturer has available a "carpal tunnel" glove, and several companies are marketing mittens and gloves with special padding to combat vibration.

The surgical treatment and medical aspects of Carpal Tunnel Syndrome were discussed at the Congress "Blockbuster" session by Sidney J. Blair, M.D., Chief, Section of Hand Surgery, Department of Orthopaedics and Rehabilitation, Loyola University Medical Center, Maywood, IL.

Surgery for Carpal Tunnel Release is indicated upon failure of conservative treatment, when pain is severe, and there is deterioration of the muscles of the thumb. Electrical tests are used to give the estimate of damage to the median nerve, Dr. Blair explains.

The surgery consists of incising the transverse carpal ligament of the wrist. Splints are worn for a short period to allow healing. Patients' return to work depends on their occupation. Patients who are doing repetitive tasks should be restricted from working for two months, in some cases, Dr. Blair advises.

Some patients will continue to have numbness for several months. Occasionally, patients may develop stiffness and pain following the surgery. This is called "Sympathetic Dystrophy." It will require prolonged therapy, and it will increase the disability. If the ligament is incompletely cut, the symptoms will persist. Most of the patients, however, will obtain relief from their surgery according to Dr. Blair. Ω

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Acknowledgments

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Therapy Can Relieve CTS Symptoms

Insight into the mechanical/medical problem of Carpal Tunnel Syndrome is offered by Robert F. Perry, R.P.T., President of Physical Rehabilitation Associates, Champaign, IL. He explains that the strength of the hand's transverse carpal ligament is a major factor in giving the 10 tendons that pass through the wrist area to the hand the mechanical advantage they need for the hand to develop the 120 to 180 pounds that is considered to be normal grip strength. But, he adds,

"It is also the strength and rigidity of this ligament that contributes significantly to the median nerve entrapment problem that we have come to know as Carpal Tunnel Syndrome."

As a physical therapist, Perry believes that the problem may be resolved at its earliest stages—a feeling of tired hands and/or sore wrists—by allowing the irritated wrist to rest until the irritation subsides. A mild anti-inflammatory medication—such as aspirin—often is prescribed by the physician, Perry reports.

But repeated, prolonged, or continuous stresses of this type often can result in a more serious irritation or inflammation of the synovial membranes (a condition called *tenosynovitis*), which will cause them to overproduce synovial fluid and swell. Involvement of the transverse carpal ligament can result in CTS, he states. A common test for CTS, according to Perry, is a measurement of the nerve conduction velocity (NCV) of the median nerve. This test is usually done in both arms, he states, so that the physician or therapist performing the test will have a normal value that can be used as a comparison value. A prolonged conduction time across the wrist joint is considered to indicate the presence of median nerve compression in the carpal tunnel, according to Perry. He also cites the possible use of fairly recent development in medical instrumentation, a non-invasive procedure known as Thermography.*

Perry has observed that the medical treatment of CTS may fall into these categories:

- In the initial stages, a night splint that holds the wrist in slight hyperextension may be prescribed to rest the wrist. Mild anti-inflammatory oral medication also may be prescribed by the physician.

- In the more developed case, it may be necessary for the physician to inject the compartment with a combination of local anesthetic and an anti-inflammatory agent. A splint often is prescribed, to be worn during the day as well as at night to prevent the forceful contraction of the fingers and thumb flexors. In the past, ultra-sound has been used in an attempt to treat the condition. The use of therapeutic ultra-sound at this stage of the condition in some instances may exacerbate the problem by increasing the swelling.

- In patients who either cannot be injected, do not wish to be injected, or have not had a good response to the injection, a trial of physical therapy including controlled laser systems, interference currents, or bioconductive therapy may be indicated.

