

penicillioides grew in detectors in damp microenvironments or on damp surfaces. The same xerophilic fungi failed to germinate or grow in buildings that had successfully undergone adequate restorative drying. The hydrophilic fungus *A. alternata* grew in wet (RH>95%) microenvironments. Periodic and consistent decline of RH to 60% or less in otherwise humid microenvironments appeared to inhibit spore germination in detectors. While fungal detectors will not replace the standard uses of dew point and moisture meters, the detectors provide inspectors with an additional tool for investigating mold growth problems in buildings.

Podium 102. Balance Issues and Upper Extremity Potpourri

Papers 7–12

7.

SLIPS, TRIPS, AND FALLS IN HOSPITAL WORKERS—PILOT OUTCOMES.

T. Courtney, H. Wellman, D. Lombardi, Liberty Mutual, Hopkinton, MA; G. Sorock, Johns Hopkins University, Baltimore, MD; J. Collins, J. Bell, NIOSH, Morgantown, WV; L. Wolf, BJC Healthcare, St. Louis, MO; R. Gronqvist, Finnish Institute for Occupational Health, Helsinki, Finland.

The health services sector is the largest employer in private industry (~10 million workers). In 2001, more health care workers were injured than workers in any other sector, and slips, trips, and falls (STF) accounted for the largest proportion of lost time injuries (21%). The incidence rate of same level STF injuries in hospitals was almost twice that of private industry (38.6 vs. 20.8 per 10,000 FTEs). A case-crossover field study was initiated to describe the circumstances of hospital worker STF and evaluate the contribution of potential transient risk factors. Health-care workers, who reported a STF to the occupational health department in five U.S. hospitals, were recruited. Fifty-nine subjects were interviewed using a structured telephone questionnaire. Eighty-six percent were women with a mean age (range) of 46 (19–67). Nurses (32%) and maids and housemen (12%) were the most frequently reported occupations. Fifty-one subjects (86%) fell: 55% after slipping, 41% after tripping. Liquid contaminants (e.g., water, cleaning solutions) were noted in 34% of the events. Fifty-nine percent of the STF occurred at a transitional area: wet to dry (31%), one type of floor to another (22%), or uneven surfaces (19%). Ninety-three percent of subjects were injured. Contusions (23% of injuries), strains and sprains (22%), and fractures (9%) were typical. To evaluate each potential transient risk factor, exposure for each worker at the time of their STF was compared with their usual frequency of exposure in the prior work month. Contaminated floors, unfamiliar pathways, rushing (e.g., responding to urgent patient needs), carrying atypical loads, and distraction were

encountered more frequently at the time of injury than in the prior work month. Prevention resources should focus on improved control of contaminants and improved transitions between surfaces and conditions.

8.

POSTURAL STABILITY EFFECTS IN

LOW-SEAM MINING TASKS. J. Gordon, T. Sobeih, A. Bhattacharya, P. Succop, University of Cincinnati, Cincinnati, OH; L. Kincl, University of Oregon, Eugene, OR.

Performing work in underground low-seam mines requires working on slippery surfaces under poor lighting conditions with restricted postures that may cause a potential loss of stability/balance, especially during material handling tasks. The purpose of this study was to determine the effect of work surface properties, task type, and environmental lighting conditions on 25 miners' ability to maintain "safe" upright balance while restricted to a 44-inch ceiling. Postural stability was quantified using a large force platform while performing simulated static tasks with different surface (dry, uneven, and slippery) and environmental lighting (poor and glare) conditions. During the testing workers performed the tasks in both a one-knee and two-knee posture. Parameters for characterizing postural stability included sway area (SA), sway length (SL), anterior/posterior (AP), and medial/lateral (ML) excursion. An increase in any of these parameters indicates an increase in postural instability. Postural instability was further evaluated using Index of Proximity to Stability Boundary (IPSB); a decrease in IPSB implies poorer balance/postural stability. Subjective ratings of perceived sense of sway (PSOS) and exertion (PE) during task performance was recorded. The tasks performed significantly increased the SA, SL, AP, and ML excursions (varying between 328% and 13,681%). The one-knee posture significantly increased the SA by 9% and the two-knee posture significantly increased the AP and ML excursions by 15% and 6%, respectively. Glare lighting conditions significantly increased the SL (by 4%). IPSB values were statistically significantly decreased (varying between 71% and 124%) for posture and task variables. The subjects' PSOS and PE were statistically significantly different for all variables of task, posture, surface, and lighting. Results from this study indicate that performing these simulated tasks may result in postural instability, especially when working on slippery surfaces and/or in glare light conditions.

9.

VALIDATION OF A COMPUTER-SIMULATION MODEL FOR HUMAN

AMBULATION ON STILTS. C. Pan, K. Miller, S. Chiou, T. Kau, R. Current, NIOSH, Morgantown, WV.

