**COMPUTERS AND HEALTH**

**INDIVIDUAL AND lNSTITUTIONAL**

# PROTECTIVE MEASURES

######  CARPAL TUNNEL SYNDROME

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ithin the past two years, substantial media attention has been directed at potential adverse health effects of long-term computer use. Renewed concerns about radiation, combined with reports of newly-recognized "repetitive stress injuries" such as carpal tunnel syndrome, have led some to call for regulation in the workplace and others to rearrange their offices and computer labs. There is little evidence that computer use is on the decline, however. On the contrary, more people are spending more time doing more tasks with computers -- and faculty, students and staff at colleges and universities have some of the most computer-intensive work styles in the world.

If, as is widely suspected, health effects are cumulative, then many of us are at risk in our offices, labs, dormitories, and homes. Unfortunately, many years will be required before epidemiological studies can provide definitive guidelines for computer users, managers, furniture suppliers, and office designers. In the interim, individuals and institutions must educate themselves about these issues and protective measures.

One set of issues concerns workstation design, setup, and illumination, together with users' work habits. The City of San Francisco, which recently enacted worker safety legislation, cited research by the National Institute of Occupational Safety and Health (NIOSH) into VDT operator complaints of eyestrain, headaches, general malaise, and other visual and musculoskeletal problems as the rationale for imposing workplace standards, to be phased in over the next four years.

A second set of issues relates to suspected radiation hazards, including miscarriage and cancer. A special concern with radiation is that nearby colleagues could be affected as well, since radiation is emitted from the backs and sides of some terminals. The most recent NIOSH study is reassuring, but some caution still seems prudent.

## Ergonomics and work habits

Most people can ride any bicycle on flat ground for a short distance with no problems. On a fifty mile ride over hilly terrain, however, minor adjustments in seat height, handlebar angle, and the like can mean the difference between top performance and severe pain. Similarly, occasional computer users may notice no ill effects from poorly designed or badly adjusted workstations, whereas those who spend several hours a day for many years should pay careful attention to ergonomics, the study

of man-machine interfaces.

The key to most workstation comfort guidelines is adjustability--to accommodate different body dimensions, personal workstyle preferences, and the need to change positions to avoid fatigue. A recommended working posture shows the body directly facing the keyboard and terminal, back straight, feet flat on the floor, eyes aligned at or slightly below the top of the screen, and thighs, forearms, wrists, and hands roughly parallel to the floor. Achieving this posture may require:

* A chair with a seat pan that adjusts both vertically and fore-and-aft, an adjustable height backrest, and adjustable tilting tension
* An adjustable height work surface or separate keyboard/mouse tray (note that many keyboard trays are too narrow to accommodate a mouse pad, leaving the mouse at an awkward height or reach on the desktop)
* A height adjustment for the video display (a good use for those manuals you'll never read!)
* An adjustable document holder to minimize head movement and eyestrain
* Adjustable foot rests, arms rests, and/or wrist rests.

Studies show that many people are unaware of the range of adjustments possible in their chairs and workstations. Although the best chairs permit adjustment while seated, you may have to turn the chair upside down to read the instructions. (Be careful not to strain your back while upending and righting the chair!) If your posture deviates substantially from that in the diagram--or if you are experiencing discomfort--experiment with adjustments or try exchanging chairs or workstations

with colleagues. A posture cushion, which maintains the natural curvature of the spine and pelvis while supporting the lumbar region, may also prove helpful. It should be noted that any adjustment may feel uncomfortable for a week or so while your body readjusts itself.

(Some people have been advised by their physicians to use a backless "Balans" chair, which minimizes compression of the spine and shifts the body weight forward with the aid of a shin rest. This posture may be uncomfortable, however, since it requires stronger abdominal and leg muscles than conventional sitting positions. The Balans chair is not recommended for overweight or exceptionally tall persons)

### Light and glare

Eyestrain, headaches, and impaired vision are often a product of improper illumination resulting in glare, which is light within the field of vision that is brighter than other objects to which the eyes are adapted. Both direct glare from sunlight and lighting fixtures directed at the user's eyes and indirect glare due to reflections from

video screens or glossy surfaces are common problems for VDT users.

