





















































































Methods: The Washington Fatality Assessment and Control Evaluation (WA FACE) Program, funded by a grant from the National Institute for Occupational Safety and Health, is a statewide surveillance system to track incidents, evaluate trends, investigate incidents, and distribute prevention information about work-related fatal injuries. Each victim of a fatal work-related incident is assigned a case ID and then demographic information and an incident narrative description, as well as coded data including ICD-9 E-codes, occupational codes (SOC), and industry classification codes (NAICS) are entered in an Access database.

Results: The Washington FACE Program identified a total of 888 work-related fatalities between 1998 and 2007. Of this total, 123 (14%) occurred to victims whose occupation was identified as “truck driver.” The majority of truck driver fatal incidents consisted of motor vehicle crashes (81 incidents) of which truck versus other motor vehicle traveling on a public roadway (30 incidents) or left the roadway and crashed (51 incidents). Forty-two truck drivers died in non-crash type incidents which included, among others, being struck by falling freight during truck loading and unloading (14), being struck by another vehicle or their own unattended vehicle while out of their truck (10), and falls from truck or loading dock (5). Fatalities were widely distributed among industries with the highest numbers in freight trucking (62), construction (12), and logging (10). This presentation will describe victim demographics and incident patterns, as well as several incident descriptions and recommendations for prevention.

Conclusions: The occupation of “truck driver” presents many hazards to the working population. Fatality injury prevention efforts should be targeted to address these hazards. Interventions to prevent fatal injuries should be targeted to truck drivers, their employers, and the affected industries.

### **Older Workers**

#### **P31**

***Title: Prevalence of Visual and Hearing Impairment Among Older U.S. Workers: The National Health Interview Survey, 1997-2004***

Author: **Davila EP**

Introduction: Population aging and delayed job retirement are rapidly augmenting the number of older U.S. workers, increasing the risk for workplace injuries due to their likely high prevalence of sensory impairment. The present study evaluated the

proportion of older (>65 years of age) U.S. workers reporting vision and/or hearing impairment by occupational groups.

Methods: Analyses of self-reported visual impairment (VI), hearing impairment (HI), either VI or HI, and concurrent impairment (HI+VI) by occupation were conducted on 5,590 older workers representing approximately 3.9 million older U.S. workers in the 1997-2004 nationally representative National Health Interview Survey.

Results: The majority of workers reported their race as White (86.5%) with approximately equal proportions of females and males. Nearly half of these workers reported having more than a high school education (46.8%). The overall prevalence rates of HI were approximately three times those of VI (33.4 % vs. 10.2%, respectively). The prevalence of VI+HI and either impairment was 5.2% and 38.4%, respectively. Relative to all workers farm operators and managers had significantly higher prevalence rates of sensory impairment [HI (53.9%), either HI or VI (57.3%), and concurrent VI+HI (12.1%)]. Other groups with significantly higher prevalence of sensory impairment compared to all workers included: mechanics and repairers [HI (46.6%), either HI or VI (53.1%)] and motor vehicle operators [HI (36.4%), either HI or VI (45.7%)].

Conclusion: Given the greater risk for injuries among the sensory impaired and the high prevalence of sensory impairment among older workers, workplace screening, and accommodations for older workers are warranted.

### **General Injury**

#### **P32**

***Title: Oral-Maxillofacial Injuries Among Active Duty U.S. Military Personnel, 1996-2005***

Authors: Mitchener T, **Canham-Chervak M**, Jones B

Introduction: Oral-maxillofacial injuries can lead to deformity and malfunction, greatly diminishing quality of life and worker productivity. Data suggest that over 10% of civilian emergency room visits are due to craniofacial injuries. The size and scope of oral-maxillofacial injuries in the military is not well understood. This study reports Department of Defense rates of oral-maxillofacial injuries, causes of oral-maxillofacial hospitalizations, and recommends approaches to improving surveillance, research, and prevention.

Methods: Active duty military personnel who sought inpatient or outpatient treatment for one or more oral-maxillofacial injuries from 1996-2005 were identified in the Defense Medical Surveillance System using International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes associated with oral-maxillofacial injuries. ICD-9-CM diagnosis codes were divided into two categories oral-maxillofacial wounds and oral-maxillofacial fractures. Multiple visits for the same diagnosis within 60 days of the initial visit were excluded to reduce the effect of follow-up visits.

Results: The oral-maxillofacial fracture rates for men were consistently 1.5 to 2 times higher than those for women. Unlike fractures, wound rates for men and women were similar over time. Active duty personnel under age 25 had the highest rates of both oral-maxillofacial fractures and wounds. Falls (27%) were the leading cause of oral-maxillofacial injury hospitalizations in 2005. Falls were 2.5 times more common than the next causes, war/enemy (11%) and land accidents (10%).

Conclusions: Military and civilian populations would benefit from a surveillance system that incorporates not only medical care data, but also dental care data. There is also a need for additional quality intervention studies on the strategies to prevent oral and craniofacial injury. Fall prevention should be considered as a strategy for reducing oral-maxillofacial injuries.

### **P33**

#### ***Title: Concentrations of PM 2.5 in a Faculty Hospital in Turkey***

Authors: **Erdogan MS**, Yurtseven E, Erginöz E

Introduction: Respirable particulates (RP) with aerodynamic parameter smaller than 10  $\mu\text{m}$  (PM10) are easily inhaled and deposited within the respiratory system. RP are divided into a coarse and a fine fraction; the latter is smaller than 2.5  $\mu\text{m}$  in diameter (PM2.5). Fine particles are generally more harmful to the respiratory system than coarse particles. Particulate exposures in hospitals may serve as a carrier for virus transmission since viral adherence to particles may occur. This exposure therefore poses a special threat to the people who visit the hospital. We attempt to characterize the indoor PM 2.5 concentrations in selected places of the hospital, where people gather.

Methods: Indoor air PM 2.5 was measured using light scattering monitor-nephelometer (manufactured by Thermo) 1.5 m above the ground for an 8-hour duration. Samples were collected at 3 lecture halls, the waiting room, and 3 rooms of the main laboratory in Cerrahpasa Medical Faculty of Istanbul University, Turkey. The lecture halls included in the study are located in one of the hospital buildings and have an audience capacity of 300, 150, 100, respectively. These were randomly selected out of 8 lecture halls of the faculty in total.

The main laboratory has a waiting room with the capacity of 70 people and it is always the most crowded space of the hospital. The rooms were selected randomly out of the following categories: "room with 1 personnel working," "2 personnel," and "more than 2 personnel." All the measurements were taken in the weekdays when the facilities were used as normal.

Results: The average/maximum PM 2.5 levels of lecture halls with the audience capacity of 300, 150, 100 were 53.0/200.9, 53.4/132.0, 30.6/100.2, respectively. The average/maximum PM 2.5 levels of the waiting room and 3 different rooms of the main laboratory with 1 personnel, 2 personnel and 3 personnel working were 160.1/367.2, 23.8/63.9, 30.9/105.1, 15.9/126.0, respectively.

Conclusion: There is no accepted permissible exposure limit for indoor PM 2.5. EPA experts provide one limit for the outdoor concentration and suggest that the indoor limit must not exceed 50 % of the outdoor limit. According to this advice from experts, our results are too high and immediate measures should be taken.

### **Emergency Response**

#### **P34**

#### ***Title: Effect of Boot Weight and Material on Gait Characteristics of Men and Women Fire Fighters***

Authors: **Chiou S**, Turner N, Zwiener J, Weaver D, Spahr J, Pan C

Introduction: According to NFPA, there were an estimated 83,400 fire fighter injuries in 2006, and overexertion and falls accounted for approximately half of those injuries. Fire fighters have traditionally worn heavily insulated rubberized boots as protective footwear. These boots can add an extra 10 pounds to a fire fighter, which may increase their risks for overexertion and fall injuries. The objective of this

study was to determine the effect of boot weight and material on fire fighters' gait characteristics and lower extremity movements.

Methods: Fifteen men and fifteen women fire fighters (31.3±5.2 years) were tested for regular gait or gait while carrying hose while wearing different rubber or leather boots of varying weights. A motion-analysis system and two force platforms were used to quantify gait and posture changes associated with different boots. Spatio-temporal gait parameters and body dynamics of fire fighters were evaluated during simulated firefighting tasks.

