Prevention of Work-Related Musculoskeletal Disorders

Sue Ferguson, Panel Chair, Institute for Ergonomics, The Ohio State University
Barbara Silverstein, Safety & Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries
Martin Cherniack, Ergonomics Technology Center Univ. of Connecticut Health Center
Arun Garg, Ind. & Manufacturing Eng. Dept, University of Wisconsin-Milwaukee
Steve Lavender, Institute for Ergonomics, The Ohio State University

This panel is discussing research conducted as part of the Work-Related Musculoskeletal Disorder Consortium with the National Institute of Occupational Safety and Health. The panel has two researchers conducting low back research and two researchers performing upper extremity research. The goal of the panel is to inform the audience about the consortium and some of the state of the art research that is being conducted.

Summary

Each year nearly one million people take time off work to be treated and recover from musculoskeletal disorders (NRC, 2001). The total economic impact of work-related musculoskeletal disorders has been estimated to be as high as $54 billion annually (NRC, 2001). The National Occupational Research Agenda (NORA) priority research areas include low back as well as musculoskeletal disorders. A Work Related Musculoskeletal Disorder (WMSD) Research Consortium with the National Institute of Occupational Safety and Health (NIOSH) was formed to address the impact of WMSD. Over the past 5 years, consortium membership has grown from 4 to 11 research groups across the United States. While each research project is unique in it's specific research question and design, attempts have been made to strengthen the overall science by identifying some common elements for case definitions, exposure parameters, and to collect some similar individual and psychosocial data. The consortium members have also had meetings to discuss common difficult recruitment, retention, and analytic issues. The panel members will discuss their research projects being conducted as part of the consortium as well as the meetings that they have participated in for the consortium.

Physical load variables associated with clinical cases of carpal tunnel syndrome, lateral epicondylitis and rotator cuff tendinitis.

Panelist : Barbara Silverstein

Work-related musculoskeletal disorders such as carpal tunnel syndrome, rotator cuff syndrome epicondylitis, low back and neck pain, take a large social and financial toll on the worker, the employer and society as a whole (Haag, 1997). The SHARP program research has focused on upper extremity musculoskeletal disorders in 12 manufacturing and health care workplaces in Washington State.

Sites were recruited where there were at least 20 fulltime workers in at least three of six upper limb force (2) by repetition (3) groups based on site walkthrough. Subjects were recruited at the worksites with informed consent. Baseline health and exposure data collected during working hours. Health data included detailed health history, current symptoms, hobbies, disability scales, psychosocial questionnaires, standardized upper extremity physical examination, electrodiagnostic testing of the median and ulnar nerves at the wrist. Individual exposure assessment included using existing tools (strain

index, ACGIH TLV for Hand Activity Level, RULA. Additionally job tasks were videotaped for detailed assessment of postures, motion patterns and duration, with and without significant hand forces in the laboratory (Wells et al., 2004; Bystrom et al., 1990). Pinch and power grip were estimated using force matching techniques with hand dynamometers. Work organization observations were made at the department level. Three annual follow-up visits collected the same health data. If there was a change in job, the job was re-analyzed. Shorter follow up visits were conducted twice between annual visits (every 4 months), with a brief symptoms questionnaire leading to a focused short physical exam if there was a change in symptom status.

We calculated a composite strain index (CSI) similar to the NIOSH composite lifting index to account for multiple task jobs. Additionally, using the detailed time-study data, we were able to construct a number of combined variables based on reference values in the literature, biological plausibility, and distribution of our data. Several load related variables were created and will be defined in the presentation.

We then used baseline health outcomes of carpal tunnel syndrome, lateral epicondylitis, medial epicondylitis and rotator cuff tendonitis to evaluate these exposure variables using logistic regression analyses with age, gender and body mass index (BMI) in the models.

There were 733 participants meeting the eligibility requirements at baseline that were used in the baseline analysis. There were 61 subjects with clinical carpal tunnel syndrome, 38 with lateral epicondylitis, 16 with medial epicondylitis and 53 with rotator cuff tendinitis. Body mass index was a significant positive indicator in all analyses. Gender was not a statistically significant variable. Age was of borderline significance. These three variables were kept in all analyses.

