Office Ergonomics and Exposure Assessment

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Musculoskeletal discomfort and pain in the shoulders, neck, back, and hand/wrist are common among visual display terminal (VDT) workers. Hagberg and Wegman showed that use of VDT for more than 20 hours per week was associated with excessive risk for certain musculoskeletal endpoints. Bergqvist reported that increased keyboard use increased the risk of hand/wrist problems. Foglman and Brogmus, based on the workers' compensation data, found that musculoskeletal disorders associated with computer mouse use appears to be a growing problem and deserves more research.

We have conducted two studies in an engineering firm where engineers' VDT usage has been implicated in the development of self-reported musculoskeletal discomfort. In the first study we used Intranet as a means to conduct a survey of musculoskeletal discomfort survey and of self-reported VDT usage. Anecdotal data indicated that musculoskeletal pain and discomfort are common among engineers working with VDTs in a major engineering corporation. It was decided that a survey of activities, work tasks, and discomfort patterns could be used to begin the process of investigating any association between keyboard ergonomics and workplace discomfort and injury. This report presents the methodology and process in developing a questionnaire delivered through the Intranet to survey for discomfort among engineers who perform tasks on VDTs.

An occupational medicine physician and an industrial hygienist familiar with ergonomic factors developed the content of the questionnaire. Two engineers experienced with the work site, the computer workstations, and Hypertext Mark-Up Language (HTML) contributed specific workplace information and converted the questionnaire to HTML. Preliminary data served to develop a checklist of the components of workstations and computers. The questionnaire contains several elements. Initial questions gather general data such as age, gender, height, and weight. Next are exposure assessment questions to establish computer and workstation usage. These are followed by questions on computer experience to establish historical use patterns. An important section is a discomfort survey, which allows the subject to choose an area on a body chart and then rate the discomfort in that area based on a Borg scale. A checklist of outside activities searches for activities that might be confounders for musculoskeletal discomfort. Body charts and questions were added to establish workstation postures. The initial questionnaire was further reviewed for accuracy by a vocational rehabilitation specialist at the engineering corporation. The programmers translated the questionnaire into HTML utilizing hypertext fields that were placed within questions, body charts, and tables. Buttons, pull-down menus and text boxes allow rapid data input. Graphics were imported as GIF files. The data file used a common gateway interface (CGI) script. Java script was used to manipulate certain items on the form. Informed consent issues were also addressed.

The chosen format provides three major advantages over a hard-copy questionnaire. First of all, the Intranet allows the questionnaire to be rapidly provided to each and every engineer.

Secondly, the engineers can easily answer the questionnaire by use of a simple point-and-click method. Thirdly, the individual fields allow for rapid extraction and compilation of data.

In the second study, we used a keyboard usage tracking software developed in our laboratory to study the association between engineers' actual VDT usage and their self-reported musculoskeletal discomfort. Seventy-one female and twenty-seven male engineers participated in a study profiling engineers' usage of keyboard and mouse in visual display terminal (VDT) related tasks. Number of keystrokes and mouse clicks made by these participants were recorded every second during a workday with a software-based surveillance tool installed in their personal computers. Overall, the engineers had their computers on for duration ranging from 115 minutes to 700 minutes. More than 50% of the participants had their computer on for more than 480 minutes, since most of the engineers work 10 hours per day for 4 days per week. However, the actual VDT time duration that the participants spent using the computers as a percentage of the computer-on time ranged from 1% to 65%. There was no significant gender difference in the computer-on time and in the actual VDT usage time. Total number of keystrokes made by the engineers ranged from 203 keys to 18,242 keys with a mean of 5086 keys and a standard deviation of 4386 keys. Total mouse clicks including left and right, single and double clicks, made during the workday ranged from 27 clicks to 5749 clicks with a mean of 1045 clicks and a standard deviation of 940 clicks. There was a significant gender difference in the number of keystrokes made during the day. The results showed that female engineers made more than twice as many keys as that made by male engineers during the workday, 5957 vs. 2794 keys, ($p<.001$). There was no statistically significant gender difference in the number of mouse clicks made in the workday. Participants also rated their musculoskeletal discomfort using the Borg scale. There was no apparent association between the prevalence of discomfort and duration, total number of keystrokes and number of mouse clicks.