The objective of this study is to validate a model to evaluate overexertion and potential fall-related injuries associated with the use of

stilts. Under normal gait conditions, this computerized model could be used to evaluate stresses in various anatomical joints and simulate whole-body postural instability. Three construction workers between the ages of 34 and 40 with at least 12 months of experience in the use of stilts were recruited for walking tasks on 24-inch stilts. Twenty-eight reflective markers were placed on the subject's body and stilts. The model was validated using whole body center of mass and ground reaction forces. A PEAK™ motion system and two Kistler™ force platforms were used to collect data, producing an output file with time-synchronized records of both kinetic and kinematic measures. Inverse- and direct-dynamics simulations were performed using the model to generate center of mass and ground reaction force. For three coordinates (X, Y, Z) of the center of mass, the results of univariate analyses indicated very small variability (0.14 cm ± 0.11 cm, 5.4 cm ± 0.07 cm, 3.71 cm ± 0.03 cm) for the mean difference between the model and the actual measurement. The results of correlation analyses indicated similar trends for three coordinates ($r_x = 0.82$, $r_y = 0.88$, $r_z = 0.99$). Plotting the magnitude and vertical ground reaction force for both right and left feet showed small discrepancies, but the overall shape was identical between the model and the actual measurement. The percent difference between the model and the actual measurement for three coordinates of the center of mass, as well as magnitude and vertical ground reaction force, never exceeded 20%. Using this validated model, researchers will be able to examine whether stilt use increases the joint loadings and postural instability parameters while walking on stilts.

10.

IMPACT OF WORKPLACE RISK FACTORS ON POSTURAL STABILITY OF OLDER WORKERS.

T. Sobeih, J. Gordon, A. Bhattacharya, P. Succop, University of Cincinnati, Cincinnati, OH; L. Kincl, University of Oregon, Eugene, OR.

The incidence of falls increases substantially in people above 65 years of age. As more older workers (OW) are returning to the workplace, there is a need to understand the impact of risk factors affecting their postural stability. The purpose of this study was to: 1) determine the changes in postural balance in OW while performing simulated tasks, and 2) determine the contribution of individual and combined risk factors (personal and work environment) on postural stability. Ninety-five subjects (age range 45 to 75) performed 3 tasks (stationary, sudden loading, and reach) while wearing two types of footwear, under two environmental lighting conditions, and standing on two types of surface slipperiness. Postural stability was quantified using a force platform and a human kinematics analysis system. Parameters for characterizing postural stability included sway

area, sway length (SL), antero-posterior and medio-lateral (ML) excursions, and index of proximity to stability boundary (IPSB) (based on both the subject's center of pressure and center of mass). An increase in the first four parameters or a decrease in IPSB indicates a decrease in postural stability. Task had the greatest impact on postural stability ($p < 0.0001$) for all parameters. Reach significantly decreased postural stability followed by sudden loading when compared to stationary. Poor lighting and slippery surface significantly decreased postural stability. Subjects in the older age group had significantly lower postural stability when compared to the younger group ($p < 0.0002$ for both SL and ML). Footwear was insignificant. Results from this study indicate that OW may be at increased risk of postural instability, especially when working on slippery surfaces and/or in low light conditions as aging process affects their vision and somatosensory system.

11. **ERGONOMIC EVALUATION OF A SHROUDED VENTILATED ROTARY SANDER TO DECREASE PHYSICAL EXERTION DURING DRYWALL**

SANDING. P. Vi, D. Sahai, Construction Safety Association of Ontario, Toronto, ON, Canada.

The purpose of this project was to document the potential ergonomic and hygiene benefits of using a shrouded ventilated rotary sander (Porter Cable Sander) as a method to prevent musculoskeletal injuries and dust-related illness. This paper presents the results of the ergonomic study.

The research was conducted in a controlled setting. Ten participants were asked to perform two drywall sanding methods, the first using the traditional pole sanding technique and the second using the shrouded ventilated rotary sander (SVRS). While the participants were performing the experimental tasks, videotapes of the participants' working postures and electromyography (to measure muscular activity) were recorded. The amplitude probability distribution function (APDF) analyses technique, as specified by Jonsson (1982), was used to analyze the electromyography data.

Despite the large differences in weight between the SVRS (8 lbs) and the pole sanding tool (2 lbs), working with the SVRS significantly ($p < 0.05$) required less muscular activity in the static and median load level of the shoulder and forearm muscles. Furthermore, working with the SVRS allowed the muscles to exert at a level that is well below the TLV® suggested by Jonsson (1982).

The high muscular effort in the manual pole sanding condition was due to the forceful and repetitive movement of the upper extremity in order to create high friction force between the sanding paper and the wall. While using the SVRS, however, little muscular effort is

required because the majority of the sanding force was generated by the SVRS. The muscular effort generated by the upper extremities was mainly used to support and guide the SVRS along the walls. Based on the ergonomic measures, we concluded that the SVRS is an effective method for reducing physical exertion during drywall sanding.

