# The benefits of breaks and micropauses - a survey of the literature

## Wellnomics White Paper

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January 2000

The following papers were found through existing known reference and online searches of the Medline, CINAHL, PsycLIT and Wilson Social Science Index.

Keywords used were: pause, rest break, static load, occupational health, fatigue, Occupational Overuse Syndrome (OOS), Repetitive Strain Injury (RSI), Cumulative Trauma Disorder (CTD), musculoskeletal disorders, data entry, computer users, visual display unit (VDU), visual display terminal (VDT).

*They are listed chronologically.*

### W. Laporte, "The Influence of a Gymnastic Pause Upon Recovery Following Post Office Work." *Ergonomics* 9, no. 6 (1966): 501-506.

This study identified (by interviews and observations) a "critical" point of fatigue in a group of Post Office workers in the afternoon of work. The investigators implemented a 10-minute pause at this time of the day. One group performed a "gymnastic" pause (exercises for the arms, legs, neck and trunk to music) and one group a passive pause. Three psychophysical tests measuring fatigue and a hand grip strength were performed before and after the pauses. They found that the "gymnastic" pause was superior to a passive pause in relieving fatigue. There is no description of the tasks the workers were doing or if there were any reports of musculoskeletal discomfort.

### D. B. Chaffin, Localized Muscle Fatigue - Definition and Measurement. *Journal of Occupational Medicine* 15, no. 4 (1973): 346-354.

A fairly landmark study regarding fatigue. Chaffin asserts that increased muscle tremour after sustained exertion of muscles used to support the forearm and hand in a static posture, results in a great increase in the time it takes a person to perform 2 different types of task requiring precision positioning of the hands. He describes a 0neuromuscular theory for fatigue mechanisms: a sustained contraction of a muscle can result in the fibres losing their tension producing capacity, additional motor units are then needed to maintain the total tension state of the muscle. The increased number of active motor units is accomplished by increased tension in the spindle sensory systems, thus facilitating central nervous system commands to the motor units that produce movement and tension. The paper then discusses what is now commonly known as the "muscle tension theory of OOS". Design recommendations are then given with respect to muscle fatigue. Rest breaks are not mentioned.

### W. Rohmert, "Problems of Determination of Rest Allowances. Part 1: Use of Modern Methods to Evaluate Stress and Strain in Static Muscular Work". *Applied Ergonomics* 4, no. 2 (1973): 91-95.

This is a classic, landmark study of fatigue and recovery that is often referred to in other papers. The paper asserts:

- No reduction in maximum strength occurs if holding force is limited to 15% of maximum strength.
- The longer the tiring static work lasts the greater the reduction in available maximum strength.
- With the same holding time, the reduction in available maximum strength is greater the heavier the previous tiring holding work was.
- There are no differences between groups of muscles used if forces are related to the individual maximum force. Similarly, there is no difference from worker to worker if forces are related to the individual maximum force.
- Recovery is a function of the degree of fatigue. Compensating for the same decrease in maximal strength takes the same amount of recovery eg a 10% decrease in maximal strength takes 0.72min for recovery.

Rohmert also suggests natural alternations between tiring continuous work and recovering relaxation must only be interrupted by additional rest pauses in those cases in which:

- The intensity of each muscle contraction is too high.

The speed is not optimal.

The relationship between time for relaxation and contractions is too small.

Static muscle components with greater than 15% maximum voluntary contraction (MVC) are included.

The duration of a resting period necessary to remove any remainder of fatigue in static muscle work was considered and found to be dependent on force and duration of muscle contraction, in the manner of an exponential function linked by a multiplication formula. Eg doubling the hold time from 25% to 50% of maximum time (exhaustion time) requires the rest allowance be increased from 150% to 400%.

### W. Rohmert, "Problems of Determination of Rest Allowances. Part 2: Determining Rest Allowances in Different Human Tasks." *Applied Ergonomics* 4, no. 3 (1973): 158-162.

Physiologically orientated methods have been developed and are presented in this paper to calculate rest allowances for different work tasks. VDU tasks are not included due to the age of this paper. It is, however, asserted that with the exponential increase of fatigue during work the rule of thumb for rest breaks is little and often. This ensures short working periods with a small average degree of fatigue as well as the frequent experience of the high rate of recovery at the beginning of a break. The exception noted for this rule is that breaks do cause a loss on skill, physiological and psychological adaptation to work, and length and frequencies of breaks have to be adjusted accordingly.

### M. Hagberg, "Muscular Endurance and Surface Electromyogram in Isometric and Dynamic Exercise." *Journal of Applied Physiology* 51 (1981): 1-7.