Results: The Repeated Measure ANOVA revealed significant gait changes associated with boot types, including reductions in cadence and increases in percentage of double-stance time with heavier boots ( $p<0.001$ ). The increases in the time when both feet were in contact with the floor suggest greater energy cost and a longer time was needed for the body to re-establish stability from one step to another. There were significant reductions in sagittal range of motion at ankles ( $p<0.001$ ) and increases in hip internal and knee external angles ( $p<0.01$ ) when wearing rubber boots. As the weight of boots increased, ankle ranges of motion decreased.

Discussion: This study demonstrates that boot types affect fire fighters' gait characteristics and lower extremity kinematics. Findings from this study are useful for fire fighters and boot manufacturers in boot selection and design modifications, to reduce biomechanical stresses of the lower extremity and to improve gait performance.

### **Intervention Evaluation**

#### **P35**

##### ***Title: The Sacred Vocation Program: A Meaning-Centered Intervention to Reduce Injuries in Health Care***

Authors: Amick III B, Tullar J

Introduction: A recent systematic review (Amick et al, 2007) highlighted the limited number of well-designed interventions to reduce injuries in health care settings. The Sacred Vocation Program (SVP) was designed to change the meaning of work for health care workers. The SVP intervenes at both the individual and organizational level. First, the SVP attempts to connect healthcare workers with meaning from their work through a series of peer group sessions. Second, employees engage in a participatory action research process to suggest changes to the worksite to support

them and allow them to engage in meaningful acts with patients and co-workers.

Methods: Patient care assistants, those with the most direct care with patients in hospitals, from a large health care system in the Dallas area participated in the SVP. A non-randomized field trial was implemented over a 2-year period; one group participated in the SVP ( $n=203$ ) and one group did not participate ( $n=318$ ). The intervention was guided by a theory of change that has as a key outcome injuries. Injury data was collected from on-going injury surveillance systems in the health care system and is not based on self-reports. Exposure time was determined by use of both payroll records and the identification of the work units the employees worked on. Multi-level logistic regression models were estimated to determine if participation in the SVP reduced the risk of injury.

Results: Injury rates were significantly reduced among SVP participants post-intervention compared to other employees with the same job. In unadjusted models the odds ratio was 0.44 (95% CI 0.2-0.98). In adjusted models (adjusted for job tenure, the odds ratio was still significant at 0.45 (95% CI 0.2-0.99).

Discussion: This research shows that interventions that target changing job content can reduce workplace injuries in a population with significant injury problems.

#### **P36**

##### ***Title: A Communication-Based Train-the-Trainer Program as an Injury Prevention Tool***

Authors: Smith A, Chen P

Introduction: Leadership plays an important role in injury prevention in any organization. For example, Zohar (2004) found that employee perceptions that supervisors support safety negatively related to occupational injuries. Research also supports that climate for error management and climate for safety communication predict safety behaviors and accidents on the job. The present study describes an intervention targeted at teaching supervisors in the construction industry how to support a climate for safety communication with their employees.

Methods: The intervention took place at a large mechanical contractor in the northeast. Slides describing how to give appropriate feedback, positive recognition, and daily verbal exchanges emphasizing safety were added to the company's existing foreman orientation materials. Thirty-six site-level supervisors (e.g. superintendents, project managers) participated

in a train-the-trainer session introducing the new foremen orientation materials, practiced delivering the materials, and were taught adult learning principles to incorporate into their orientation delivery to maximize foreman learning and engagement with the material. In addition, the site-level supervisors were introduced to a communication audit to be completed twice a month to support foreman transfer of training.

Results: The post-intervention assessment of communication climate and employee injuries will be conducted next month. These results will be ready for presentation in October. Pre-training and post-training surveys of participants indicated that utility perceptions of the train-the-trainer session were moderately high, most supervisors felt that the new content would improve safety on the job, and most participants intended to use the adult learning principles taught in their future delivery of the foreman orientation materials.

Discussion: Interventions targeted at employee injury prevention in a construction setting should involve both the foreman level and the support of site-level management. We hope to report that training supervisors on how to support safety communication will have an impact on worker perceptions and injuries on the job.

### **Economics of Injury Prevention**

#### **P37**

***Title: The Economic Evaluation of a Worksite Intervention to Improve the Ergonomics of Seated Environments***

Authors: **Amick, III B**, Derango K

Introduction: A recent systematic review (Tomba et al, 2007) highlighted the limited number of economic evaluations of occupational health and safety interventions. We report the results of the economic evaluation of an injury prevention intervention.

Methods: A non-randomized field trial was implemented over a 15-month period; one group received a new chair and office ergonomics training, one group received on-the-job training and a third group acted as a control group receiving the training at the end of the study. Health assessments (SF-36 Pain Scale) were made at 2- and 1-month pre-intervention and 3-, 6- and 12-month post-intervention. At the public sector worksite, (a department of revenue services), economic data was collected on revenues on a monthly basis for one-year pre-intervention and one-year post-intervention. At the private sector site, (a

medical insurance company), economic data was collected in a call center on calls/hours and in a claims service center on claims per hour and claims quality. Regression models were estimated to determine the impact of the intervention on productivity and the cost-benefit flow.

Results: At the public sector worksite, the intervention results in an 18% increase in productivity. It was estimated that about 30% of the effect was health-mediated. Further, it was calculated that the benefit (\$25,398) to cost (\$1,032) ratio was 25:1. At the private sector site there was an 8.3% increase in productivity in the call center with again about 30% explained by health. The benefit (\$2,506) to cost (\$1,032) ratio was only 2.5:1.

Discussion: This research at two worksites shows that economic evaluations can be conducted of worksite interventions and that there are tremendous economic benefits to ergonomic interventions to prevent injuries. Interestingly only about 1/3 of the productivity increase can be directly attributed to the health improvements associated with the intervention.

### **DAY TWO: WEDNESDAY, OCTOBER 22, 2008**

Session: **D1.0**

***Title: Injury Prevention in Construction - I***

Moderator: Matthew Gillen

#### **D1.1**

***Title: Diffusion of Modular Home Installation Safety Work Practices as a Result of Field Research***

Authors: **Fullen M**, Takacs B, Becker P

Introduction: While conducting training a faculty member learned of hazards unique to modular home installation and investigated them as part of a case study. No previous research has been conducted on modular home installation safety hazards. This study included field research observations, video and photograph collection, interviews, and questionnaires. The study identified the hazards faced by workers that appear to be specific to modular home installation, recommends ways to improve worker safety, and suggests areas for future research.

Methods: This research involved conducting field research of four modular home installations as well as collecting worker, supervisor, and owner survey data regarding safety during the installation process. The field research results identified hazards specific to the industry.

WVU developed and diffused industry-specific safety training based on the hazards identified as well as developing safe alternatives that included alternative work practices, use of existing technologies, as well as the introduction of conceptual tool designs. WVU also developed conceptual designs of two devices.

Results: The field research identified industry-specific hazards including the hoisting of heavy house modules with the use of a hydraulic crane, unique fall hazards, crushing hazards created by working under a tilt-up roof to secure it while a crane suspended the roof. The companies had not addressed any of the industry-specific hazards identified.

The hazards identified resulted in the development of training material that is currently being delivered through instructor-led and web-based training and is being evaluated for applicability and effectiveness.

Discussion: The process of installing a modular home is complex and dangerous. Site conditions, foundation location, and the type and size of the house can affect the potential for injury to employees. However, diffusion of knowledge through training, changes in house design, new technologies, and regulation could make this industry and process safer.

### **D1.2**

#### ***Title: Viability of Tying Off to Residential Roof Trusses for Fall Protection During Truss Erection***

Authors: **Fiorini D**, Garritano E

Introduction: Erecting preconstructed trusses in residential low-rise construction poses a challenge with respect to fall protection for the workers involved. Trusses need to be spread out along the roof, lifted into place, and braced to accept sheathing. In order to lift and brace the trusses, workers can be exposed to a fall of greater than 3 m (10 ft.) to the inside of the house. This study investigates the use of the trusses themselves as a viable fall arrest anchor while lifting and bracing all the trusses.

Methods: A residential frame was built with two walls approximately 7 meters apart (24 ft) on which trusses were erected. An end wall was built between the two walls parallel to the trusses. Trusses were erected in accordance with current practice. A rigid 100 kg (220 pounds) test mass was hung from the truss system, raised, and allowed to free fall. The truss system was observed for its ability to the dynamic forces associated with arresting the mass. The truss system bracing was modified until it was able to support the fall-arrest forces.