Percent time in forceful exertions was a significant predictor for all clinical conditions except medial epicondylitis, with a significant exposure-response relationship with carpal tunnel syndrome. There was a significant dose-response relationship for carpal tunnel syndrome with awkward wrist postures combined with high forces, with much, but not all of the effect being explained by the high force. The same was true for lateral epicondylitis. Rotator cuff tendinitis was associated with upper arm elevations greater than 30 degrees combined with significant hand force with the odds ratio very high.

All our duty cycles are on the shorter end compared with those of Hagg and Milerad (1997) and Bystrom and Kilbom (1990). This is explained by having some non-cyclical jobs in the data. The exertion of “significant forces” in our study cannot be directly compared to MVC values, but our forces are likely to be at a lower exertion level than 25% MVC.

These preliminary findings present a good basis for testing with incident cases of clinical carpal tunnel syndrome, lateral epicondylitis and rotator cuff tendinitis. Identification of the most parsimonious models will facilitate development of better exposure assessment tools for practitioners. Discussion with other consortium members will result in the development of additional model testing.

Effect of Warming Methods on Segmental NerveConduction in Vibration-Exposed Workers

Panelist : Martin Cherniack

Previous investigators have reported sensory nerve conduction velocity (SNCV) slowing in the digits of vibration-exposed shipyard workers (Sakakibara et al., 1994; Sakakibara et al., 1998). These segmental nerve conduction findings were confirmed in a North American shipyard cohort (Cherniack 2004), assembled as part of a NORA funded project on harm-arm vibration. Surprisingly, after conventional surface warming, the relationship of SNCV to surface temperature was dependent on anatomic segment. Accordingly, the investigators developed altered

the protocol to include deep tissue warming through exercise (Sanders et al., 2005).

Segmental sensory nerve conduction velocity (SNCV) was measured from the wrists to the hands and digits of a population of 134 vibration-exposed shipyard workers following systemic warming using a bicycle ergometer. Results were compared to earlier nerve conduction tests, identical in execution, except the warming process was conventional, involving the skin surface. The study was designed to investigate whether SNCVs, which were selectively slowed in the fingers after cutaneous warming, would be affected by systemic warming.

Wrist-palm, palm-proximal digit, and digital segments were determined from stimulation at the wrist with recording electrodes placed distally. Ramped sustained exercise to 100 watts for 12 minutes was used to systemically warm subjects. Skin temperatures were measured by traditional thermistry and by infra-red thermal images, taken over the entire hand and wrist surfaces.

With systemic warming, SNCVs increased by 15.1% in the 3rd digit and 20.4% in the 5th digit of the dominant hand, compared to surface warming. Increases in the non-dominant hand were 11.0% and 19.4%. A strong association between increased surface skin temperature and faster SNCV, observed with surface warming, was largely eliminated for both digit and palmar anatomic segments after systemic warming. Significant Differences in SNCV between exposed workers and unexposed internal controls after surface warming were eliminated with systemic warming. Systemic warming had only a small effect on wrist-palm (transcarpal) segmental velocities.

Reduced SNCV in the digits has been observed in vibration-exposed workers and in controls. Substituting exercise-induced systemic warming for surface warming significantly increased digital velocity and appeared to reduce differences in SNCV between vibration-exposed and non-exposed workers. There may be more general implications for clinical diagnoses, such as the carpal tunnel syndrome (CTS), especially in industrial workers.

LBP: Preliminary Results from a Multi-Center Prospective Cohort Study
Panelist : Arun Garg

A multi-center, prospective cohort study of Low Back Pain (LBP) is ongoing. To improve generalizability of the results; the study involves 600+ workers from 30 different industries, in four diverse states. The primary objectives of this research are to: (1) Determine LBP incidence rates over a total 3 year period for workers classified into the 3 exposure groups (low, medium and high) and (2) identify interactions within and between job physical, individual and psychosocial factors to better quantify risk of LBP and LBP severity measures. In addition, we will validate existing models and develop a new comprehensive job analysis model that includes interactions for determining risk of LBP and related outcomes. This will allow for a better understanding of the roles of personal and job-related risk factors for an individual's risk for LBP (and related outcomes) as well as predicting the impact of modifying one or more of these risk factors to reduce risk for LBP.