This study aimed to investigate endurance times of skeletal muscle. That is, the time that a muscle can maintain a required force. Endurance times for sustained isometric (static), dynamic and intermittent exercise of the elbow were measured at different contraction levels. The intermittent exercise consisted of 2 seconds contraction and 2 seconds rest. Results showed rapid decrease of endurance times at levels greater than 15-20% MVC for both sustained isometric and dynamic exercise. Endurance times were increased in intermittent isometric exercise compared with the sustained isometric exercise. The extrapolated contraction level that could then be maintained for 1 hour was 8.2% MVC for the sustained isometric and 25.1% MVC for the intermittent exercise. It is suggested that this is because blood flow is impaired in the sustained contraction which leads to an accumulation of metabolites and a subsequent depletion of energy which impairs the contraction process and causes local muscle fatigue. Hagberg also suggests that in the intermittent exercise the blood flow removal of contraction-inhibiting metabolites is facilitated by the rest periods. Rest breaks as short as 2 seconds may then enhance endurance times significantly, as in this study.

### K. Kogi, "Finding Appropriate Work-Rest Rhythm for Occupational Strain on the Basis of EMG and Behaviour Changes", in *Kyoto Symposium: Electroencephanolography and clinical neurophysiology,* eds. P. A. Buser, W. A Cobb, T. Okuma (Amsterdam: Elsevier, Biomedical Press, 1982), 738-49.

Types of fatigue indicators are discussed in this paper, the need to take rests and the redesign of work-rest cycles to take these indicators into account. Kogi asserts that the maximum endured time in a static contraction and time onset of local pain has a linear relationship with sustained force as a percentage of maximum voluntary contraction (MVC). He found that even for a 10-20 % MVC pain could be felt within several minutes in a sustained elbow flexion task. Fatigue was seen to be avoided by spontaneous alternation of active muscles during an overhead tracking task using a lever when EMG recordings were studied. The author's EMG studies on light industry tasks lead him to recommend that the work-rest cycles need to be adjusted at two different levels. Firstly, the contraction cycle of each contraction must be appropriate to ensure brief intra-work pauses without static load. Secondly, there must be break after a certain period of continuous work. He also suggests that common systems with 1-2 breaks and lunch are not appropriate for repetitive tasks. He asserts work schedules need to be changed to ensure spontaneous pauses are taken frequently in order to prevent excessive muscle fatigue. Kogi feels EMG data is useful in helping to determine the most appropriate schedules.

### M. Hagberg and S. Kvarnstrom, "Muscular Endurance and Electromyographic Fatigue in Myofascial Shoulder Pain," *Archives of Physical Medicine and Rehabilitation* 65, (1984): 522-525.

An endurance test was conducted on patients with at least one-year history of diffuse shoulder-neck pain. Each patient had to hold both arms in a static position of 30° flexion for as long as possible (the endurance time). EMG recordings were made. All patients demonstrated shorter endurance on their painful side or more painful side. EMG showed muscle fatigue on both sides. EMG signs of fatigue were faster on the painful side for the trapezius muscle but not supraspinatus muscle, but not significant. The findings suggest that the short endurance time in these patients is an effect of localised fatigue and that the patients' disorders had changed the work capacity of the shoulder muscles.

### H. T. Zwahlen, A. L. Hartmann,. and S. L. Rangarajulu, "Effects of Rest Breaks in Continuous VDT Work on Visual and Musculoskeletal Comfort/Discomfort and on Performance", in: *Human-Computer Interaction* ed. G. Salvendy, (Amsterdam, Elsevier Science, 1984)

An experiment was conducted with typists working on a VDU with mixed tasks: a data entry task and a task correcting errors on the screen. The tests were carried out during 2 full working days. A 15-minute rest break was given in the morning and afternoon and there was a 45-minute lunch break. At the beginning and end of each work period a discomfort rating was completed on screen by the typists. The typists were on an incentive pay scheme. The results showed that the rest breaks were beneficial in reducing musculoskeletal discomfort. The scores for visual discomfort were not as high as musculoskeletal scores and did not decrease as much with breaks. A considerable cumulative effect was seen over the course of the day for both musculoskeletal and visual discomfort. Keystroke rate was slightly higher after breaks but there were no error trends evident. The authors concluded that 2 rest breaks in addition to lunch appeared not to be sufficient to adequately reduce musculoskeletal and visual stress in continuous VDU work. However, sample size was small (n=6).

### R. E. Janaro and S. E. Bechtold, "A Study of the Reduction of Fatigue Impact on Productivity through Optimal Rest Break Scheduling" *Human Factors* 27, no. 4 (1985): 459-460.

This study compared work output when using a self-determined rest break policy and when using a rest break policy model that was developed. Fatigue was operationally defined as the "decrease in performance due to prolonged activity". The model is based on the assumptions that: work rate is a continuous function of time; that work rate decreases linearly through out periods of work; no work occurs during rest periods but work rate potential increases linearly throughout; rest periods end at the instant full recovery is reached and a time penalty is associated with each rest period (to return to work station or resume work etc). The model uses an algorithm to determine the "best" number of rest breaks. The experimental subjects rode a bicycle ergometer in 4 separate sessions. The first was for diminishing apprehension, the second for data collection of decay and recovery rates, the third the subjects rode using self-determined breaks and in the fourth were instructed to rest according to the model. Results showed that output was greater and there were more rest breaks with the model policy than the self-determined policy. Extrapolation of the results into work situations and in particular VDU tasks is questionable.