- In the final analysis, it may be necessary to divide the transverse carpal ligament surgically to obtain a good result. Following surgery, it is important that the patient undergo an adequate program of physical therapy designed to restore strength and flexibility to the wrist and resolve any remaining pain problems. This is especially important when it is anticipated that the employee will be returning to a job where a good grip is a factor in successfully performing the job. An adequate program of physical therapy also can restore the worker's confidence in his ability to perform the tasks implicit in his job, without undue fear of reinjuring himself. The therapist may use further non-invasive instrumentation to document the point at which the neurological changes have been resolved. The physical therapist may use a combination of physical modalities, such as electric stimulation, paraffin baths, or controlled laser systems to reduce any pain that may remain, plus exercises to restore the range of motion to the wrist. The therapist also may fabricate a splint to protect the wrist in the initial stages, following the surgery, if this is indicated by the surgeon. Ω

Teleconference on Cumulative Trauma Set for May 16

Experts in the field of carpal tunnel and other cumulative trauma disorders will appear at a National Safety Council sponsored teleconference. It will be beamed by satellite to 53 cities. See page 30 for details.

* *See Meyers, Jonas, and John Fournier, M.D., "Thermography: A Medical Surveillance Tool?" NATIONAL SAFETY NEWS, Vol. 127, No. 5, May 1983, p. 37.*

PART II

CUMULATIVE TRAUMA DISORDERS IN THE WORKPLACE

BIBLIOGRAPHY

A. NIOSH PUBLICATIONS/REPORTS

1. NUMBERED PUBLICATIONS *are formal publications issued by NIOSH that document the results of research conducted by or for NIOSH. Included in this category are Criteria Documents, Current Intelligence Bulletins, Alerts, Health and Safety Guides, technical reports of scientific investigations, compilations of data, worker-related booklets, symposium and conference proceedings, and administrative and management reports. Publications are listed in reverse chronological order.*

1. A National Strategy for Occupational Musculoskeletal Injuries: Implementation Issues and Research Needs. *1992.*
NIOSH PUB NO: 93-101. 22 pp.
NTIS NO: PB91-173351 PRICE: Check NTIS

The proceedings of a conference on the development of a national strategy for occupational musculoskeletal injuries were summarized. Specific topics discussed included the scope of the national program, major federal government initiatives, the passage of the Occupational Safety and Health Act, definition of acute and chronic musculoskeletal injuries, anatomical structures of concern, multi-factored risk model development, methods used for identifying job hazards, nonoccupational factors and the risk of an occupational musculoskeletal injury, fundamental research needed to understand the causes of occupational musculoskeletal injuries, and the research needed to provide the most effective prevention strategies. Evidence indicated that musculoskeletal injuries include the most costly types of occupational injuries and that they affect several million workers each year. Areas needing additional research include identifying hazardous job stressors, objectively measuring and quantifying job stress, identifying people at risk for musculoskeletal injuries, fundamental biomechanics, job hazard surveillance, and industrial planning and social/organizational issues.

2. Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries. Musculoskeletal Injuries. *1986.*
NIOSH PUB NO: 89-112. 22 pp.
NTIS NO: PB90-170903 PRICE: Check NTIS

Four elements have been identified which contribute to death and disease through musculoskeletal injuries. These factors include environmental hazards, human biologic factors, behavioral factors or unhealthy lifestyles, and inadequacies in the existing health care and ancillary systems. Hazards to the musculoskeletal system associated with work are described as workplace traumatogens, a source of biomechanical stress stemming from job demands that exceed the worker's strength or endurance such as heavy lifting, or repetitive forceful manual twisting. Human biologic factors include the anthropometric or innate attributes that influence a worker's capacity for safely performing the job. Behavioral factors or unhealthy lifestyles refer to acquired behaviors or personal habits that increase the worker's risk of incurring musculoskeletal strain or injury. Inadequacies of the existing health care and ancillary systems include a lack of medical knowledge and appropriate training for health care personnel on the etiology, diagnosis, and treatment of musculoskeletal problems that result from biomechanical strain. Topics considered in this report include the musculoskeletal conditions to be addressed, the scope of the national problem, the potential for prevention and control, the tactical areas of a national strategy for prevention, and the action plan.