Results: To support the dynamic arresting forces, truss bracing must support tensile loads in addition to compressive loads. This was accomplished by using metal strapping over the braces secured into the truss chords. The toes of the trusses were stabilized by nailing two common nails adjacent to each side of the toe on the wall (allows adjustment to the truss but prevents lateral kick-out). Tie off points at truss joints were found to be stronger than at mid chord positions.

Discussion: Adequately braced trusses can be stable and strong enough to withstand the forces associated with arresting the fall of a 100-kg mass (at a 7-m, or 24-ft clear span).

### **D1.3**

#### ***Title: Train-the-Trainer Training—A Case Study***

Authors: **Smith A**, Chen P, Rosecrance J

Introduction: Leadership plays an important role in injury prevention in any organization. For example, Zohar (2004) found that employee perceptions that supervisors support safety negatively related to occupational injuries. Research also supports that climate for error management and climate for safety communication predict safety behaviors and accidents on the job. The present study describes an intervention targeted at teaching supervisors in the construction industry how to support a climate for safety communication with their employees.

Methods: The intervention took place at a large mechanical contractor in the northeast. Slides describing how to give appropriate feedback, positive recognition, and daily verbal exchanges emphasizing safety were added to the company's existing foreman orientation materials. Thirty-six site-level supervisors (e.g., superintendents, project managers) participated in a train-the-trainer session introducing the new foreman orientation materials, practiced delivering the materials, and were taught adult learning principles to incorporate into their orientation delivery to maximize foreman learning and engagement with the material. In addition, the site-level supervisors were introduced to a communication audit to be completed twice a month to support foreman transfer of training.

Results: The post-intervention assessment of communication climate and employee injuries will be conducted next month. These results will be ready for presentation. Pretraining and post-training surveys of participants indicated that utility perceptions of the train-the-trainer session were moderately high, most supervisors felt that the new content would improve safety on the job, and most participants intended to

use the adult learning principles taught in their future delivery of the foreman orientation materials.

Conclusions: Interventions targeted at employee injury prevention in a construction setting should involve both the foreman level and the support of site-level management. We argued that training supervisors on how to support safety communication will have an impact on worker perceptions and injuries on the job.

#### **D1.4**

##### ***Title: Demonstration of Proximity Warning Systems (PWS) to Reduce Worker Exposure to Asphalt Trucks at Highway Paving Operations***

Authors: **Beaupre JE**, Merinar TR, Fosbroke DE

Introduction: Between 1992 and 1998, the Census of Fatal Occupational Injuries (CFOI) reported 841 fatalities in the highway and street construction industry (Standard Industrial Classification 1611), accounting for 11% of all construction deaths over this period. The majority of fatalities in this industry occurred in work zones with 95% of the fatal events involving vehicles and equipment. In 318 of these fatalities (38%), a worker-on-foot (WOF) was struck by a vehicle, typically while backing (51%). The primary injury source for these WOF fatalities was a truck (61%). The objective of this study is to evaluate the efficacy of proximity warning systems (PWS) in reducing WOF exposure to dump trucks at asphalt paving operations.

Methods: The project involved the installation and evaluation of PWS on asphalt delivery trucks. Control and treatment data collection occurred for 6 to 8 days at each company. PWS, including sonar, radar, and camera, were installed on eight asphalt trucks at each of three companies. Data collection methods included global positioning system (GPS) receivers, video observations, and direct observations with the addition of alarm activation data on the treatment sites.

Results: Based on preliminary analysis of direct observation data, the site exposure rate declined by 18.8% from the preintervention rate of 30.3 (95%CI: 35.5–25.1) exposures per hour to the post-intervention rate of 24.6 (95%CI: 29.6–19.6) exposures per hour.

Discussion: Data show a reduction of WOF exposure to equipment, based on preliminary results gathered from direct observations at the site level. Though not statistically significant, these site-level results provide evidence that installation of PWS on asphalt delivery

trucks can reduce worker risk to backing construction equipment. More detailed analysis of truck level video, alarm activation, and GPS data are being conducted.

Session: **D2.0**

##### ***Title: Examining the Risk Factors Associated with Slips and Falls***

Moderator: Wen Chang

#### **D2.1**

##### ***Title: Bilateral Lower Extremity Response to Unexpected Slips***

Authors: Moyer BE, Redfern MS, **Cham R**

Introduction: Slips that occur at heel contact have been shown to be associated with the greatest risk of falls. Previous slip research has primarily focused on the response of the perturbed leg. The goal of this talk is to present an overview of bilateral lower extremity responses to unexpected slips, focusing on the characterization of the trailing leg's biomechanics.

Methods: Twenty-eight healthy participants, divided into a younger (20–33 years) group and an older (55–67 years) group, were exposed to two conditions. First, baseline gait trials (a known dry environment) were collected. Second, a slip was unexpectedly induced at heel contact of the leading foot using a diluted glycerol contaminant. Bilateral force plate and motion data were collected to conduct inverse dynamics analyses.

Results: Four slip-related trailing leg strategies were identified. These strategies included responses ranging from a minimal disruption of swing phase to a premature (~50 ms after toe off) interruption of the trailing leg's trajectory. The trailing leg response was found to be associated with the corrective reaction generated at the knee in the leading/slipping leg. Intra-limb coordination between the hip and the knee was also evident in the trailing leg. The response of the leading/slipping leg preceded that of the trailing limb. Finally, determinants of trailing leg strategy included normal walking patterns and the dynamics associated with early stance during slips. These findings were similar in both age groups.

Discussion and Conclusions: In summary, both the leading/slipping leg and the trailing leg actively contribute to whole-body recovery responses to slips. Inter-limb and intra-limb coordination play an important role in maintaining dynamic stability in response to slips.

Acknowledgements: We would like to thank Dr. Furman for screening the participants. Funding was provided by NIOSH (R03OH007533 / R01OH007592).

## D2.2

### *Title: Worker Slips and Falls in Limited Service Restaurants*

Authors: **Courtney T**, Verma S, Huang Y-H, Chang W-R, Li K-W, Filiaggi A

Introduction: Slipping and falling (STF) are responsible for a substantial injury burden in the global workplace with slipperiness contributing to between 40 and 50% of fall-related injuries.

Restaurant environments are challenged by STF. This study assessed individual and work environment factors related to slipping and/or falling in U.S. fast-food restaurant workers.

Methods: Ten fast-food restaurants in the Northeastern U.S. were recruited to participate. Employees' occupational slip and/or fall history within the past 4 weeks was collected by multilingual, written questionnaire. Age, gender, tenure, work hours per week, and shift length were also collected. Shoe type, condition, and visible shoe contamination were visually assessed. Participants were compensated, and the study was conducted under approval of an institutional review board. Floor friction was measured, and restaurants were ranked by global mean friction score. Multivariate logistic regression assessed the degree of association.

Results: One hundred twenty-six employees participated in the study (Resp = 87.5%). Participants averaged 34.5 work hours per week, had a mean age of 30 years, and had worked in their restaurant location an average of 34.5 (median = 17) months. Lower restaurant friction ranking was significantly associated with a positive slip history within the last 4 weeks (OR = 0.839, 95%CI = 0.719–0.979). To put this in perspective, from the restaurant with the highest mean global friction rank to the restaurant with the lowest mean global friction rank, the odds of a positive slip history increased by a factor of 5.8.

Conclusion: Published findings of association between friction and slipping and falling, in actual work environments, are rare. In addition the majority of restaurant global mean friction scores were above levels typically specified. The findings underscore the importance of floor surface friction (compared to other factors) in the prevention of STF.

## D2.3

### *Title: Design and Evaluation of Multi-Modal Methods to Follow-up Multilingual Fast-Food Workers in a Prospective Cohort Injury Study*

Authors: **Verma S**, Chang W-R, Courtney T, Lombardi D, Huang Y-H, Brennan M, Perry M

Introduction: Internet, telephone, and written surveys were developed to collect the weekly slip experience of fast-food workers participating in a twelve-week prospective cohort study to examine risk factors for slipping at work. Acceptability and response rates for different methods were evaluated for a multilingual worker population.

Method: Sixty-five fast-food workers from five restaurants in Massachusetts and Connecticut were recruited to participate in a 12-week cohort study to examine risk factors for slipping. After completing the baseline survey, participants reported their slip experience every week for the next 12 weeks. Participants had a choice of reporting their weekly experience using either internet, telephone, or written method. For internet-based surveys an e-mail was sent each week with a link to the survey. For the telephone-based method, an interactive voice response system was developed where responses were recorded using telephone keypad and voice for open-ended questions. For the written method, weekly surveys and 12 self-addressed stamped envelopes were given. All three methods were developed in English, Spanish, and Portuguese. Participants were compensated, and the study was approved by an institutional review board.