### M. Hagberg and G. Sundelin, (1986) "Discomfort and Load on the Upper Trapezius Muscle when Operating a Wordprocessor." *Ergonomics* 29, no. 12: 1637-1645.

This study measured discomfort and load on the trapezius muscle by EMG during VDU work. The effects of introducing short pauses were evaluated. The types of work periods used were:-

- 5 hours continuous with coffee breaks and lunch.
- 3 hours continuous with coffee breaks.
- 3 hours of work with short pauses 10 times per hour reminded by soft music playing for 15 secs every 6$^{th}$ minute.

The operators were instructed to put their hands on their laps and try to relax their shoulders and arms during the pauses. Operators were allowed spontaneous short pauses also. Musculoskeletal and visual discomfort was rated by the operators before and after VDU work periods. The number of pauses was noted from video reco0rdings. Electromyographies (EMG) of the upper trapezius muscles were taken. MVC of shoulder elevation was measured before each work period. The discomfort ratings increased after all 3 work periods. This was less where short pauses were introduced. Spontaneous short pauses were fewer when operators were reminded by the music to pause. EMG recordings showed no significant difference in load levels in the 3 work periods. There was a negative correlation between the number of spontaneous short pauses taken by the operators and the static median loads on the upper trapezius. The investigators were not able to demonstrate any effect of the introduced short pauses on muscle load, though the discomfort rate decreased. The paper reports that physiological studies indicate that pauses can be short (2s) but need to be taken frequently to enhance endurance and decrease fatigue.

### B. Jonsson, "The Static Load Component in Muscle Work," *European Journal of Applied Physiology* 57, (1988): 305-310.

It is suggested in this paper that static loading may be the most important factor in muscular fatigue during work. Past research is reviewed, including the research that suggests that static load should not exceed 5% MVC and that fatigue will appear after one hour at 5% MVC. It has been suggested that job rotation helps to decrease static load. In this paper EMG recordings were taken from electronic assembly tasks, glass blowing and mining tasks involved in job rotation schemes. In some of the less dynamic tasks there was very little difference in muscle load between the tasks. This suggests that if seeking to decrease static load by varying tasks, the type of tasks included in the rotations is important.

### R. A. Henning, S. L. Sauter, G. Salvendy and E. F. Krieg, "Microbreak Length, Performance, and Stress in a Data Entry Task," *Ergonomics* 32, no. 7 (1989): 855-864.

The effects of brief rest pauses were evaluated in terms of performance and well being for a repetitive data entry task. The evaluation was in a simulated office environment and consisted of 6 40-minute work periods. There was a 10-minute break away from the workstation between work periods and a 45-minute lunch break. The subjects (n=20) were given a microbreak after 20-minutes of work. The length of this was self-regulated and the subjects were instructed to resume work when they felt ready to continue. A mood survey (to measure tension, fatigue, irritation, boredom and perceived stress) was computer administered before and after each 40-minute work period. Results showed that the mean microbreak length was 27.4 seconds, keystroke output was significantly less and the correction rate greater in the second half of the work period. Microbreak length was predictive of correction rate and heart rate eg a long microbreak predicted low correction rate and a lower heart rate in the second half of the work period. A high level of "fatigue" and "boredom" were associated with long microbreaks. 'Tension', 'fatigue' and 'irritation' levels significantly elevated above resting levels throughout the sessions. The authors proposed that the decreased output and increased correction rates in the second half suggest that discretionary rest breaks were not effective in controlling fatigue as the worker terminated the break before performance recovery was completed. This may be done to avoid task interruption and loss of adaptation to work. Also, it was suggested that a single microbreak might not provide sufficient time to allow adequate recovery. They concluded that microbreaks are instrumental in reducing fatigue and associated performance decrements but in order for workers to receive the full benefits of a scheduled break the length may need to be more closely controlled.

**N. G. Swanson, S. L. Sauter and L. J. Chapman. "The Design of Rest Breaks for Video Terminal Work: A Review of the Literature", in *Advances in Industrial Ergonomics and Safety I: Proceedings of the Industrial Ergonomics and Safety Conference, ed.* A. Mital, (London: Taylor and Francis, 1989): 895-899.**

This paper is a literature review of rest breaks in light, repetitive work and in VDU/ office work to 1989. Support is outlined for short, frequent rest breaks in terms of increased productivity, worker satisfaction and fatigue studies. Studies advocating activity or exercises during rest breaks are cited. The authors conclude that the evidence suggests frequent rest breaks benefit production and comfort in VDU work. (*Most of the more recent studies referenced are included in this Extended Bibliography Version 2.0 and also in WMSD and Rest Breaks*).