Many offices are too bright for computer use, which may be a carryover from the days when paperwork required such brightness or the result of many office workers' preferences for sunlight and open windows. A NIOSH study recommends 200-500 lux for general office work; other sources suggest 500-700 lux for light characters on dark monitors and somewhat more for dark-on-light. If documents are not sufficiently illuminated, desk lights are recommended in preference to ceiling lights, which

increase reflections from video screens. Reducing overhead lighting could also result in substantial energy savings.

VDT workstation placement is also important. Terminal screens should be positioned at right angles to windows, so sunlight is neither directly behind the monitor nor behind the operator, where it will reflect off the screen. If this is infeasible, blinds or drapes should be installed. Screens should also be positioned between rows of overhead fixtures, which can be fitted with baffles or parabolic louvers to project light downward rather than horizontally into the eyes or terminal screens.

Some users have found filters placed in front of the screen to be effective in reducing reflections, however some dimming or blurring of the display may result. Experts 1advise trial and error, since the best solution appears to depend upon specific conditions and user preferences. Finally, if you wear glasses or contact lenses, be sure your physician is aware of the amount of terminal work you do; special lenses are sometimes necessary. Bifocals, in particular, are not recommended for extensive terminal work, since the unnatural neck position compresses the cervical vertebrae..

### Breaks and exercises

Working in the same position for too long causes tension buildup and is thought to increase the risk of repetitive motion injuries, such as carpal tunnel syndrome. Remedies include changing postures frequently, performing other work interspersed with computing (some studies recommend a 10-15 minute break from the keyboard every hour), and doing exercises such as tightening and releasing fists and rotating arms and hands to increase circulation. Be aware, also, that the extra stress created by deadline pressure exacerbates the effects of long hours at the computer.

### Radiation hazards

For at least a decade, concerns have been raised about possible effects of radiation from video display terminals, including cancer and miscarriages. Earlier fears about ionizing radiation, such as X rays,

have been laid to rest, since these rays are blocked by modern glass screens. Also well below exposure standards are ultraviolet, infrared, and ultrasound radiation.

More recent controversy surrounds very low frequency (VLF) and extremely low frequency (ELF) electromagnetic radiation produced by video displays' horizontal and vertical deflection circuits, respectively. Researchers have reported a number of ways that electromagnetic fields can affect biological functions, including changes in hormone levels, alterations in binding of ions to cell membranes, and modification of

biochemical processes inside the cell. It is not clear, however, whether these biological effects translate into health effects.

Several epidemiological studies have found a correlation between VDT use and adverse pregnancy outcomes, whereas other studies found no effect. The most recent analysis, published this year by NIOSH, found no increased risk of spontaneous abortions associated with VDT use and exposure to electromagnetic fields in a survey of 2,430 telephone operators. This study, which measured actual electromagnetic field strength rather than relying on retrospective estimates, seems the most trustworthy to date. The authors note, however, that they surveyed only women between 18 and 33 years of age and did not address physical or psychological stress factors.

A 1990 Macworld article by noted industry critic, Paul Brodeur, proposed that users maintain the following distances to minimize VLF and ELF exposure:

* 28 inches or more from the video screen
* 48 inches or more from the sides and backs of any VDTs.

Although these guidelines seem overly cautious, a fundamental principle is that magnetic field strength diminishes rapidly with distance. Users could, for example, select fonts with larger point sizes to permit working farther from the screen. Remember that magnetic fields penetrate walls.

Over-reaction to ELF and VLF radiation can also compromise ergonomics. In a campus computer lab, for example, all displays and keyboards were angled thirty degrees from the front of desktops to reduce the radiation exposure of students behind the machines. The risks of poor working posture in this case appear to be greater than the radiation risks.

A final form of radiation, static electric, can cause discomfort by bombarding the user with ions that attract dust particles, leading to eye and skin irritations. Anti-static pads, increasing humidity, and grounded glare screens are effective remedies for these symptoms.

### A continuing process

Massive computerization of offices, laboratories, dormitories, and homes represents a fundamental change in the way many of us work and communicate. It would be surprising if there were no adverse effects from such profound changes. It would also be surprising if all policy debates were based on sound scientific evidence, rather than parochial politics and media exposes. But, as University of Pennsylvania bioengineering professor Kenneth Foster has written, "One difficulty is that 'safety,' if considered to be the absence of increased risk, can never be demonstrated. A hazard can be shown to exist; absence of hazard cannot."