Results: English, Spanish, and Portuguese were the primary languages of 33 (51%), 22 (34%), and 10 (15%) participants, respectively. Forty-two (65%) participants completed weekly surveys via telephone, 19 (29%) by internet, and 4 (6%) by written methods. Thirty-six percent of English speakers, 50% of Portuguese speakers, and 9% of Spanish speakers completed the surveys via internet. Loss to follow-up for written method was higher (44%) as compared to internet-based (26%) and telephone methods (24%). Additional results by age and education level will be discussed.

Conclusion: Few participants selected the written method to complete weekly surveys and reporting method may depend on primary language. Loss to follow-up was similar in telephone and internet-based methods.

#### **D2.4**

***Title: Beware! Slippery Floor: An Interactive Game to Improve Floor Cleaning and Prevent Slips and Falls in the Food Industry***

Author: **Quirion F**

Introduction: In Québec, the frequency of slips and falls on the same level is about twice higher for the food industry workers, 4.43 %, than the overall frequency of 2.25%. The floors of institutional and restaurant kitchens are often greasy and thus slippery. If floor cleaning could be improved, then the floors should be less slippery. Based on this hypothesis, the IRSST (Québec) has promoted research activities aiming at preventing slips and falls through the improvement of floor cleaning.

Method: Since 1997, laboratory investigations allowed us to identify optimal floor cleaning conditions for different flooring-fat combinations. Field investigations also confirmed that improving floor cleaning reduces floor slipperiness. However, field visits indicate that workers receive very little training on the subject of floor cleaning. Thus, laboratory results and field observations were used to develop training tools that promote good floor cleaning practices.

Results: A selection guide was developed to help owners and managers choose adequate floor cleaners and to convince them of the importance of good floor cleaning practices. The “Beware! Slippery floor” interactive game was developed to train young workers or students in the workplace or at school. The game is easy to play and the knowledge acquired can be evaluated through a quiz section. These tools are available for free on a Web site dedicated to the promotion of good floor cleaning practices ([www.qinc.ca/entretien](http://www.qinc.ca/entretien)).

Discussion: It is too early to evaluate the impact of these training tools on the incidence of slips and falls in the food industry. We hope that the number of teachers and health and safety instructors using these tools will continue to increase over the years.

#### Session: **D3.0**

***Title: Nonfatal Injury Prevention Activities in Other Countries***

Moderator: Larry Jackson

#### **D3.1**

***Title: A Method to Calculate the Period Prevalence of Workers Receiving Compensation Benefits***

Author: **Phaneuf R**

Introduction: A procedure has been developed to answer the question “How many people are on workers' compensation in our region?” In other terms, calculate the daily prevalence for workers receiving workers' compensation for the last several years, then summarize the period prevalence on a monthly and yearly basis and do so for several subgroups for age and sex. The critical data available includes: the date of the insurance claim, the number of calendar days for which a claim was maintained prior to the returning to work. The last day of compensation was assumed to be the date of the event plus the number of days where the person received benefits.

Methods: An sql formula was developed that calculates the number of workers absent on each day of our study period: 1999 through 2005, using Microsoft Access©. The solution requires looking at each of the 45,254 declared cases occurring between 1997 through 2005 and counting the number of cases where work absence was present for each of the 2,557 days during the study period, then summarizing the daily results on a monthly and annual basis.

Results: The average annual prevalence work loss increased about 650 persons in 1999 to nearly 900 in 2005. In 1999 the proportion of women was 26%, but in 2005 the proportion changed to 34 %. Overall more than half of the increased yearly prevalence is attributable to women, while nearly 75% is among workers over 40 years of age.

Conclusion: Period prevalence approximates the burden of occupational trauma better than incidence data especially when there are structural changes in the workforce such as the proportion of workers in the manufacturing sectors, as well and age and sex. The compilation of prevalence data offers additional opportunities to analyze occupational health statistics.

### D3.2

#### ***Title: Patterns of Severe Work-Related Traumatic Hand Injury in the People's Republic of China***

Authors: **Jin K**, Lombardi D, Courtney T, Sorock G, Perry M, Li M, Pan R, Wang X, Lin J, Liang Y

**Introduction:** In this study we describe the type, location, and severity of acute traumatic hand injuries of 560 workers treated in 11 hospitals in three cities in the PRC over a two-year period.

**Methods:** A structured questionnaire was used to collect participants' information. A log-linear model was constructed to delineate relationships between injury frequency and interest variables. A logistic model was used to seek interest variables contributing to injury severity.

**Results:** Participants ranged in age from 16–64 with a mean age of 31.7 (SD 10.5). Approximately 74.4% were men, 85.4% of participants were employed in manufacturing industries (machinery, fabricated metal products, and motor vehicles). 51.7% of injuries were to the left hand. The index finger was the most frequently injured digit in both hand and the highest severity occurred in the right thumb. 68.3% of participants had only a single type of injury: 29.7% were crushes, 25.7% were amputations, and 18.5% were fractures. Injuries in food products (79.2%), furniture (72.2%), nonmetallic mineral products (71.4%) and wood products (70.6%) were more severe in nature. Powered machines were involved in 59.5% of injuries. Manufacturing (OR 21.2, 95% CI 9.8–45.5), gender (male vs. female, 7.6, 3.4–16.7), powered machine (OR 5.0, 2.1–12.0) and company size (employee  $\leq$  100 vs  $>$  100, OR 3.8, 2.9–4.9) significantly affected injury frequency. The severity of injury was impacted by gender (male vs. female OR 0.61, 95% CI 0.37–0.98), powered machine (OR 2.21, 1.31–3.74).

**Discussion:** The present study suggests that powered machines in the manufacturing industries are the primary source of severe hand injuries in hospitalized workers.

### D3.3

#### ***Title: Prevalence and Predictors of Work-Related Injuries Among Children Laboring in the Streets of Latin America***

Authors: **Pinzon-Rondon A**, Koblinsky S, Hofferth S, Pinzon C

Although children are working in streets throughout the world, child labor is most prevalent in the developing world, including Latin America. Currently, little is known about the prevalence and nature of child street labor injuries and about factors associated with these injuries. This study investigated the occupational injuries of Latin American child street workers, as well as factors that predict their occurrence.

**Methods:** Participants in this cross-sectional study were 584 children between 5 and 18 years of age who worked in the streets of Bogota (Colombia), Lima (Peru), Quito (Ecuador), and Sao Paulo (Brazil). Interviewers administered an oral questionnaire to children engaged in begging, selling, performing, and car washing/guarding which addressed child demographic characteristics, working conditions, and lifetime injuries. Descriptive analyses as well as multivariate analyses using binomial logistic regressions were conducted.

**Results:** Two-thirds of study children had been displaced from their home regions. Forty percent of child street laborers reported significant injuries, including scratches (20%), cuts (16%), burns (9%), car accidents (9%), sprains (5%), and amputations (< 1%). Logistic regression analyses (controlling for individual and environmental factors) revealed that longer work hours, older age, performing, being male, nonminority status, and residence in Quito significantly increased the risk of occupational injury. For example, each additional hour of work increased injury risk by 1%, and each additional year of age increased the injury rate 6%.

**Conclusion:** Children working in the streets are at a very high risk of suffering an occupational injury. Findings underscore the need for interventions to reduce such injuries, including enforcement of anti-child labor laws; social/health services to address displacement and child injury; campaigns stressing the importance of child safety and education; mandatory, skill-oriented education; and increased family incomes.

#### **D3.4**

##### ***Title: Development and Evaluation of an Intervention Study to Prevent Injuries at Work Among Stevedores in Havana***

Authors: **Aguirre CR**, Roque IA

**Aim:** To develop and evaluate an education-based intervention for prevention of work injuries among stevedores in Cuba.

**Methods:** The methodology was developed in three stages: diagnosis, intervention, and evaluation. During the diagnosis phase, injury counts and rates from 1998–2002 were examined for each port terminal (enterprise) in Havana. Two enterprises with the largest number of injuries were selected as the intervention site (Haiphong enterprise) or control (Juan Manuel). Job tasks and safety behaviors were analyzed and safety checklists developed. Interventions focused on reducing human error and were developed based on both quantitative and qualitative techniques and consultations with workers, health and safety groups, and employers. Training was conducted only at the intervention enterprise. Pre and post-intervention questionnaires of worker knowledge, attitudes, and practice were administered, as were observational studies of on-site safety behavior and comparison of injury rates.

