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Participatory Ergonomics Applied to Mammographers' Work

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A participatory ergonomics process has been initiated, the aim of which is to work with mammographers to develop interventions that will improve their work conditions and reduce their occupational exposure to risk factors for musculoskeletal discomfort. Mammography is an understudied occupation, but worthy of attention, based on the number of workers and the elevated prevalence of musculoskeletal discomfort they experience. The presentation describes the research methodology and results from the first stages of the process.

Introduction

There has been a fair amount of recognition of and research into the physical toll that sonographers (ultrasound technologists) (Magnavita *et al.* 1999, Schoenfeld *et al.* 1999, Russo *et al.* 2002, Ransom 2002, Muir *et al.* 2004, Friesen *et al.* 2006) and radiographers (x-ray technologists) (Wright and Witt 1993, Kumar *et al.* 2003, 2004b, a) experience on the job, but little attention has been paid to mammographers (Hearn and Reeves 2003, Gale *et al.* 2007, Lavell and Burkitt 2008) in the published research literature or published injury statistics. We are conducting an intervention study in which mammography is one of five imaging technology areas of interest. Through our research we are learning that mammography does not stand out, in that group of five, as a "safe" area which is free from work-related risk factors for physical and cognitive stress. Mammographers contend with physical, psychosocial, organizational, and environmental stressors on a daily basis. These stressors and some preliminary intervention concepts are discussed in this presentation of our research methodology.

Methods

The research is conducted by an interdisciplinary team consisting of subject matter experts, a designer with expertise in co-creative participatory design processes, and engineers with expertise in ergonomics, design, and intervention research.

In the first phase of the research, mammographers were recruited from local hospitals and outpatient clinics to participate in a multi-stage experience of *workbook* preparation, a discussion and idea-generation *workshop*, and intervention *concept review*. Nine female mammographers volunteered and provided informed consent. Two had four years of experience in mammography, and the rest 14 to 32 years. Five worked in another imaging modality prior to working in mammography. One of the most experienced worked in a mobile mammography unit at the time of the workshop.

Participation included completing a workbook in advance of the workshop. Workbooks were designed to elicit information on the participant's background, organization of their work tasks, and descriptions of their work environment. Preparing and submitting workbooks in advance of the workshop provides participants an opportunity for reflection and priming, and reviewing workbooks in advance provides researchers opportunities to fine tune the workshop.

The workshops were divided into four elements: introductions, review of some workbook elements and discussion of selected workbook photographs submitted by the mammographers, (issues) card sorting and voting to identify their most important challenges based on the issues they had just discussed, and intervention idea generation. The latter element is conducted from the viewpoint of design as co-creation, in which researchers provide tools to non-designers to use to express their needs and solution ideas creatively. Sanders (Sanders 2002) described this participatory methodology as a manifestation of "a belief that all people have something to contribute to the design process and that they (non-designers) can be both articulate and creative when given appropriate tools with which to express themselves".

For the intervention generation element of the workshop, participants divided into small groups based on their preference of problem/challenge they wanted to address in a 20-30 minute interval. At the end of the time period, one member from the group presented the group's results, after which the other mammographers and the researchers asked questions and provided additional ideas and suggestions. The group session fully utilized the experiences of participants and provided the participants a means to present their thoughts to the researchers, and to each other. The toolkit used in the intervention generation portion of the workshop is shown in Figure 1.

Findings

From the workbooks. Eight of nine mammographers

reported experiencing work-related musculoskeletal discomfort. When asked to describe the most physically demanding exam or procedure they perform on a regular basis, seven responses involved specific patient attributes, alone or in the context of a specific type of exam. The attributes include tenseness, mobility limitations (including wheelchair use), obesity, certain breast attributes, height difference from mammographer, and sensory or cognitive limitations. These attributes can interact with equipment or exam room design deficiencies to exacerbate the challenge to performing the exam. In describing the steps in an exam they perform frequently, those who described either a screening or diagnostic mammogram most commonly rated the most strenuous step in a range of 2-5 (on the Borg CR-10 scale), though one person rated no steps as strenuous (all 0) and one provided a rating range of 5-10 for two steps. Those who described a stereotactic biopsy rated the most strenuous step as 3 or 5.