**G. Sundelin. and M. Hagberg, "The Effects of Different Pause Types on Neck and Shoulder EMG Activity During VDU Work", *Ergonomics* 32, no. 5 (1989): 527-537.**

EMG recordings of the trapezius and levator scapulae muscles and discomfort ratings of operators (n=12) were studied during 3 30-minute work periods of VDU work. Three different types of pauses were introduced and compared: an active pause with pause gymnastic movements (no more specifics given); passive pause (the operator relaxed her arms into her lap, leaned backwards in her chair and closed her eyes) and a diverting pause (the operator left the work station for a walk). Each pause lasted 15-20 seconds and operators were reminded of it every 6 minutes with soft music. Results showed the static muscular load was low and did not change with different kinds of pauses, though it is questionable whether 30 minutes is long enough to develop a measurable increase in muscle tension. High contraction levels differed significantly between the three types of pauses, reflecting the activity during the pause. There was greater muscle activity pattern variation with active pauses compared to passive pauses, though the percentage of reference voluntary contraction (measured before the work periods) was lower with passive pauses. Discomfort ratings tendered to be higher with passive pauses and operators tended to find pauses with activity more relaxing than passive pauses. The operators generally regarded the introduced pauses as disturbing to their work routines.

**S. E. G. Byström, S. E. Mathiassen and C. Fransson-Hall. "Physiological Effects of Micropauses in Isometric Hand Grip Exercises," *European Journal of Applied Physiology* 63 (1991): 405-411.**

These researchers studied the physiological response to a continuous and intermittent hand grip exercise to exhaustion at 25% MVC. The intermittent condition consisted of a 10-second pause every 3 minutes. They found that the maximal endurance time was 43% longer in the condition with pauses than the continuous exercise condition. The subjects also reported less fatigue with the intermittent exercise. Subjects in the pause group also returned more rapidly to their normal MVC. Blood flow was significantly higher during the rest pauses than during the contractions. However, the results did show that there were greater downward shifts in electromyography (EMG) frequency after intermittent exercise, indicating that more motor units were being recruited to maintain the same level of tension. This change lasted 24 hours compared with 4 hours in the continuous exercise group. There was no physiological evidence to explain the differences in endurance times and the authors suggest that the longer times in the pauses group could be due to differences at a sensory level and also due to psychological factors. They propose pauses could give an immediate sense of relief and therefore postpone the subjective threshold of fatigue. Due to this, they warned against using pauses to prolong muscle work exposure time and therefore risk musculoskeletal disorders. The study, however, was conducted at 25% MVC and to exhaustion so extrapolation of this risk into the VDU workplace is tenuous.

### J. Dul, M. Douwes and P. Smitt. "A Work-Rest-Model for Static Postures," in *Designing for Everyone: Proceedings of the 11th Congress of the International Ergonomic Association*, volume 1, ed. Y.Queinnec and F. Daniellou (New York: Taylor and Francis 1991): 93-95.

This paper discusses the development of a mathematical work-rest-model to predict the course of musculoskeletal fatigue and recovery during work with static postures and rest. It asserts that supplying sufficient and properly distributed rest pauses during work can prevent musculoskeletal fatigue. The model combines studies on muscle fatigue and recovery during static isometric contractions. It defines the muscle effort (% MVC) as the muscle load expressed as a percentage of the critical muscle group (the muscle with the largest effort in a given posture) strength. The work time is the duration of the muscle effort of the critical muscle group. The rest time of a work-rest period is the duration that the critical muscle group can relax after loading during the work time. The model then calculates the absolute maximum work time, which is the maximum possible holding time of the critical muscle group's muscle effort and the maximum work time, which is the remaining maximum holding time of muscle effort until exhaustion. The major output of the model is muscle fitness, which is the maximum work time as a percentage of the absolute maximum work time. Other experiments have shown that muscle fitness is linearly related to body part discomfort eg 100% muscle fitness = "no discomfort". This model, for static muscle work, predicts that for a given total work time and total rest time, many short work-rest periods are better than a few long work-rest cycles given that work periods are constant. Eg for a muscle effort of 20% and a total work time of 16 minutes and a rest time of 16 minutes, increasing the number of rest breaks from 2 to 4 to 8 to 16, the minimum muscle fitness increases from about 0 to 40 to 60 to 70% respectively. The model was trialed with subjects holding a weight with an elevated arm and showed relatively good agreement with a biomechanical model, individual muscle strength measurements and body discomfort scale. A computer program was developed and trialed by 13 Occupational Health Officers in the Netherlands to develop and support recommendations for changing work-rest times during monotonous, static posture work. The negative points of this model are commented on in Mathiassen and Winkel (1992).

### I. Kuorinka. "Prevention of VDU-Related Musculoskeletal Problems; A Shift from a Specialist's to a Participatory Approach," in *Work with Display Units 92: Proceedings of the third International Scientific Conference on work with Display Units, eds.* H. Luczak, A. Cakir and G. Cakir, (Berlin: Technische Universitat 1992): 217-220.