**Results:** The intervention site experienced increases in worker knowledge (48%), recognition of hazardous situations (26%), and observed safety behavior (21%). The corresponding differences in the intervention compared to control site were 59%, 50%, and 40%, respectively. Stevedores from intervened enterprise increased 15 % or more in knowledge compared to workers in the control enterprise and increased 10% or more in hazardous-situation recognition. The number of accidents also decreased in intervention enterprise over the last 4 years and the prevention fraction (PF) was 46 %.

**Conclusion:** The intervention site had greater improvements in safety knowledge, attitudes, and practice compared to the control and also had decreased injury rates. This study demonstrates that increases in safety behavior in the work environment are possible among workers through improved training. These activities should also be reinforced by passive strategies in order to obtain better results.

#### Session: **D4.0**

##### ***Title: Identifying and Characterizing Injuries in Agriculture***

Moderator: James Harris

#### **D4.1**

##### ***Title: Statewide Surveillance of New York Farm Injuries: An EMS-based Method***

Authors: Earle-Richardson G, **Brower M**, Jenkins P

**Introduction:** There are unique challenges associated with occupational injury surveillance within agriculture. This study employs an innovative approach for tracking agricultural injuries and fatalities, comparing emergency medical services (EMS) ambulance report data with active community surveillance data. If EMS data proves to be as complete as active surveillance data, review of EMS ambulance reports may provide an efficient and cost-effective way of tracking agricultural injury and fatality events.

**Methods:** Ambulance reports from ten highly agricultural counties in New York are compiled by the state's data management agency and are reviewed for farm-related events. Additionally, active community surveillance is ongoing through three channels: (1) monthly telephone calls to 36 county officials (e.g., sheriffs, coroners, EMS coordinators) throughout the study counties, (2) newspaper review for farm incidents, and (3) correspondence with the New York State Department of Health's Center for Fatal Occupational Injuries.

**Results:** At the time of this submission, only data from the community surveillance methods had been analyzed. Forty-five agricultural events were documented in the study counties between January 2007 and February 2008: nine fatalities and 36 injuries. EMS services were utilized in 41 of these 45 cases (91% of the time). Falls (2), runovers (2), and being struck by an object or animal (2) were the most common causes of fatality. Nonfatal injuries were most commonly attributable to rollovers (9), being struck by an object or animal (7), runovers (6), and falls (6). Ambulance report data will be presented, and challenges encountered during data collection will be discussed.

**Discussion:** Preliminary findings demonstrate the diversity of occupational hazards in agriculture and underscore the need for improved injury surveillance. Establishment of a surveillance system using pre-existing ambulance report data would allow for

effective large-scale agricultural injury and fatality data collection.

#### **D4.2**

##### ***Title: Occupational Injury Rates and Treatment Patterns Among Migrant and Seasonal Farm Workers in the Northeast***

Authors: **Earle-Richardson G**, Brower M, Jenkins P, May J

Background: Migrant and seasonal farm workers are thought to be at increased risk for occupational injury and illness. Previous research in seven Northeastern states revealed an estimated occupational injury incidence rate of approximately 8%. However, uncertainties remained regarding the representativeness of this data due to collection methodology (migrant health center (MHC) and emergency room (ER) medical chart review). The proportion of farm workers using these sources of care was unknown, and it was unclear whether a large proportion of farm workers injured on the job obtained no medical care at all. To address these questions, the Northeast Center conducted an additional study in two of the seven original states.

Methods: In New York and Maine, researchers conducted: (a) an occupational injury and illness survey with farm workers, (b) MHC chart review, and (c) hospital ER chart review. From survey results, proportions of occupational morbidity by treatment location were calculated. A correction factor was then computed to adjust chart review occupational injury and illness rates.

Results: Proportions of morbidity by treatment location did not differ significantly between New York and Maine and were combined for this analysis. Farmworker surveys documented 55 work-related injuries among 1,103 survey subjects. Of those injured, 30 (54.5%) were treated at MHCs. Of the remaining injuries, seven (12.7%) were treated at ERs, 10 (18.2%) were treated at some other location (e.g., at home, by a relative, by a chiropractor), and eight (14.5%) were untreated. Other results pertaining to farmworker healthcare access will be discussed.

Discussion: It is evident that a chart-review based surveillance system (preferably incorporating both MHC and ER data), combined with a correction factor, provides an effective method of estimating occupational illness and injury rates in this population. With this validating evidence, results from the seven-state study will be presented.

#### **D4.3**

##### ***Title: Impact on the Agricultural Industry: Animal-Related Injuries***

Authors: **Gerberich S**, Ryan A, Erkal S, Renier C, Alexander B

Introduction: While agricultural injury has been identified among the major causes of occupational injury mortality and morbidity, data have been limited pertinent to the magnitude, consequences, and risk factors for animal-related injuries—a major source of morbidity among agricultural operations.

Methods: Comparable demographic, exposure, and injury data were collected for 1999 and 2001 among agricultural household members of all ages in a five-state region. Nested case-control studies examined exposures for risk of injury among those < 20 years of age. Causal models facilitated survey design, data analyses, and interpretation of results; Directed Acyclic Graphs guided multivariate modeling and adjustments were made for age, gender, total hours of farmwork, nonresponse, and within-household correlation.

Results: From 7,420 households (84% response of eligible), a total of 5,045 injury events were reported among all ages (32,603 persons; < 20 years, 51%); 1,016 (20.1%) were animal-related (31.8 per 1,000 persons). For those cases < 20 and 20+ years of age, 48% and 46%, respectively, resulted in lost work time on their agricultural operations (20% and 16%, one week or more).

Respectively, for 1999 and 2001, case-control multivariate analyses (Odds Ratios [OR] and 95% confidence intervals [CI]) revealed increased risks for those < 20 years of age working with dairy (1.4, 0.9–2.2; 1.5, 0.9–2.5), horses (2.3, 1.5–3.4; 2.0, 1.3–3.0), sheep (2.3, 1.2–4.3; 2.0, 1.2–3.3), beef (2.0, 1.4–2.9; 2.0, 1.4–2.9), swine (1.6, 1.0–2.7; 1.4, 0.8–2.4), and poultry (1.2, 0.6–2.4; 2.7, 1.7–4.5). The overall risk for children and youth working with any animals was OR = 4.5, CI = 2.8–7.12. Specific activities involved in working with these animals are associated with these risks.

Discussion: Animal-related injury has a major impact on the agricultural operation household members and the agricultural operations, in general. Results serve as a basis for further research and appropriately designed interventions.

#### **D4.4**

##### ***Title: Injury Severity Related to Overturn Characteristics of Tractors***

Authors: **Myers M**, Cole H, Westneat S

Introduction: Early studies of injuries associated with overturns indicated that more fatalities occurred when a tractor overturned beyond 90° (continuous roll) relative to the impact plane. No population-based study has been conducted that compares the severity of fatal and nonfatal injuries between a 90° roll and a continuous roll for both ROPS-equipped and non-ROPS tractors.

Methods: A Kentucky Farm Tractor Overturn Survey was administered in 2002, in which 6,063 randomly selected farm operators responded to questions that differentiated between tractors that were equipped versus not equipped with a ROPS in the event of a tractor overturn. From this population, 541 reported experiencing a tractor overturn. Overturn characteristics were collected that included to the side (90°), upside down (180°), beyond upside down (> 180°), and to the rear for both ROPS-equipped and non-ROPS tractors.

Results: Of the 541 most recent overturns reported in this study, 505 of the respondents reported the overturn characteristics of the tractor, 86 of which were ROPS-equipped and 505 with no ROPS. For side overturns, 66% occurred with the ROPS-equipped tractors and 48% occurred with non-ROPS tractors. The percentage of deaths related to these side overturns was, respectively, 1.6% and 3.7%. There were no deaths related to overturns beyond 90° for ROPS-equipped tractors whereas there were 6.6%, 5.4%, and 6.8% of fatal overturns, respectively, for 180°, > 180°, and rear overturns. Regarding 90° side overturns, 13% resulted in nonfatal injuries with an average of 1 day of hospitalization for ROPS-equipped tractors, and 22% resulted in nonfatal injuries with an average of 18 days of hospitalization for non-ROPS tractors.

Discussion: The results from this study indicate that a ROPS is effective at stopping an overturn at 90°, which is associated with a reduction in the severity of injury in the event of a tractor overturn.