3. Occupational Safety and Health Symposia. *1979.* Hadler N. **Arthritides: Effects of repetitive motion on the musculoskeletal systems.** pp. 120-128.
NIOSH PUB NO: 80-105. 178 pp.
NTIS NO: PB80-175706 PRICE: Check NTIS

The effect of pattern of usage on the structure and function of the hand was studied in a group of female worsted mill employees. The employees had engaged in the highly repetitive, stereotyped tasks of burling, winding, and spinning for at least 20 years. Data were obtained from clinical measurements of active ranges of motion, measurements of distal and proximal interphalangeal circumferences, and radiographs. Range of motion, malalignment, radiographic degenerative joint disease score, and derivatized circumference data were collected. Differences existed between the right and left hands, and most task related impairments were in the right hand. All three tasks were differentiated by patterns of usage of the women's hands. Guidelines for further testing of diseases associated with stereotyped, repetitive tasks are proposed by the author.

2. TESTIMONY *consists of both written comments and oral testimony presented before Congressional committees or at hearings convened by regulatory agencies. The following list of NIOSH testimony on cumulative trauma disorders is arranged in reverse chronological order.*

1. NIOSH [1993]. **Comments by R. Niemeier to DOL on the Occupational Safety and Health Administration Proposed Rule on Ergonomic Safety and Health Management, February 1 and August 24.** 66 pp.
(A copy of this testimony is in Part I, pages 15-88.)

2. NIOSH [1989]. **Congressional Testimony by L. Fine, Statement before the Employment and Housing Subcommittee, Committee on Government Operations, U.S. House of Representatives (Repetitive Trauma Disorders), June 6.** 6 pp.
NTIS NO: PB90-179250 PRICE: Check NTIS

This testimony concerned the activity of NIOSH in the field of repetitive trauma disorders. Such disorders were a class of musculoskeletal disorders involving damage to the tendons, tendon sheaths, and the related bones, muscles, and nerves of the hands, wrists, elbows, arms, feet, knees, legs, neck, and back. Diseases associated with such disorders included carpal tunnel syndrome, tendinitis, tenosynovitis, DeQuervain's Disease, low back pain, and vibration-induced Raynaud's syndrome. Such injuries have occurred as a result of repeated harm, not isolated accidents. Since 1984 the numbers of such reported injuries have doubled, exceeding 72,900 cases in 1987, and accounting for up to 39 percent of all occupational illnesses reported to OSHA in 1987. Manufacturing industries had the highest rate, with the five highest manufacturing industries being meatpacking, manufacturing and household appliances, rubber and plastic footwear, office and furniture fixtures, and motor vehicles and equipment. A manual was developed by NIOSH [see Part I, page 89] which identified cumulative trauma disorders (CTDs) of the upper limbs and identified risk factors, evaluated jobs and records and surveyed workers to determine if a problem was occurring, and provided guidelines for protecting workers in jobs that pose a serious risk. Current research programs in this area were described.

3. NIOSH [1984]. **Congressional Testimony by B. Johnson, Statement before the Subcommittee on Postal Personnel and Modernization, Committee on Post Office and Civil Service, U.S. House of Representatives (Carpal Tunnel Syndrome), June 8.** 11 pp.
NTIS NO: PB90-153792 PRICE: Check NTIS

This testimony concerned NIOSH research on carpal tunnel syndrome as an occupational disorder. The name, carpal tunnel, derives from the eight bones in the wrist called carpals which form a tunnel-like structure. The tunnel contains tendons which control finger movement and provide a pathway for the median nerve to reach sensory cells in the hand. Nerve compression results from various conditions. Repeated flexing and extension of the wrist causes the tendons to swell and thereby increases pressure in the bony tunnel which can pinch or trap the median nerve. Job tasks which involve highly repetitive manual acts or necessitate wrist bending or other stressful wrist postures are connected with incidents of carpal tunnel syndrome or related problems. Patients suffering from this syndrome lack the ability to sense cold or hot by touch and experience an apparent loss of strength in their fingers. Treatment may involve surgery or the use of antiinflammatory drugs. However, success in treatment has been limited. Jobs which have been identified as causing carpal tunnel syndrome have included the assembly of small parts and the manual inspection of manufactured products. Control measures focus on relieving excessive wrist deviations and arm and hand movements requiring force. Some tools have been redesigned.

of work stations and the use of fixtures to mount work at angles and reduce the need for the worker's hand to bend at the wrist. NIOSH studies of postal worker jobs and letter sorting machine operations were described.