International Society of Computer-related Health Hazards

Mission Statement
To gather information, educate, perform research and advocate for prevention and treatment of computer-related health hazards.

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Disabilities Related to the Use of Computers: the Health Hazard of the Technology Age

INTRODUCTION

Today, individuals of all ages in a wide variety of jobs use computers. It has been noted that 53% of Americans use computers daily for work, education and recreation. As computer usage increases so do the medical problems related to computer usage. Computers and their attendant peripherals can cause such disabilities which, in the workplace, lead to workers' compensation (WC) claims. Computer usage can cause joint pain and/or fatigue involving the neck, shoulder, elbow (e.g., tennis elbow), wrist and fingers (e.g., carpal tunnel syndrome and tendonitis), lower back pain (e.g., sciatica) and even knee problems. These disabilities are called Repetitive Strain Injuries (RSI's) which constitute a class of pathologies caused by excessive frequent use of a particular joint or tissue, especially in combination with awkward positioning and/or inadequate or no rest periods. Among these musculoskeletal injuries, lower back pain is the most common, followed by neck, arm and finger pain and numbness. Other often-used terms, which mean the same thing as RSI include Cumulative Trauma Disorder, Repetitive Motion Injury, Repetitive Trauma Disorder and Overuse Syndrome.

Visual disturbance such as eyestrain, dry eye and refractory problems are some of the well-studied side effects associated with computer usage. Migraine triggers and tension headaches are reported in the literature. Psychological issues such as anxiety and depression are also associated with the use of computers. The surrounding low-frequency electromagnetic fields and job stress associated with computer use are suggested by some to affect reproductive outcomes in women. However, this issue is yet to be proven by valid scientific research, since there have been several research projects that do not support any reproductive effects associated with computers.

Medical treatment of injured workers closely parallels the medical treatment of injured athletes. However, the difference between the athlete and the industrial worker with regard to the purpose of activity and the pressure to continue the activity is that the athlete does it for enjoyment and self-esteem while the worker does it for survival and financial necessity. Nevertheless, sports medicine research may be applied to the treatment of injured industrial workers. For purposes of this discussion an individual who spends the majority of his/her workplace time using a computer may be termed a "computer athlete." An experienced keyboard user performs 10,000 keystrokes per hour. Office work

has traditionally been categorized as sedentary, a term that belies the continually flying fingers of computer athletes. However, the most competent computer-using office workers everywhere are at greater risk for physical injury than are workers in heavy industrial occupations. Office workstations have been fine-tuned and "improved" to provide everything the computer user needs within arms' length. However, these super-efficient workstations fail to allow for much needed recovery time (such as walking to a supply room or to a non-local printer) for the dedicated office worker.

Fast-paced and/or heavy work loads and performance stress all serve to accentuate the problems of prolonged repetitive forceful or awkward hand movements, poor posture or holding for an extended period a posture that promotes muscle tension, poor conditioning of heart and lungs and poor muscle endurance, poorly fitting furniture and the basic inadequacies of keyboard design. Therefore, the principal causes of RSI's and other disorders are 1) pressure for speed and endurance of the small muscles of the hand and forearm, as well as 2) the static posture of the trunk, neck, shoulders and arms.

CAUSATION

The role of the treating physician is to make an accurate diagnosis and give an opinion of the work-relatedness of the injury (causation). An acute work injury such as a broken bone resulting from a fall has clear causation. The diagnosis is easily made with the help of an x-ray, the work-relatedness is unambiguous and the onset of injury is precise. However, in repetitive strain injuries (RSI's), the diagnosis, work-relatedness and the onset of injury are often unclear.

The medical model for studying causation utilizes three different methods, 1) biopsy, 2) epidemiological, and 3) physiological. First, biopsy, is the classic approach which simply requires a sample - or biopsy -- of the suspected injured tissue. The introduction of the causative agent, i.e., computer, should result in the development of the disease. In RSI's biopsies are not routinely done because they usually will not affect the treatment plan. Tissue biopsies with significant abnormal results have been reported in different conditions such as carpal tunnel syndrome. The most noteworthy study in this area was conducted in 1990 by F. Schuind et al. The second method is epidemiological where the association between the causative agent (computer) and the injury is established by studying the increased rate of occurrence of a particular injury in the population being studied. A fictitious example of an epidemiological study is one in which 100 normal individuals with similar demographic backgrounds are divided into two groups of fifty each. Only those individuals in Group A are exposed to extensive computer use. After a specified length of time, both groups are tested using electrodiagnostic studies. The individuals in Group A exhibit a significantly higher rate of carpal tunnel syndrome. One may conclude that there is an association between computer use and the development of carpal tunnel syndrome. The third method is the physiological approach. This consists of pertinent patient history, physical examination and abnormal results of diagnostic testing such as imaging, thermography and nerve testing.