This paper discusses VDU related musculoskeletal problems and problems with the prevention strategies currently offered. Kuorinka suggests that the classical medical model does not explain these disorders well since they have multifactorial causes and the reaction and attitudes of the sufferers modulate outcomes considerably. She asserts that the most common prevention strategies are concerned with improvement in workstations, work organisation and/or physical activation of the workers. These approaches usually require the use of ergonomists and health professionals and she proposes that a participatory approach may be more effective. Kuorinka suggests that it can be a very effective and efficient way of improving job content and physical improvements in the work place to address musculoskeletal problems. To be successful these approaches may need to be adapted to the target group eg quantitative for technical workers, strategic for management. Kogi's[1] six step approach is cited as been proven to be valuable in implementing changes in workplaces and involves building on local practice, focussing on achievements, linking work conditions and management goals, learning by doing, exchanging of experiences and promoting worker involvement.

### S. E. Mathiassen and J. Winkel. (1992) "Can Occupational Guidelines for Work-Rest Schedules be based on Endurance Time Data?" *Ergonomics* 35, no. 3 (1992): 253-259.

This paper comments on the above paper (Dul et al, 1991) and disputes the value of the Dul model as a predictor for musculoskeletal disorders. The authors discuss how total endurance time is significantly

[1] Kogi, K. (1991) in K. Noro and A.S Imada (eds) *Participatory Ergonomics*, 73-80, Taylor and Francis, London

influenced by exercise protocol, the muscle group that is being used, changes in position and coordination and individual variants. With respect to pause breaks it comments that studies on handgrips at 25% MVC showed that a 10-second pause every 180 s increased total endurance time by 43% (Bystrom et al 1991, still trying to get hold of this article) compared to continuous exercise. The subjects' perceived rate of exertion increased at a lower rate also. However, none of the blood flow parameters or EMG frequencies differed significantly, and blood pressure and heart rate tended to be higher during intermittent exercise. The intermittent exercise induced more changes in potassium homeostasis than continuous and recovery times were prolonged. This may imply that the upset in homeostasis from pause breaks cause a delay in recovery. This paper also questions the causal link between short-term fatigue and long-term development of musculoskeletal disorders.

### C. N. Ong. "Musculo-Skeletal Disorder, Visual Fatigue and Psychological Stress of Working with Display Units: Current Issues and Research Needs," in *Work with Display Units 92: Proceedings of the third International Scientific Conference on work with Display Units, eds.* H. Luczak, A. Cakir and G. Cakir (Berlin: Technische Universitat 1992): 221-228.

This is also a review paper of current knowledge regarding issues of visual fatigue, musculoskeletal problems and stress with respect to VDU. It suggests that the highest risk of injuries is amongst keyboard operators in occupations related to data and information processing. Prevalence rates vary widely with 1% to 50% being quoted in various studies. Ong states that the US bureau of Labour Statistics in 1989 indicated Repetitive Motion Trauma accounts for more than half of all job related illness. VDU operators also have had a higher prevalence of subjective visual symptoms or distress reported. Rates again vary and have been reported to be between 40%and 92% for occasional problems and 10% and 40% for daily complaints. Higher prevalence was noted amongst conversational terminal users compared with data entry operators. Ong reports that recent findings suggest work duration (the total time looking at the screen) may be a primary factor in the visual problem. He suggests that studies have also shown the increasing importance of psychological and work organisational factors as a contributing cause for musculoskeletal problems. The main risk factors cited include heavy work pressures, surges in work load, concerns over job security, lack of social support and the amount of daily VDU work. Ong suggests elimination and prevention of these problems requires an integrated approach including improved workstation design, a well scheduled work-rest regime with adequate pauses, improved job design and employee education.

### N. G. Swanson and S. L. Sauter, "The Effects of Exercise on the Health and Performance of Data Entry Operators," in *Work with Display Units 92: Proceedings of the Third International Scientific Conference on Work with Display Units,* eds. H. Luczak, A. Cakir and G. Cakir, *(Berlin:* Technische Universitat 1992): 288-289.