#### Session: **D5.0**

##### ***Title: Motor Vehicle Safety***

Moderator: Audrey Reichard

#### **D5.1**

##### ***Title: Sleep Apnea and Motor Vehicle Crashes—A Systematic Review and Meta-Analysis***

Authors: **Greenberg M**, Phillips B, Tregear S, Tiller M, Rizzo M, Hegmann K, Anderson G

Introduction: Obstructive sleep apnea (OSA) is characterized by a reduction or cessation of breathing during sleep coupled with symptoms including excessive daytime sleepiness. Consequently, individuals with OSA who operate motor vehicles may pose a threat to road safety.

Methods: Data from published studies that have addressed the association between obstructive sleep apnea and motor vehicle crash were synthesized. Relevant articles were identified using sensitive search strategies applied to 13 electronic databases. Additional hand searches of bibliographies were also performed. A priori criteria for article inclusion were: (1) English language publications, (2) full-length articles, (3) controlled (case-control or cohort) study design, and (4) enrolled  $\geq 10$  patients. The quality of all included studies was determined using a revised version of the Newcastle/Ottawa Scale. Random-effects meta-analysis was used to pool data from different studies. Sensitivity analyses to test the robustness of our findings included the use of cumulative random-effects meta-analysis. Publication bias was tested for using the “trim and fill” method.

Results: Our searches identified 17 relevant articles all of which provided evidence rated in the low-to-moderate range. Meta-analysis found that individuals with OSA have a substantially increased risk for a motor vehicle crash (Crash Risk Ratio = 2.72, 95% CI: 1.30–5.72;  $p = 0.008$ ). The risk of an individual with OSA experiencing a motor vehicle crash is between 30% and 47.2% greater than individuals without the disorder.

Discussion: Risk factors for crash among individuals with OSA included the presence and degree of subjective daytime sleepiness, severity of sleep-disordered breathing during sleep, blood SaO<sub>2</sub> levels, and BMI. OSA increases the risk for motor vehicle crashes. This risk is of special concern for drivers of commercial vehicles as these vehicles usually require special driving skills.

## **D5.2**

### ***Title: Using Technology to Improve Driver Behavior***

Author: **Fleishman H**

Introduction: The use of telematics in fleet management has been employed as a method to give managers data and statistics on employee driving behavior. With this data, the desired outcome for managers is two-fold: (1) to accurately portray significant statistics on employee driving behavior, and (2) to leverage these statistics to effectively mitigate risky driving behavior. This presentation will focus on the latter, delving into the utilization of technology as a practical approach towards reducing risky driving behavior and, ultimately, road accidents.

Methods: To test the hypothesis, GreenRoad Technologies' deployed its Safety Center system into T-Mobile UK service vehicles in late 2006. The system consisted of a dashboard monitor to provide real-time feedback to the driver to indicate driving behavior using light signals (green, yellow, red) and an embedded sensor that detects 120 different driver maneuvers across five categories—speed, braking, acceleration, lane handling, and turning—all via algorithms that analyze raw motion data and convert it into meaningful data corresponding to driver behavior and patterns. These results were collected over six months and then compared to driver safety statistics to measure their significance.

Results: The findings indicate that in six weeks, the T-Mobile UK Fleet had reduced risky driving behavior (characterized as “red” driving) by 50%, and after two months the accident rate declined by 23%. Over a six-month period, driving improved dramatically from 69% red drivers and 10% green drivers to 35% red drivers and 38% green drivers.

Discussion: While the implementation of technology to reduce risky driving behavior will continue to evolve in the next several years, the adoption of such technology, as it stands now, has significantly proven to reduce road accidents due to better driving behavior, ultimately saving fleet managers money on vehicle repair.

## **D5.3**

### ***Title: The Effect of Passengers on Large Truck Collisions Involving Older Male Drivers***

Authors: **Bunn T**, Slavova S, Bathke A

Introduction: The effect of passengers on at-fault vs. not-at-fault large truck collisions (LTCs) involving older male drivers is unknown.

Methods: A retrospective population-based case-control study was conducted to determine whether the presence of passengers decrease the likelihood that a driver will be at fault in a LTC. Cases were identified as male drivers, 50 years of age and older, in at-fault LTCs, and controls were male drivers, 50 years of age and older, in not-at-fault LTCs using the Kentucky Collision Report Analysis for Safer Highways (CRASH) electronic database from 2000–2006. Unit type classifications included: trucks and trailers, truck-single unit, truck-tractor and semitrailer, and truck-other combination. All vehicles were designated as commercial vehicles in the CRASH file. Multiple logistic regression was performed.

Results: One or more passengers, 4-lane highways, and daytime driving were protective factors for a male driver > 50 years of age to be at fault in a LTC. In contrast, drivers sixty years of age and older, posted speed limits of under 45 mph compared to speed limits > 55 mph, and curvy and graded/hillcrest roads increased the odds that the driver would be at fault in a LTC.

Discussion: The presence of passengers had a protective effect on older adult male driver LTCs. The results of this study have the potential to inform and influence public policy in regard to the presence of passengers and their positive protective effect on large truck drivers, particularly in long-distance driving performed by solo drivers vs. team drivers in commercial trucking operations.

## **D5.4**

### ***Title: Global Collaboration to Improve Worker Safety on Roads***

Authors: **Hingston J**, Fingerhut M, Pratt S

The National Institute for Occupational Safety and Health (NIOSH) and stakeholders in the United States and abroad are working together within the new National Occupational Research Agenda (NORA). For the past 10 years, NORA has served as a framework to guide occupational safety and health research, not only for NIOSH but for the entire U.S. occupational safety and health community. NORA has had

substantial impact in the United States. NIOSH and partner governmental agencies have funded NORA research annually at increasing levels, rising from \$15 million in 1996 to \$130 million in 2005.

Building on the success of NORA, the second decade of NORA is using a sector-based approach, which includes all employers, all workers, and all workplaces. NIOSH and its partners have formed eight Sector Research Councils, gathering all sectors into these eight groups. Each council includes participants from academia, industry, labor, and government and will draft strategic and subsector-based research goals, objectives, and action plans. These agendas will provide guidance to the entire occupational safety and health community for moving research to practice in workplaces. In addition, a Cross-sector Research Council will be formed to identify opportunities for common research (e.g., musculoskeletal disorders) across sectors. Global collaborations is an important cross-cutting theme for all sectors. In our global village, the sharing of solutions to common problems can increase the health and safety of workers on all continents.

This presentation will illustrate the benefits of global collaborations in the Transport Sector to prevent road injuries to workers globally. An online library of best practices in place globally has been developed, and partners are gathering at an international conference in 2008 to plan additional implementation and evaluation activities.

Session: **E1.0**

***Title: Training in Construction***

Moderator: Thomas Bobick

**E1.1**

***Title: Informal Training in Small Construction Work Systems***

Authors: **Smith-Jackson T**, Kleiner B, Artis Sa, Baldev D, Hughes C, Lancaster G

Introduction: Companies with 20 or fewer workers make up a majority of the construction industry, yet few efforts have focused on providing compatible methods to facilitate safety training. Small construction companies comprise a disproportionate number of injuries and fatalities within the construction industry. This study was conducted by the Center for Innovation in Construction Safety and

Health (CICSH) to identify ecologically valid training methods for small construction work systems.

Method: This research effort combined qualitative and quantitative approaches to conduct a needs analysis of very small construction companies to identify barriers to and preferences for training. Qualitative methods using interviews and focus groups provided a list of requirements or themes supporting a preference for informal training and barriers to the use of other types of training approaches. Quantitative methods revealed preferences for flexible training methods and a supportive safety climate. Analyses included content analysis, principal components, regression, and heuristic review by external evaluators.

Results: Informal training was found to be the most compatible training approach for these environments. The manner in which the training should be conducted is unique to this work system. We applied a research-to-practice approach developed by the CICSH, which supported development of guidelines and strategies associated with integration of risk perception, work-family dynamics, and situated learning in construction environments were identified.

Discussion: This research identified an informal training approach that is unique to construction environments that meet the following criteria: fewer than 20 workers, workers connected by family/friendship, interference of personal dynamics during the work day, limited time and resources, and poor safety climates. A situated training strategy was identified that was reported by several workers in a number of different ways. Best practices of the situated training strategy were also identified. Future efforts will focus on informal training frameworks.