At risk in RSI's is the musculotendon unit where muscle and tendon join. When microtrauma exceeds the tissues' ability to recover, injury occurs. Microtrauma of the musculotendon unit produces inflammation and swelling of muscle and tendon fibers which result in a reduced blood supply to the injured tissues and eventually scarring in which fibrous tissue forms, replacing healthy muscle tissue. The use of muscles increases blood flow to that area with dilation of blood vessels leading to edema (swelling) or fluid collection in the spaces outside the blood vessels and muscles. The swelling occurs in a confined space which leads to resistance of blood flow to muscle and tendinous tissues, resulting in

insufficient blood supply or ischemia. Reduced blood circulation provides an inadequate supply of oxygen and slows the removal of metabolic waste products. If the muscle areas are repeatedly subjected to ischemia due to excessive use, the muscles become shortened and more subject to microtrauma.

The muscle disorder of RSI appears to precede and probably leads to neurovascular entrapment, the compression of nerve tissue and blood vessels, such as carpal tunnel syndrome, a pressure on the median nerve at the wrist. If the muscles become swollen and enlarged in a confined space, pressure on the nerve of the area occurs and leads to compression of neural tissue. This may cause numbness and tingling, decreased sensation, and weakness. Nerve entrapment may also occur in the neck (radiculopathy), chest (the thoracic outlet syndrome), elbow (the cubital tunnel syndrome), or anywhere along the course of a nerve.

Continued use of the hands and arms after the computer operator experiences symptoms increases the risk of permanent injury and the individual may eventually be forced to give up use of the hands entirely because of the severity of the pain.

PAIN

What is pain? The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." Pain is an unpleasant sensation induced by stimulation of the pain pathways transferring the message to the central nervous system, which, in turn, will process and modify the message. There are three kinds of pain: 2) nociceptive; 1) neurogenic; and 3) psychogenic. The origin of nociceptive and neurogenic types of pain are embedded in the peripheral nervous system while the psychogenic type of pain is rooted in the central nervous system. Only the first two of these will be discussed here.

Nociceptive pain occurs when the pain receptors of the sensory nerve fiber are triggered by mechanical compression or chemical irritation secondary to damaged tissue. When there is a tissue injury, the body responds by releasing chemicals that cause excitation of the nerve endings which mediates the pain perception. Furthermore, these chemicals cause hypersensitivity of the nerve endings. Hypersensitivity is when the perception of pain is magnified, but the pain, nevertheless, is real. The chronic stimulation of the sensory nerves may be processed in the central nervous system so that even stimuli not normally harmful to the tissue may convey a perception of pain. Neurogenic pain occurs when the sensory nerve fiber is directly irritated, as, for example, in sciatica or carpal tunnel syndrome.

FATIGUE

All structures have a breaking point. A strong, sudden force may cause disruption with just one occurrence. A weaker force, repeated over time, will eventually cause fatigue and disruption. Fatigue is the inability to generate or sustain a desired force due to mechanical, metabolic or electrophysiologic limitations of the neuromuscular pathways. Fatigue may cause the work to be performed with less care or precision, thereby leading to otherwise preventable accidents - not to mention less than satisfactory production.

The possible mechanisms involved in the development of work-related fatigue and pain are:

1) Motor control -- The hundreds of muscle fibers in a specific muscle like the biceps are activated in a graduated manner according to the forces necessary. Therefore, only a limited number of muscles are recruited to perform a low-force task. A continuous demand only puts more stress on those few muscle fibers in use while the rest are spared. This phenomenon may cause muscle injury and therefore pain and fatigue in those few muscle fibers that are in continual use.

2) Mechanical forces - There is an upper limit of stress to which muscles, tendons, bones, skin and other tissues can be subjected and beyond which injury will occur. This limit varies greatly from one individual to another. Mechanical overload may cause disruption of the internal structures of the muscle fiber along with release of chemicals inducing inflammation and therefore pain.