To monitor research and develop institutional guidelines, the University of Pennsylvania has created a Task Force on Computing in the Workplace, with representatives from the Offices of Environmental Health and Safety, Fire and Occupational Safety, Information Systems and Computing, Radiation Safety, Purchasing, University Life as well as staff and faculty from the Wharton School and Schools of Engineering, Medicine and Nursing. Interested readers are welcome to contact the authors for information on the Task Force and its work.

Until more conclusive research becomes available, individuals, departments, and institutions will have to weigh the evidence and make their own decisions about protective measures to minimize the risks of computing. And, in our opinion, the information technology managers and their vendor partners who provided the leadership to computerize our campuses, now owe it to their colleagues to work with epidemiology and ergonomics experts to create computer-intensive environments that are both productive and healthful.

##### Avoiding carpal tunnel syndrome: A guide for computer keyboard users

Carpal tunnel syndrome (CTS) is a painful, debilitating condition. It involves the median nerve and the flexor tendons that extend from the forearm into the hand through a "tunnel" made up of the wrist bones, or carpals, and the transverse carpal ligament. As you move your hand and fingers, the flexor tendons rub against the sides of the tunnel. This rubbing can cause irritation of the tendons, causing them to swell. When the tendons swell they apply pressure to the median nerve. The result can be tingling, numbness, and eventually debilitating pain.

CTS affects workers in many fields. It is common among draftsmen, meatcutters, secretaries, musicians, assembly-line workers, computer users, automotive repair workers, and many others. CTS can be treated with steroids, anti-inflammatories, or physical therapy, or with surgery to loosen the transverse carpal ligament. Recovery of wrist and hand function is often, but not always, complete.

### Causes

Like many skeletomuscular disorders, CTS has a variety of causes. It is most often the result of a combination of factors. Among these are:

Genetic predisposition. Certain people are more likely than others to get CTS. The amount of natural lubrication of the flexor tendons varies from person to person. The less lubrication, the more likely is CTS. One study has related the cross-sectional shape of the wrist, and the associated geometry of the carpal tunnel, to CTS. Certain tunnel geometries are more susceptible to tendon irritation.

Health and lifestyle. People with diabetes, gout, and rheumatoid arthritis are more prone than others to develop CTS, as are those experiencing the hormonal changes related to pregnancy, menopause, and the use of birth control pills. Job stress has also been linked to an increased likelihood of CTS. And CTS seems to be more frequent among alcoholics.

Repetitive motion. The most common cause of CTS that's been attributed to the workplace is repetitive motion. When you flex your hand or fingers the flexor tendons rub against the walls of the carpal tunnel. If you allow your hand time to recover, this rubbing is not likely to lead to irritation. The amount of recovery time you need varies from fractions of a second to minutes, depending on many circumstances, including the genetic and health factors mentioned above, as well as the intensity of the flexing, the weight of any objects in your hand, and the extent to which you bend your wrist during flexing.

Trauma. A blow to the wrist or forearm can make the tendons swell and cause or encourage the onset of CTS.

### Prevention

Computer keyboard users can take several steps to lower their chances of developing CTS. Some of these center around the configuration of the workplace, or "ergonomics." Others have to do with human factors.

Ergonomics. Proper seating is crucial to good ergonomics. The height of your seat and the position of your backrest should be adjustable. The chair should be on wheels so you can move it easily. Arm rests on the chair, though optional, are often helpful.

Table height. To adjust the chair properly, look first at the height of the table or desk surface on which your keyboard rests. On the average, a height of 27-29 inches above the floor is recommended. Taller people will prefer slightly higher tables than do shorter people. If you can adjust your table, set your waist angle at 90 degree, then adjust your table so that your elbow makes a 90 degree angle when your hands are on the keyboard.

Wrist angle. If your keyboard is positioned properly your wrists should be able to rest comfortably on the table in front of it. Some keyboards are so "thick" that they require you to bend your hands uncomfortably upward to reach the keys. If so, it will help to place a raised wrist rest on the table in front of the keyboard. A keyboard that requires you to bend your wrists is a common cause of CTS among computer users.