**E1.2**

***Title: Construction Safety Training Issues for New Construction Employees***

Authors: **Hubbard B**, McGlothlin J, Hubbard S, Mena I, Soendjojo A

Introduction: The construction industry has a large number of work-related deaths, and previous studies suggest that workers may be most vulnerable to construction injuries and fatalities at the beginning of their career in construction, when they have the least experience on the construction site. To minimize the threat to new employees, adequate safety training programs are a necessary part of construction work. This research is a pilot study to identify issues that

may affect the impact of safety training on new employees.

Methods: To address the issues associated with safety training programs for new employees, a series of three surveys was conducted with student interns in the construction industry. Students completed surveys (1) prior to OSHA 10-hour safety training, (2) after the OSHA 10-hour safety training and before working on the construction site for their first internship, and (3) after working on the construction site for their first internship.

Results: The results of these surveys indicate both benefits and limitations of existing training. Findings confirm that safety training can play an important role in safety and can familiarize new employees with potential construction hazards. However, one significant limitation of existing safety training is that it requires an understanding of construction terminology that many inexperienced workers do not have. Furthermore, the findings indicate that even workers with some exposure to construction may not understand terminology associated with construction specialties, such as electrical. The lack of understanding of basic terms used in the OSHA training indicates a significant issue for the trainer and the training process.

Conclusions: This pilot survey suggests that safety training may be enhanced by providing clear definitions and pictorial explanations of construction terminology that may be unfamiliar to new employees. Additional research may provide a better understanding of the issues that affect new employees and how these issues can be addressed through safety training material.

### **E1.3**

***Title: Diffusion of Fall Hazard Safety Training for Hard-to-Reach Residential Construction Workers Through the Internet and Utilizing New Media***  
Authors: **Fullen M**, Takacs B, Shambaugh N

Introduction: The numbers of workers in the residential construction industry are on the rise. Falls have continually been the largest contributor to residential construction worker deaths and injuries. These workers are largely self-employed or working for small companies. These individuals are difficult to reach through traditional methods. This research proposed to use the internet to reach this group and engage them in the curriculum development cycle.

Methods: An instructional design research method known as Type I Developmental Research was utilized to study the methodology, product, implementation, and outcomes for this program throughout the design, implementation, and evaluation stages. Two complete cycles of design, implementation, and evaluation cycles have been evaluated. Type I developmental research treats the design-development-evaluation process as a form of inquiry and does so by embedding traditional research methods into the development project and utilizes the case study method (Richey, Klein and Nelson).

The research questions are: (1) Does the training program addressing residential fall hazards and safety bring about individual or group behaviors that may reduce the likelihood of falls from heights on residential construction sites? (2) Does the technology-based availability and delivery of this training material increase trainee interest? (3) Does including residential construction worker, supervisor, and expert feedback into the developmental cycle of training development impact the relevance and acceptability of the residential fall protection training material?

Results: Initial results have shown that the newly developed material has brought about increased knowledge and fall protection usage. The availability of the training material on the internet has led to a broad diffusion and use of the training material, although most seekers of this material were trainers and safety professionals rather than workers. Finally, including workers and others in the training development cycle has impacted the relevance and acceptance of the material.

### **E1.4**

***Design and Preliminary Evaluation of a Fall Protection Curriculum for Apprentice Carpenters in Residential Construction***

Authors: Kaskutas V, **Abraham R**, Dale AM, Lipscomb H, Gaal J, Fuchs M, Evanoff B

Introduction: Results of a comprehensive needs assessment were used to modify the fall prevention curriculum at a carpenter apprenticeship training program.

Methods: We conducted a comprehensive needs assessment via focus groups (n = 36), questionnaires (n = 1,026), and worksite audits (n = 197) to determine gaps in the apprentice carpenters' fall protection training. The current fall prevention curriculum was evaluated and training opportunities

identified. We used these data to develop learning objectives, lesson plans, and training methods. After initiating the revised curriculum, we solicited apprentice evaluation and feedback to guide ongoing curricular improvements.

**Results:** We found that apprentices perform tasks that place them at risk for falls before receiving training. Fall prevention learning objectives (n = 43) were integrated into early apprenticeship training and are reinforced throughout the four-year program. We used adult learning principles to emphasize hands-on experiences and integration of real-life stories. A portion of a framed structure of a residential construction site was fabricated to allow apprentices to observe and practice fall protection behaviors. Preliminary results show that 96% of early term apprentices agree that the residential prop is an effective training tool, and 81% state they will change their stepladder work habits as a result of training. The training appeared to impact many of the apprentices as evidenced by feedback, such as “I will use these safety tactics daily, I had no knowledge of them before” and “I learned a lot about my own interpretation of risks...risk perception is different than it seems at first.”

**Conclusions:** Integration of needs assessment results and apprentice feedback was invaluable in revising a fall prevention curriculum. Working closely with the instructors to tailor learning experiences to best meet our learning objectives has provided preliminary positive results. Effectiveness of curriculum changes will be assessed through repeat questionnaires and worksite observations.

Session: **E2.0**

**Title: Physical and Ergonomic Risk Factors Associated With Slips**

Moderator: Sharon Chiou

**E2.1**

**Title: Physics-Based Computational Modeling for Shoe-Floor-Contaminant Friction**

Authors: **Beschorner K**, Lovell M, Higgs III CF, Redfern M

**Introduction:** While many devices quantify slipperiness of shoe-floor combinations, these devices are limited by their inability to reproduce a slip and by the dependence of coefficient of friction (COF) on the device. Computational modeling approaches may provide potential to efficiently quantify slipperiness across a range of testing conditions while considering

complex loading patterns and shoe kinematics. The purpose of this abstract is to discuss recent research efforts by our group to develop computational physics-based models for shoe-floor-contaminant friction.

**Methods:** The computational friction model is based on a mixed-lubrication approach, where the normal load is shared by the contacting surfaces and the fluid. The contact region is solved with Hertzian mechanics, and the thin-fluid film region is solved with Reynolds Equation. Iterative methods determine the load supported by the fluid and the contacting surfaces based on the criteria that the summed force from the fluid and contact must equal the total applied force. COF values were determined using a linear rule of mixtures based on the load supported by the asperities and the fluid. The modeling approach is applied to a pin-on-disk apparatus and model output values are compared with experimental results for two different shoe materials.

**Results:** The analytical model predicted a nonlinear reduction in coefficient of friction consistent with experimental values for both shoe materials. The model was particularly accurate at high speeds where the fluid carried more of the load. The analytical model also predicted that the peak hydrodynamic pressure occurs just outside the contact region, and the peak contact pressure occurs in the center of the pin.

**Discussion:** The physics-based modeling approach described here predicts COF values, which match experimental results. This research aims to serve as a starting point towards developing similar analytical models for an entire shoe.

**E2.2**

**Title: The Stochastic Distribution of Available Friction Coefficient for Human Locomotion**

Authors: **Chang W-R**, Matz S, Chang C-C

The available friction coefficient for human locomotion is the maximum friction coefficient that can be supported without a slip at the shoe and floor interface. The required friction coefficient is the minimum friction coefficient needed at the shoe and floor interface to support human locomotion. A statistical model was recently introduced to estimate the probability of slip incidents by comparing the available friction coefficient with the required friction coefficient, assuming that both coefficients have stochastic distributions. The stochastic distribution of the required friction coefficient was recently investigated by this research team. The current paper

presents an investigation of the stochastic distributions of the available friction coefficient under dry, water- and glycerol-contaminated conditions as an input to the statistical model. In this experiment, a walkway with plain quarry tiles was constructed. Fifty tiles on this walkway were selected for friction measurements with the Brungraber Mark II using the Neolite liner under three different surface conditions. Two friction measurements were performed on each selected tile, one in each walking direction. The protocols for friction measurements and cleaning of the samples before friction measurements used in this study were previously developed and published in the literature by this research team. Barnett obtained 400 measurements of the available friction coefficient over 100 new tiles under the dry condition with the Horizontal Pull Slipmeter (HPS) and reported that the distribution of the available friction coefficient was near a Weibull distribution. In the current study, the Kolmogorov-Smirnov goodness-of-fit test was used to determine if the distribution of the available friction coefficient was a good fit with the normal, log-normal, and Weibull distributions. The results indicated that the available friction coefficient appears to fit the normal and log-normal distributions better than the Weibull distribution for the water and glycerol conditions.

