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Examination of comptuer task exposures in radiologists: a work systems approach

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Abstract. Radiologists are intensive computer users as they review and interpret radiological examinations using the Picture Archiving and Communication Systems (PACS). Since their computer tasks require the prolonged use of pointing devices, a high prevalence of Musculoskeletal Disorders (MSDs) is reported. The first phase of this study involved conducting a Cognitive Work Analysis in conjunction with a Participatory Ergonomics approach to perform a total work system analysis. We also conducted an ergonomic survey as well as collected computer use data, specifically for the mouse and keyboard. The goal of the study was to reduce the physical exposures for radiologists. This paper presents Phase I results describing the analyses and redesign process of the radiologists tasks, training design, computer use, and selected survey results.

Keywords: work systems analysis, participatory ergonomics, computer task exposure, musculoskeletal discomfort, training

1. Introduction

Among the population of knowledge healthcare workers who use computers intensively are radiologists as they review and interpret examinations on the Picture Archiving and Communication Systems (PACS). Their prolonged use of computer pointing devices (>6 hours a day) and a high prevalence of upper extremity MSDs (recently reported as 58%) indicates a need for intervention [1]. One way to minimize this exposure is through task redesign, which may consist of decreasing the duration of exposure, improving computing postures, and reducing static loading associated with prolonged mouse usage [2].

The overall goal of this study was to reduce radiologists' awkward or non-neutral postures, repetitive motions, and MSDs associated with this prolonged usage. A secondary goal was to quantitatively compare the relative use of the computer mouse by radiologists compared to a control group of non-radiologist computer workers, and to qualitatively assess the perceived impact of mouse activities on radiologists' ergonomic symptoms.

2. Methods

2.1. Participants

The study participants consisted of radiologists who represent an injured occupational cohort. They use the PACS for 4-9 hours a day (mostly mouse use) in conjunction with a hand-held dictation system.

2.2. Work systems analysis

We conducted a Cognitive Work Analysis (CWA) with a Participatory Ergonomics (PE) approach to perform a work system analysis (Robertson et al., 2011). We examined the physical and external environment constraints of a soft-copy interpretation workflow in an academic radiology department using a CWA model based up Vincente [8].

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The research team facilitated the participatory ergonomics process with two experienced radiologists (>10 years' experience) and one Fellow radiologist. They served as Subject Matters Experts on the PE design team and provided input into the redesign effort of the input devices mapping and the hand-held Dictaphone setup.

The design process was iterative; after each mapping of the functional task priorities, the assignment schema was assessed by ease of use and level of acceptance. These evaluation sessions were conducted one-on-one and served as valuable feedback sessions for the redesign effort of the PACS input devices and the dictation system. Benefits of this bottom-up, Participatory Ergonomics (PE) design approach is the building of ownership and acceptance of the redesign effort, all leading to improved human-work system interactions [3,4,7].

2.3. Training design

We conducted a needs analysis to guide us in the design of the training. The PE design team and a researcher designed and developed the various trainings, which were based on the training needs analysis [6]. Results of this analysis determined the learning objectives, content, format, and delivery style needed to successfully train the radiologists on how to use the new input devices, set up their workstations, and adopt them into their daily workflow.

Interaction monitoring software was used to record each radiologist's total amount of computer use and interactions with the keyboard or mouse. This software was installed on sixteen PACS workstations within a radiology reading room in an academic medical center in order to track mouse and keyboard usage during interpretation of imaging studies over a 3-month period. The software has been used previously to monitor computer use on other populations, including a group of 118 university computer workers. Relative mean percentages of mouse and keyboard usage during computer work were compared between the radiologists and these university workers (a standard industry control).

Additionally, an ergonomics survey was administered to staff (attending radiologists) and trainee (residents and fellows) radiologists (n=123) in the same department which asked respondents to identify which workstation-related factors among a list of items contribute to their repetitive stress symptoms, and to rate each on a 1-5 scale regarding its perceived contribution to any repetitive stress symptoms (1=does not contribute; 2=<25%; 3= 25-50%; 4=50-75%; 5=>75%).

3. Results

3.1. Work system analysis

The work systems goals, priorities and constraints, functionality, and operations were all defined. The need for adopting a hands-free dictation system was revealed to free up the hands for input device usage. This setup would allow the radiologists to more effectively use the other input devices to read cases, and further reduce awkward postures. Results of Mapping the Operation Requirements indicated that the majority of PACS-related tasks were performed with complex and prolonged pointing and hand-held device activities. The PE design team tested several different assignment options of the main functions to a new commercially available input device.

3.2. Training design

Using the results of the needs analysis, we worked with the PE team to design the three training sessions. Train-the-trainer sessions were given by a research member to the design team on three topics: 1) computer ergonomics, 2) use of the dictation system, and 3) how to set up and use the new input devices (see Figure 1). Two of the PE design team members delivered one or more of the trainings.

Figure •. An SME radiologist is working with an ergonomist on how to teach the new setup of the highly adjustable sit/stand PACS workstation, input devices and hands-free dictation system.

3.3. Computer use: keyboard and mouse use

Quantitatively, radiologists demonstrated relatively higher mean mouse use (69% versus 42%) and much lower mean keyboard use (2% versus 22%) during computer use compared to a control group.

3.4. Selected ergonomic survey results

Qualitatively, among the 73 radiologists who responded to the survey (59% response rate), the mouse was perceived to contribute more to ergonomic symptoms than any other workstation-related factor (mean ratings: mouse=2.71; fixed table height = 2.43; keyboard = 2.04; monitor = 2.00).

4. Discussion

Having conducted a Cognitive Work Analysis in conjunction with a Participatory Ergonomics approach, we achieved an input device and Dictaphone configuration allowing more healthy and comfortable, neutral postures with equal usability. Training was designed, developed and delivered by the PE design team to instruct radiologists on how to use the new input device, the hands-free dictation system, and overall computer ergonomics. It was important to have members of the PE design team delivering the training and ensuring that the radiologists were practicing using the new devices and adopting them into their daily work flow.

Using a commercially available, alternative input device (which substitutes for many keyboard and mouse functions) and a hands-free dictation system, we have the potential to improve the safety of radiologists' work by reducing the number of repetitive motions and the unhealthy and awkward postures involved in PACS interpretation.

The radiologists' heavy mouse usage and the perceived impact of this device on their repetitive stress symptoms, indicates the need for ergonomic initiatives. Thus, these results validate and support the goal of this study. We sought to reduce these risks for MSDs through a work system effort that redesigned the input devices and dictaphone system used for PACS functional tasks along with specialized training on their use.

Overall, it is important to note that radiologists should pay careful attention to the ergonomics of their physical work environment and should be active participants in enhancing its safety. We will be quantifying the biomechanical impact of this system upon working postures and MSDs as well as the usability and acceptance of this redesign effort for the second phase of this study.

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