This study is a follow on from a study by the same authors[2] that showed that frequent rest breaks decreased psychological and musculoskeletal strain and increased productivity in VDU workers. There was, however, still a cumulative increase in discomfort and decreased productivity over the course of the workday in the study. So, this study investigated if physical exercise inserted into a frequent restbreak schedule would further decrease or eliminate daily discomfort and productivity decrements in a repetitive VDU task. Subjects performed a data entry task at a rate of at least 6000 keystrokes per hour. They received a 10 minute break after 100 minutes of data entry in the morning and afternoon, a 3 minute break at 50 minute intervals in the morning and after 30, 65 and 150 minutes of work in the afternoon. 30-second microbreaks were taken every 10 minutes in the morning and afternoon. One group sat passively during the 3 minute and 30 second breaks while the other group did simple exercises targeting the neck, shoulders, back and extremities that were prompted on-screen. Musculoskeletal discomfort, mood and productivity were measured. No differences were seen in musculoskeletal

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[2] Sauter, S.L and Swanson, N.G. (1991) *Increases restbreaks yield increased productivity in repetitive VDT work*. Paper presented at the 35th Annual Meeting of the Human Factors Society, San Francisco, CA, September 2-6.

discomfort and mood between groups. Productivity showed no differences overall but did show a significant decline in keystroke productivity over the last half of each work day for the passive group compared with the active group. The authors concluded that there was no benefit in doing exercises but that the exercises may help to stabilise performance over the course of the workday.

### T. R. Hales, S. L. Sauter, M. R. Peterson, L. J. Fine, V. Putz-Anderson, L. R. Schleifer, T. T. Ochs, and B. P. Bernard, "Musculoskeletal Disorders among Visual Display Terminal Users in a Telecommunications Company," *Ergonomics* 37, no. 10 (1994): 1063-1621.

This cross sectional study of 533 VDU users in a telecommunication company examined relationships between workplace factors and upper extremity musculoskeletal disorders. Symptoms, demographics, individual factors, work organisation and practice were measured by self-administered questionnaires. Psychosocial factors were measured with scaled questionnaires. Physical examinations were also conducted. Descriptive statistics showed 22% of participants met the criteria for an upper limb disorder. Statistical analysis showed modest associations between an upper limb disorder and non-white race, thyroid conditions, and use of bifocals. Seven psychosocial work factors were also associated with the disorder: increasing work pressure, fear of being replaced by computers, surges in work load, routine work lacking decision-making opportunities, high information processing demands, jobs which required a variety of tasks and lack of a production standard. There were several limitations to this study including exposure misclassification due to self-reporting biases and the cross sectional design, which limits causal inferences.

### P. Koparadekar and A. Mital, "The Effect of Different Work-Rest Schedules on Fatigue and Performance of a Simulated Directory Assistance Operator's Task," *Ergonomics* 37, no. 10 (1994): 1697-1707.

A telephone directory assistant's data entry task was simulated to determine the preferable work-rest schedule. The schedules were:- 30 minutes followed by a 5 minute break; 60 minutes followed by a 10 minute break; 120 minutes without any break. Number of errors and subjective feelings of alertness, boredom and fatigue before and after the tasks were measured. Results showed that performance did deteriorate when the work duration was increased from 30 minute to 60 minutes by 11% more errors but this was statistically non-significant (but practically significant?). If no rest is then provided performance deterioration becomes large with errors increasing by almost 80% during 120 minutes of continuous work. Similarly, the subjective responses did not change significantly between 30 and 60 minutes but did deteriorate significantly after 120 minutes without a break. Deterioration in performance was halted after a rest break.

### S. E. Mackinnon and C. B. Novak. "Clinical Commentary: Pathogenesis of Cumulative Trauma Disorder," *The Journal of Hand Surgery* 19 (5) (1994): 873-883.

This is a discussion paper on the clinical presentation of Cumulative Trauma Disorder (CTD), suggested course of treatment and a hypothesis for the pathogenesis of the disorder. These authors suggest that muscle imbalance with secondary chronic nerve compression are the main contributors to the development of CTD. They recommend that treatment includes postural training, splinting, exercises, breathing training, work station modification and frequent rest breaks.

### K. L. Barker, "Repetitive Strain Injury- A Review of the Legal Issues," *Physiotherapy* 81, no. 2 (1995): 103-106.

This paper is a review of the recent legal issues regarding Repetitive Strain Injury (0RSI) claims in the United Kingdom. The key factor for compensation is proof of causation. Plaintiffs need to prove their employers were negligent in protecting them from workplace injury and that the injury was foreseeable. The Employer's Duty of Care is to provide a safe working environment for employees and is determined by a balance between taking precautions against foreseeable risk and the expense and difficulties of taking these precautions. It is generally determined on the basis of the level of knowledge and technology available in each particular industry as a whole. Problems in proving causation are mainly due to lack of reliable, accepted diagnostic 0criteria and asserting that the injuries are in fact work related. Examples of several landmark cases are detailed in the paper. The outcome of these cases have tended to be more to do with the way cases are presented and the way the individual judges emphasis the Employer's Duty of Care than consistent rulings. It is thought that this will remain so until the House of Lords make a judgment on an appeal case. The Health and Safety Regulations do, however, impose clear employer responsibility. These include Section 2 of the Health and Safety at Work Act (1974) and the updated Health and Safety Regulations (1992). The points included in these regulations tend to be the main points cases are argued on. They include: provision of a safe working environment, provision of training and supervision to ensure safety, performance of workstation assessment and reduction of risks, provision of ergonomically sound workstation and planning of workers' activities to include breaks and changes of activities.