Fig. 1 Toolkit for idea generation session portion of workshop.

Photographs submitted by the mammographers provided examples of the awkward postures they are forced to adopt in order to correctly position patients, and illustrated aspects of exam room layout and equipment design that contribute to these awkward postures. Subsequent REBA analysis (Hignett and McAtamney 2000) of a typical posture assumed when a taller mammographer positions a shorter patient for a medio-lateral (MLO) view scan yielded a score of 10 (risk level high, action is necessary soon) (Fig. 2).

Diary portions of the workbook provided insights into patterns of work exposure, with respect to types of exams, patients, and musculoskeletal discomfort encountered day-to-day.

From discussion and card sorting. The main themes that emerged from the discussions concerned problems with equipment (machine design, paddles, foot pedals), patient characteristics, room layout (exam and computer), and mammographers' work postures.

Each of these themes emerged from numerous specific points that were first written down on 4 X 6 cards by the researchers when a participant mentioned one of them during the discussion. At the end of the discussion, participants grouped the specific points into themes and then voted on what was most important to them. Next, participants divided into small groups to brainstorm and create interventions to address one of the highest priority themes.



Fig. 2 Posture assumed when positioning patient for MLO view scan, one of two views typically taken in every screening mammogram.

From intervention generation. What was most interesting were the common needs, across the groups, that were expressed through these sessions. Each small group, independent of the others, generated ideas that addressed means for providing physical support for the patient and for some alternative remote method for controlling the equipment (such as voice activation or a hand-held remote control). Other intervention ideas included means for improving communication with patients during exams and reducing patients' physical discomfort during the exam. Both of these can affect the tenseness of the patient, which in turn affects the level of difficulty of the exam.

Post-Workshop: Intervention concept generation and review. Because the participants are expressly instructed to be as open to ideas and as creative as they wish to be, the intervention ideas generated in these workshops are considered expressions of need, rather than specific means to address a specific problem. So, full review and analysis of the needs expressed through all of the venues afforded the participants (workbooks, focus group discussion, and idea generation) is an essential step in a research process that employs these qualitative methods.

From this review, a list of 125 expressions of need were identified. Each was translated into an interpreted need and initial ideas for interventions were generated by the research team. Next, ten solution themes were used to group most of the needs, and to consolidate solution concepts. This yielded a list of 28 preliminary intervention concepts. The next step is to categorize these as either low-hanging fruit, blue sky, or somewhere in between, and to categorize

them as within the scope of the current funded project, close, or out-of-scope.

Some of the concepts already exist in some form, though design modification or implementation challenges may first need to be addressed. Other concepts are only ideas and need to be developed, which is a part of this project. For each of the concepts that are either low-hanging fruit or in-between, a poster will be developed to present to the mammographers in a concept review session. The posters will describe each concept, along with the needs we believe they address. Four aspects of feedback from the mammographers will be most important at this stage: usability issues they foresee for the concept or existing solution, barriers to adoption, additional or alternative ideas they have, and priority rankings they assign to the concept solutions. Given that, as anticipated, there are many more ideas than we can pursue in this particular funded project, we want to make sure we choose to follow through with interventions that appear to be most feasible and from which mammographers would expect to gain the most benefit.

Discussion & Conclusion

The work of mammographers is an area deserving of attention by ergonomics researchers. The prevalence of musculoskeletal discomfort in our small group of participants is similar to the 70 of 84 respondents in a survey conducted in Great Britain (Hearn and Reeves 2003).

There were also some commonalities between intervention ideas presented by our participants and the intervention recommendations in a recent NHS report (Gale *et al.* 2007). These include a tube head that moves fore and aft, to improve access for preparing the MLO view (this feature is provided by one manufacturer), paddles made of non-glare material, foot pedal design issues, and more appropriate locations and design of button controls on the machine.

However, our participants actually focused much of their ideation on patient-related concepts. Based on their experience, the characteristics of the patients are a primary factor in the degree of challenge to performing any exam. As such, interventions that can make the patient more at ease or less difficult to position for the exam appear to be a high priority for our participants. This will be confirmed (or refuted) when we meet with the mammographers for the concept review session and as the concepts are refined and tested in later stages of the project.

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