3) Intramuscular pressure - This pressure is increased during muscle tension. Studies show that pressure of approximately 30 mm of mercury (Hg) and above maintained for a long time lead to muscle damage that can be objectively quantified 48 hours following a pressure increase. The increase in intramuscular pressure impairs the blood flow to the muscle, reducing delivery of nutrients such as oxygen and glucose.

4) Metabolic crisis - Impaired blood flow leads to accumulation of lactic acid, potassium outside of the cell and calcium inside of the cell as well as free radicals and other toxins. This constitutes a metabolic crisis leading to muscle injury.

These four mechanisms involved in the development of work-related fatigue and pain provide us with the knowledge about how to intervene, thereby preventing workplace injuries. Some of these interventions are:

A) Reducing local mechanical loads that exceed the tissue point of failure. See Example following B) below

B) Avoiding prolonged highly repetitive work. Example for Numbers #1 and #2: Silverstein demonstrated that work exposure from low force to high force and from low repetition to high repetition increases the odds ratio for hand and wrist tendonitis in 574 male and female workers studied.

C) Reducing work intensity so that it does not exceed the body's energy metabolism capacity. Example: A study by de Krom demonstrated a significant increase in odds ratio for developing carpal tunnel syndrome defined electrodiagnostically by spending 20 to 40 hours per week doing work involving wrist extension and flexion.

D) Avoiding prolonged static muscular loads and nsuring adequate recovery after each work period. Example: Snook demonstrated that the repetitive motion of the wrist increasing from 2-20 per minute the force that the workers could exert, dropped by about one third, thereby illustrating the necessity of intermittent breaks to prevent fatigue and potential injury.

E) Insuring optimal joint range of motion. Example: Sakakibara showed that looking upward to pick fruit can compromise cerebral blood flow, especially if coupled with twisting of the neck.

NUMBNESS

Nerve tissue can be injured or irritated by elevated hydrostatic pressure, mechanical contact or stretching. Artificial increases in the pressure of the carpal tunnel beyond 30 mm Hg induces symptoms

mimicking those of carpal tunnel syndrome (progressive sensory loss, then motor loss). These symptoms appear over hours or even minutes. Rempel showed that backward movement of the hand beyond 30? increases the pressure within the carpal tunnel above 30 mm Hg. This pressure, if maintained for substantial periods of time, e.g., sitting at a computer for seven hours a day, decreases micro-circulation which causes carpal tunnel syndrome. Cadaver tests have shown that the median nerve is trapped between the flexor tendons and the flexor retinaculum. If the wrist is held in a flexed posture combined with pinching or gripping

CONCLUSION

Computers are here to stay and their applications will continue to expand, so we must learn to take preventive measures and try to condition our bodies through proper body mechanics by overcoming muscular weakness, skeletal misalignment and structural instability. Egoscue referred to these issues as dysfunctions, emphasizing that they precede the onset of pain attributed to accidents, overuse and aging. Treatment is difficult if delayed. Rest and modified activity are a vital part of any treatment. Later, strengthening exercises must be done - but in a graduated program that does not increase the injury. Medical treatment varies from conservative measures such as: activity modification, exercise, bracing, modalities, chiropractic manipulation, anti-inflammatory medications, pain-killers, muscle-relaxants, anti-depressants to the more invasive interventions such as acupuncture, steroid injections and surgery. However, some people have bodies that can never be suitable for what they are attempting to do. Modes of intervention in injuries related to the use of the VDTs include: Work reorganization (work rates, task variation, work pauses), workstation adjustment (chair, desk, Video display unit, keyboard, mouse) and environmental modification (lighting, temperature, noise.) Ergonomics is the study of the design of work in relation to the physiological and psychological capabilities of people. An ergonomic evaluation would identify the risk factors associated with their injury and implement steps towards reducing those risk factors. Furthermore, as preventive measure, ergonomic assessment and education should be a routine part of pre-employment training for individuals using personal computers, (and health care professionals as well). This approach will prevent human suffering, improve job satisfaction and productivity and reduce the cost of health care. Early intervention and evaluation by a specialist knowledgeable in evaluation, documentation and treatment of the computer-related disabilities are key factors to consider.

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BIOGRAPHY

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