We have completed baseline job physical exposure assessments on all workers. Job physical exposures rely primarily on measurements to objectively quantify exposures, while also utilizing methods that are practical for use in industry (r2p). Changes in job physical exposures and work organizational factors are monitored quarterly. All subjects have complete baseline health assessments, including: (i) Questionnaires, (ii) Structured Interviews, and (iii) Standardized Physical Examinations. This study will continue *monthly* follow-up using computerized Structured Interviews and when triggered Standardized Physical Examinations. LBP outcomes include LBP incidence rates, LBP with markers of severity (e.g., medication use, lost time, restricted time), and LBP with neurological signs ("sciatica") for 3 levels of job

physical exposures. Both Job Physical Exposure and Health Outcomes Assessment Teams are blinded to each other throughout the field observation phase.

Preliminary data analyses showed that baseline prevalence of LBP (≥ 3/10 in the last one month) was 38.6%. 10.9% had a history of sciatica. Univariate analyses showed that gender (female), age, body mass index, tobacco use, diabetes and cholesterol were associated with increased risk of low-back pain incidence. Similarly, psychosocial factors associated with the increased risk of low-back pain incidence included: getting along with supervisor, nervousness or anxiety, feeling downhearted and sad, feeling tired for no reason and feeling uneasy. Preliminary analyses of Job physical demands using the Revised NIOSH Lifting Equation showed a strong relationship between job physical demands and incidence of LBP, LBP with prescription medicine taken, LBP resulting in light duty and LPB resulting in lost time.

Low Back Injury Risk in Distribution Centers
Panelist : Steve Lavender

The goal of this project is to determine a safe amount of cumulative lifting for people who work in distribution center jobs. Previous work has shown that in manufacturing jobs, back injury risk can be predicted using the load moment, which is defined as the object weight multiplied by its horizontal distance from the spine. This research work sought to expand this finding, via a cross-sectional and prospective study in distribution environments where repetitive manual lifting continues to occur, and where the lifting tasks are much more variable in terms of the load moment exposures. This proposal describes work we have completed over the past five years. In this process we have developed the automated Moment Exposure Tracking System (METS) that allows the load moment to be continuously monitored over extended sampling periods. We have used this monitor to study over 40 distribution jobs. This presentation will summarize the data that have been obtained and how they relate to the risk of low back injury.

References

Bystrom SE, Kilbom A.(1990) Physiological response in the forearm during and after isometric intermittent handgrip. Eur. J. Appl. Physiol. Occup. Physiol. 60(6), 457-66.

Cherniack M, Brammer AJ, Lundstrom R, Meyer J, Morse T F, Nealy G, Nilsson T, Peterson D, Toppila E , Warren N , Fu RW, Bruneau H. (2004) Segmental Nerve Conduction Velocity in Vibration Exposed Shipyard Workers. Int. Arch. Occup. Environ. Health 77(3), 159-176.

Hagg G, Milerad E. (1997) Forearm extensor and flexor muscle exertion during simulated gripping work -- an electromyographic study. Clin. Biomech. 12(1), 39-43.

National Research Council, Institute of Medicine. (2001) Musculoskeletal Disorders and the Workplace Low Back and Upper Extremity. National Academy Press, Washington DC.

Sakakibara H, Kondo T-A, Miyao M, Yamada S. (1994) Digital nerve conduction velocity as a sensitive indication of peripheral neuropathy in vibration syndrome. Am. J. Indus. Med. 26, 359-366.

Sakakibara H, Hirata M, Hashiguchi T, Toibana N, Koshiyama H. (1998) Affected segments of the median nerve dectected by fractionated nerve conduction measurement in vibration-induced neuropathy. Indus. Health 36, 155-159.

Sanden H, Edblom HM, Mats Hagberg M, Wallin BG. (2005) Bicycle ergometer test to obtain adequate skin temperature when measuring nerve conduction velocity. Clin. Neurophysiol. 116, 25-27.

Wells R., Van Eerd D., Hagg G., (2004) Mechanical exposure concepts using force as the agent. Scand J Work Environ Health. 30(3), 179-90.