12. **RESPONSE OF THE BASE OF THE PALM TO IMPACT.** D. Cochran, P. Shinde, University of Nebraska, Lincoln, NE.

In reviewing the literature on determining exposure levels or acceptable levels for hand impacts, only one study was found to have been conducted (Potvin, et al., 2000). This research builds on that study. Subjects were exposed to low intensity, pendulum impacts to the base of the palm of each hand. The impacts differed in the kinetic energy (three levels) and angular velocity of the pendulum when first striking the hand. Three different pendulum mass levels were also used to achieve the same energy levels. This necessitated changing the starting angle from vertical such that the three energy levels were maintained for each mass. Subject's age and gender were considered. Physical and psychophysical measures were recorded to characterize the impacts and the response of the hand to the impacts. The dependent measures used included measures of impact, peak force, peak deceleration, pattern of deformation of the tissue, changes in sensory sensitivity, and changes in the deformability of the tissue at the base of the palm under compressive load. The results show the changes in the dependent measures as a result of the gender effects, age effects, and their interrelations between energy, mass, and angular velocity. This study was just a first step in an attempt to eventually establish a dose-response relationship between quantitative measures of impact and the resulting short and long term consequences.

Podium 103. Occupational Exposure Assessment and Epidemiology for Chemical Mixtures

Papers 13-18

13. **ESTIMATION OF THE HEALTH RISKS ASSOCIATED WITH POLYCHLORINATED BIPHENYL (PCBS) CONCENTRATIONS FOUND ONBOARD OLDER U.S. NAVY VESSELS.** D. Arfsten, K. Still, W. Jederberg, Naval Health Research Center Toxicology Detachment, Wright-Patterson AFB, OH; B. Larcom, Office of the Secretary of the Air Force, Washington, DC.

PCBs have been identified on surfaces and in component materials and equipment from inactive U.S. Navy nuclear submarines commissioned prior to 1970. Health risks associated

with PCBs present onboard submarines were estimated for hypothetical crewmembers and shipyard workers. Median noncancer hazard quotients for shipyard workers and submarine crew ranged between 0.4-54.6 with the highest quotients estimated for unprotected shipyard workers. Median cancer risk estimates ranged from 7.3×10^{-6} to 1.1×10^{-3} with the highest estimated risk calculated for unprotected shipyard workers. Our findings suggest that PCB surface concentrations found onboard inactive nuclear submarines commissioned prior to 1970 may be high enough to constitute a possible risk to the health of persons involved in the dismantling of Navy submarines if PCB exposure is not minimized. Potential sources of uncertainty in our risk assessment include the correlation between PCB contamination levels on inactive versus active nuclear submarines vessels, the relationship between wipe sample concentrations and human exposure, dermal contact frequency with PCB-contaminated surfaces, carcinogenicity of PCBs in humans, and uncertainties inherent with the PCB cancer slope factor and oral RfD. Our findings support Navy policy that shipyard workers should wear personal protective equipment when PCB contamination is suspected or has been identified and that IH surveys should continue to identify sources of PCB contamination onboard vessels and reduce PCB contamination to concentrations that are reasonably achievable.

14. **RETROSPECTIVE CHEMICAL EXPOSURE ASSESSMENT OF LABORATORY WORKERS AT THREE DEPARTMENT OF ENERGY SITES IN OAK RIDGE, TENNESSEE.** S. Henn, WES-TAT, Cincinnati, OH; W. Tankersley, Oak Ridge Associated Universities, Oak Ridge, TN; D. Utterback, NIOSH, Cincinnati, OH.

A qualitative exposure assessment was conducted for a cohort mortality study of 4015 chemical laboratory workers (CLWs) employed between 1943 and 1984 at three Department of Energy sites in Oak Ridge, Tenn. Previous studies of CLWs were on members within associations, where exposure assessment was not feasible, or from industrial companies where laboratory and production workers were combined.

Since industrial hygiene records were unavailable for all three sites, duration of employment was used as a surrogate for the magnitude of exposure. Potential exposure indices were calculated for each worker using number of days employed at the sites along with weighting factors for job title and decade. Workers were then separated into equal exposure categories of low, medium, or high using the 33rd and 66th percentiles. 590 unique job titles indicative of a CLW were collapsed into 14 general job titles. Through interviews with current and retired workers along with organizational charts, responsibilities, and tasks for

The Premier Conference and Exposition for Occupational
and Environmental Health and Safety Professionals

May 8-13, 2004 • Georgia World Congress Center, Atlanta, GA



Promoting OEHS Excellence

AIHce

**2004
Abstracts**



American Industrial Hygiene
Conference & Expo 2004

Sponsored by
The American Industrial Hygiene Association
and ACGIH®