### U. Bergqvist, E. Wolgast, B. Nilsson, and M. Voss, "The Influence of VDT Work on Musculoskeletal Disorders," *Ergonomics* 38, no. 4 (1995): 754-762.

This study formed part of a longitudinal study of office workers in Sweden: "VDT work and health". A group of 322 office workers, VDU users and non-VDU users, were investigated through questionnaires, physiotherapy assessment and workplace assessment. A non-VDU worker was defined as someone who used a VDU for less than five hours per week and comprised 19% of the office group. Associations between the different muscle problems and current VDU work or accumulated VDU work dose, and VDU work duration and type were estimated and analyses made to evaluate certain interactions between VDT work and other factors. The results of this study showed that muscle problems were not exclusively related to VDU work. However, risk groups were identified among VDU users. Data entry work was associated with increased odds for discomforts in the neck and shoulder region, if the opportunity for unscheduled rest breaks was limited. Data entry work was also associated with discomfort of the hands and arms, if the keyboard was placed low. Working more than 20hr/week at a VDU was associated with intensive neck/shoulder discomforts if it occurred in a situation with repetitive movements for individuals who often reported stomach- related stress reactions (upset stomachs). Prolonged VDU work duration was also associated with tension neck syndrome with users of bifocal or progressive lenses. Prolonged VDU working hours was also associated with arm or hand region problems with individuals with limited rest break opportunity combined with non-use of lower arm support.

### U. Bergqvist, E. Wolgast, B. Nilsson, and M. Voss, "Musculoskeletal Disorders among Visual Display Terminal Workers: Individual, Ergonomic, and Work Organisational Factors," *Ergonomics* 38, no. 4 (1995): 763-776.

This is another paper analysing the data collected in the above study. These results were restricted to the VDU users (n=260). Univariate and multivariate analysis was used to find the major factors associated with musculoskeletal disorders in individual, ergonomic and organisational areas. Univariate associations were found between musculoskeletal problems and gender, women with children at home, age and stomach related stress reactions. Limited rest break opportunity (the inability to take unscheduled breaks) and extreme peer contacts had increased odd ratios for the majority of the musculoskeletal problems. Neck/shoulder discomforts were associated with static work posture, insufficient table space and with keyboard and VDU in a high position. All individuals with ulnar deviations reported discomforts. Arm/hand problems were associated with non-use of lower arm supports and use of high profile keyboards. Multivariate analysis revealed the combined presence of limited rest break opportunity and non-use of lower arm support produced an odds ratio of 10.1 compared with others (reference category odds ratio=1.0). The investigators concluded that the individual factors that were important in relation to musculoskeletal problems were: age, women with children at home, and stomach related stress reactions. Organisational factors showed that the limited rest break opportunity appeared to be a major factor for several muscular problems, limited or extensive peer contacts was also associated. Ergonomic factors that showed the most association with neck and shoulder problems were only sitting or only standing, highly placed keyboards and highly placed VDU. Arm/hand problems were associated with hand and keyboard position and non-use of lower arm support.

### A. M. Genaidy, E. Delgado and T. Bustos, "Active Microbreak Effects on Musculoskeletal Comfort Ratings in Meatpacking Plants," *Ergonomics* 38, no. 2 (1995): 326-336.

This study examined the effects of microbreaks on perceived rates of discomfort on workers at a meat packing plant. The employee was given control over frequency and length of microbreaks. They were told that the break should be less than 2 minutes, include stretching exercises, that they should stop work when they felt discomfort and resume work when you feel reasonable recovery. Regular breaks were unchanged. Discomfort ratings were collected three times per day during the experimental stage. Results showed higher discomfort ratings in the upper extremity without microbreaks. The average length of microbreak was 48 seconds and frequency of only 2 per day.

### R. A. Henning, E. R. Callaghan, A. M. Ortega, G. V. Kissel, J. I. Guttman and H. A. Braun, "Continuous Feedback to Promote Self-Management of Rest Breaks during Computer Use," *International Journal of Industrial Ergonomics* 18, (1996): 71-82.

Two experiments tested if a continuous feedback display could improve worker self-management of discretionary rest breaks. This was conducted since rest breaks have been shown to seldom be regulated effectively by workers (Henning, et al, 1989), since the workers tend to work until discomfort is noticeable or until a task is completed. Subjects entered lines of words on a VDU. If discretionary rest breaks did not meet a standard, a total of 30 second every 10 minutes, the computer administered a rest break. This was reduced proportionately to what had been already taken. The subjects were supplied a feedback time bar on the VDU that indicated how they were managing their breaks compared to the standard. The controls did not receive this feedback. Typists with the feedback received virtually no computer-administered breaks. Control typists received more, though non-significantly. Correction rate was lower in the feedback group and no significant differences were found in mood or musculoskeletal discomfort.