Elbow angle. With your hands resting comfortably at the keyboard and your upper arms vertical, measure the angle between your forearm and your upper arm (the elbow angle). If it is less than 90 degree, raise the seat of your chair. If the angle is greater than 90 degree, lower the seat. Try to hold your elbows close to your sides to help minimize "ulnar displacement" - the sideways bending of the wrist (as when reaching for the "Z" key).

Waist angle. With your elbow angle at 90 degree, measure the angle between your upper legs and your spine (the waist angle). This too should be about 90 degree. If it is less than 90 degree, your chair may be too low (and your knees too high). Otherwise, you may need to alter the position of the backrest or adjust your own posture (nothing provides better support than sitting up straight). (Note: If making your waist angle 90 degree changes your elbow angle, you may need to readjust the height of your chair or table.)

Feet. With your elbows and waist at 90 degree angles, your feet should rest comfortably flat on the floor. If they don't, adjust your chair and table height and repeat the steps above. If your table isn't adjustable and your feet don't comfortably

reach the floor, a raised footrest can help. Otherwise, you may need a different table.

### Work routine

You need very little recovery time between keystrokes to cool and lubricate the flexor tendons. If you type constantly, however, the need for recovery builds. Further, working with your hands bent upward at the wrists or frequently bending your wrists sideways heightens the friction within the carpal tunnel. It takes longer to recover from these motions. Working under stress (deadline pressure, anger, or other anxiety) can make matters even worse.

Many studies recommend a 10-15 minute break each hour to give yourself the recovery time you need. This needn't be a break from productive activities - just a break from your keyboard. Exercises can help, too. Try the following:

a) Make tight fists, hold for one second, then stretch your fingers out wide and hold for five seconds. Repeat several times.

b) With arms outstretched in front of you, raise and lower your hands several times. Rotate your hands ten times (make circles in the air with the fingertips).

Variety is the key. CTS occurs most frequently in workers whose motions are not only repetitious but are kept up for hours at a time. If you use a keyboard, structure your workdays to include a mix of activities each hour. For example, instead of typing all morning and filing all afternoon, mix typing and filing throughout the day.

### Early detection

The most painful cases of CTS are those that have gone undetected or untreated over a long time. CTS can be caught easily in its early stages, however, and much of the pain and all of the disability avoided.

Early symptoms include a tingling in the fingers, often beginning several hours after work activity has stopped. Because of this delay in the appearance of symptoms, many CTS sufferers don't make the connection between their work activities and the pain they feel until it's too late. The tingling can lead, over time, to stiffness and numbness in the fingers and hand, and then to severe wrist and hand pain.

For many individuals the early symptoms of CTS go unnoticed. Employers and co-workers can help one another identify the onset of CTS by watching for and pointing out any unconscious shaking of the hands, rubbing of the wrists, or unusual postures or hand positions at the keyboard.

At the first sign of CTS, you should be examined by a doctor who specializes in hand and wrist disorders. The doctor can perform a number of simple tests to detect CTS, and can prescribe specific steps for avoiding the problem.

### Summary

Carpal tunnel syndrome is common among computer keyboard users. It can strike anyone, and its consequences are serious. Awareness of the problem and its causes is crucial to preventing CTS. With proper ergonomics and attention to the work routine you can prevent CTS; with early detection and treatment it need never become debilitating. The employer's attention to stress levels, proper ergonomics, and the early warning signs of CTS are important in keeping the ailment at bay in the workplace.

 Summary

We hear a lot about hazards associated with working with computers, and learn from experience that long hours at the keyboard can bring on eyestrain and various aches and pains. These concerns, and the steps we can take to make computer work safer

and more comfortable are the subject of many books and articles.

The good news is that problems can be avoided through well-designed offices, properly set-up workstations, and sensible work habits. Checklists and guidelines for setting up and using computers abound. The bad news: there is substantial variation in opinion as to what constitutes proper workstation set-up, quick and easy solutions to ergonomic problems are not always possible, and checklists don't capture the complexities of the possible combinations of people, task, equipment, and workspace. Fortunately, there are measures that really do work. A few quick and universally agreed upon precautions:

* Use the minimum force necessary to press the keys.
* Vary your tasks during the day to avoid sitting in one position for several hours or performing the same hand motions without interruption.
* Take periodic breaks.
* Keep your wrists in a natural, unforced, straight position.

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