In the second experiment, typists reverse-typed on one word in each data line. The feedback indicated how the typists' discretionary rest breaks compared with the target (30s over 8 mins). Results showed greater discretionary breaks in the feedback condition than in the control and breaks were longer. Feedback condition subjects were able to manage with greater stability than the control group. Back discomfort was less in the feedback group. Typists reported more task interruption in the control group, suggesting a self managed rest system helps VDU users minimise task disruptions from short rest breaks.

### S. R. Stock, D. C. Cole, P. Tugwell and D. Streiner, "Review of Applicability of Existing Functional Status Measures to the Study of Workers with Musculoskeletal Disorders of the Neck and Upper Limb. *American Journal of Industrial Medicine* 29 (1996): 679-688.

This is a paper which reviews the relevance and comprehensiveness of existing functional status measuring instruments for epidemiological studies of Work Related Upper Limb and neck Disorders (WRULD). These tools are important in order to provide empirical evidence of the effectiveness of preventative strategies eg exercise regimes, workstation modifications and work organisation changes (including rest breaks). Twelve domains are identified that reflect the major areas of life affected by people with WRULD. These are: work, household and family responsibilities, self-care, transportation, sexual activity, sleep, social activities, recreation, mood, self-esteem, financial effects and iatrogenic effects of assessment and treatment of the disorder. Existing instruments were reviewed and only instruments that included items of work, self-care and domestic responsibilities were considered. Of these 21 instruments none covered all of the 12 domains adequately. As a response to this apparent shortfall in appropriate outcome measuring instruments the authors are developing a new 35-item functional status instrument for workers with WRULD and are completing reliability and validity studies.

**R. A. Henning, P. Jacques, G. V. Kissel, A. B. Sullivan, and S. M. Alteras-Webb, "Frequent Short Breaks from Computer Work: Effects on Productivity and Well-Being at Two Field Sites. *Ergonomics* 40, no. 1 (1997): 78-91.**

This study aimed to determine if frequent, short rest breaks had a positive influence on worker productivity and well-being during VDU work at two work sites where insurance claims are processed (n=78 and 19). At the larger site workers were divided into 3 groups: - a control group (neither breaks nor exercises), a breaks only group and a breaks and exercise group. The smaller site was evaluated with a within-subjects design, 3 weeks of no breaks or exercise was followed by 3 weeks of breaks only and ended with 3 weeks of breaks and exercises. The workers were prompted by small indicating lights to take breaks from computer work, at 15 minute intervals for 30 seconds for the first three breaks and 3 minutes for the last break in each hour, in addition to regular breaks. During the breaks only condition, workers were instructed to remove their hands from the keyboard and relax back in their chair during the 30 second breaks. During the 3-minute breaks operators performed other non-VDU work. In the breaks and exercise condition the workers were instructed to perform one stretching exercise for 15 seconds of the 30 second break and at least two during the three minute breaks. The operators were asked to complete a mood survey, measuring tension, fatigue, vigour and calm, and a musculoskeletal discomfort survey 3 times per day. Analysis was performed on reduced number due to insufficient compliance or data (n=26 to 34 and n=10 to13). Results showed that there was no significant overall treatment effect for any measures at the larger site. At the smaller site the results showed statistically significant improvement in eyes, legs and foot comfort and improved productivity with the breaks and exercise condition. The discussion suggests that the lack of results at the larger site was possibly due to the breaks not being well integrated into the task. Also, due to an incentive pay scheme it was thought the workers compliance may have dropped if they perceived a conflict between breaks and productivity goals. It is suggested that a more effective system would be if tasks could be computer tracked and rest breaks administered at the least disruptive time or if workers could self-manage rest breaks eg Henning et al 1996.

**J. Greening and B. Lynn. "Vibration Sense in the Upper Limb in Patients with Repetitive Strain Injury and a Group of At-Risk Workers," *International Archives of Occupational and Environmental Health* 71, no. 1 (1998): 29-34.**

Repetitive Strain Injury (RSI) is often characterised by symptoms that include sensory and autonomic disturbances that are not explained by major neurological signs or changes in nerve conduction velocities. Decreased vibration sensation can be an early sign of peripheral neuropathy and so this study examined vibration thresholds. Three groups were compared: (i) a RSI patient group (ii) an at risk group of intensive VDU users from a large publishing firm (iii) a control group of non-intensive VDU users. A vibrametre was used to record vibration thresholds, both above and below detection. Recordings were taken before and after 5 minutes keyboard use. Response to suprathreshold vibration tolerance was also measured after keying and subjects were asked to report any sensory experiences other than vibration. The results showed an increased threshold in both the office and the patient group. The patient group showed an increased threshold after keying and also a decreased suprathreshold tolerance with reports of pain or other types of unpleasant sensations. The authors proposed that these results might indicate fascicular and endoneurial vessel damage and a minor polyneuropathy indicating damage to small sensory nerve fibres. They suggest that measurements of vibration may be useful in patient assessment and at risk worker screening