### **E2.3**

#### ***Title: Assessing Floor Slipperiness: The Effects of Friction and Perception on Gait***

Authors: **Chang C-C**, Lesch M, Chang W-R

Introduction: Falls following slips are one of the leading causes of accidental injuries in the home and workplace. This study assessed floor slipperiness by investigating gait changes in response to sensory feedback received when walking on different combinations of floor surface material and contaminant conditions.

Methods: Five different floor materials were tested in random order. Participants wore a harness and were asked to walk repeatedly on each floor as quickly as possible without slipping. For each floor material, three surface conditions (dry, water, and glycerol) were tested. The available friction coefficient (ACOF) was measured by a PIAST slipmeter. After completing each test condition, participants rated slipperiness. The peak utilized friction values (Peak3) at the heel strike landing phase were calculated from the ground reaction force data collected using forceplates embedded under the walkway.

Results: A lower Peak3 value was observed only when floor ACOF was reduced to a certain amount. Some floors with similar ACOF, however, resulted in different Peak3 values. In addition, for some floors, when its ACOF changed from the dry condition (0.81) to the glycerol condition (0.19), the participants' peak3 value only reduced slightly from 0.2 to 0.18, which is close to the floor's available COF. By examining participants' perception ratings, however, individuals seemed to see only a small difference in the slipperiness.

Discussion: The analysis indicated that individuals could adjust their gaits to accommodate floor condition changes. However, ACOF may not be the only factor that affects an individual's gait. Differences in the visual characteristics of the floors and the proprioceptive feedback received while walking on the floor surfaces may have also influenced changes in gait which were reflected in the ground reaction force profiles.

### **E2.4**

#### ***Title: Influence of Localized Muscle Fatigue of the Knee Joint on Kinematics and Kinetics Related to Slip-induced Falls***

Authors: **Lockhart T**, Parijat P, Liu J

Existing epidemiological evidence suggests that localized muscle fatigue might be considered as an intrinsic risk factor that causes lack of balance control leading to falls. The goal of the study was to examine how localized muscle fatigue of the knee joint (quadriceps) alters gait parameters and joint kinetics (joint moment and power) that are related to slip propensity. Sixteen healthy young participants were recruited to walk across a vinyl floor surface in two different sessions (Fatigue and No fatigue). Kinematic and kinetic data were collected using a three-dimensional video analysis system and force plates during both sessions. An inverse dynamics model was developed to calculate the knee joint moment and power. In terms of gait parameters, the fatigue session results indicated a substantial increase in heel contact velocity (HCV) and required coefficient of friction (RCOF), as well as a decrease in the transitional acceleration of the whole body COM (TA), walking velocity (WV), and step length (SL). Furthermore, the results demonstrated an increase in the peak knee joint moment and peak knee joint power generation in the fatigue slip trials. There were four reported falls in the fatigue session. These findings provide new insights into the biomechanical relationship between localized muscular fatigue and joint kinetics and gait parameters linked with slip propensity. The study concluded that

localized muscular fatigue can be considered as a potential risk factor for slip-induced falls.

Session: **E3.0**

**Title: Injury Assessment and Methods**

Moderator: Suzanne Marsh

### **E3.1**

**Title: Modeling Occupational Low Back Injury Risk Due to Repeated Joint Loading**

Authors: **Mughal W**, Morrison J, Robinovitch S

Introduction: Previous research has shown that peak loading and work history are correlated with risk of injury, although the relationship is not clearly understood. The purpose of this study was to develop a model that will predict probability of low back injury as a function of repetitive loading of the L4/L5 joint, joint material properties, and work history in residential care settings.

Methods: Low back injury data from a 5-year period were extracted from an employer's database and filtered to exclude repeat injuries. Focus groups identified and demonstrated the tasks regularly performed in residential care. Peak L4/L5 joint forces were calculated from a biomechanical model. By combining actual injury rates and biomechanical data, a low back injury model was developed using material fatigue theory to predict injury risk due to cumulative peak compressive loading.

Results: Biomechanical analyses revealed peak L4/L5 joint compressive forces of 467 N to 3811 N and peak anterior-posterior shear forces of 66 N to 471 N. A cumulative probability distribution curve was generated from the low back injury model to illustrate probability of injury over a working career. The model predicts 50% of residential care workers will experience a low back injury by their 8<sup>th</sup> year of work and 95% by year 15.

Discussion: While fatigue failure models have been used previously to assess health effects of repeated shocks on vehicle operators, this study is novel in its application of a fatigue model to predict injury from manual handling tasks. While not validated, the model output compares favorably to historical injury onset characteristics of residential care workers. In addition, the value of L4/L5 ultimate compressive strength obtained from the best fit model compares favorably with values reported in the literature. Future work will test the model against other work populations.

### **E3.2**

**Title: Comparison of Injury Types and Severity Among Workers Admitted to Hospitals vs. Treated in Emergency Departments**

Authors: **Dischinger P**, Smith G, Ho S, Auman K, Kufera J

Introduction: Little information is currently available concerning the nature of work-related injuries severe enough to require treatment in a hospital.

Methods: As part of a statewide surveillance of occupational injury, all workers either hospitalized or treated in Maryland emergency departments were identified, and an incident-specific database created for the years 2001–2004. ICD-9 codes were obtained from hospital discharge records. For those with multiple injuries, ISS scores were also computed.

Results: There were a total of 173,304 workers either treated in an ED or admitted to a hospital. The most common injuries were upper extremity injuries, followed by lower extremity injuries. Workers hospitalized were significantly older than ED cases (42 vs. 37,  $p < .001$ ), and more likely to be men (82% vs. 68%,  $p < .001$ ). Among those admitted, the primary upper extremity injury was forearm fracture (21%); for lower extremity injuries it was ankle/foot fracture (23%). In contrast, for ED cases the primary upper extremity diagnosis was finger laceration (28%); for lower extremity injury, ankle/foot sprain. For both ED patients and those hospitalized, the majority of injuries, based on ISS score, were minor (ISS 1-8); among those admitted, however, approximately one quarter had serious injuries (ISS 9-75).

Significance: This is the first statewide injury surveillance study of serious occupational injuries and thus the first to identify the types and severity of such injuries. Although the majority may still be considered relatively minor in nature, some, like mild traumatic brain injuries and ankle/foot fractures, have been shown to have a major impact on long-term functional status and quality of life. This data can be used within the state to learn more about causative factors in order to prioritize prevention strategies.

### E3.3

#### ***Title: Work-Related Physical and Psychosocial Exposures are Risk Factors for Incident Symptoms and Functional Impairment of the Hands and Wrists***

Authors: Coomes J, Dale AM, Franzblau A, Descatha A, Strickland J, **Evanoff B**

**Introduction:** This study sought to identify independent personal, work-related, and psychosocial risk factors for incident cases of CTS, hand/wrist symptoms, and functional impairment in a working cohort.

**Methods:** We analyzed data from an ongoing study of musculoskeletal disorders among workers. At the time of this analysis, 682 of 898 eligible workers (76%) had completed surveys at both six and 18 months after hire. Questionnaires measured risk factors at 6 months, including demographic data, self-reported physical exposures assessed by the Nordstrom scale, and the Karasek scales for social support, job skill discretion, job decision-making authority, and job insecurity. Incident outcomes occurring between six and 18 months included new CTS defined as a reported clinical diagnosis or new typical symptoms defined by a Katz hand diagram, new hand/wrist symptoms causing at least moderate discomfort (greater than 5 on a 0–10 discomfort scale), and new functional impairment defined as work disability or change on the Levine functional status scale. We performed multivariate logistic regression to assess independent risk factors for the study outcomes of CTS, hand/wrist symptoms, and functional impairment.

**Results:** In our preliminary analyses of this ongoing study, we found that 5.6% of subjects met our case definition for CTS, 13.9% had hand/wrist symptoms of at least moderate severity, and 14.1% reported functional impairment. Independent predictors of the three study outcomes differed, but included job physical exposures (pinch, forceful grip, lifting/carrying objects > 2 lbs.), psychosocial factors (low job social support and job skill discretion), and personal factors (female gender, thyroid disorders).

**Conclusion:** Personal, work-related, and psychosocial factors were all independent predictors of incident cases of CTS, hand/wrist symptoms, and functional impairment. Efforts to reduce morbidity related to hand-wrist disorders in working populations should recognize the multifactorial nature of these disorders.

### E3.4

#### ***Title: Etiology of Work-Related Electrical Injuries: A Novel Taxonomy and In-depth Narrative Analysis of Workers' Compensation Claims***

Authors: **Lombardi DA**, Matz S, Brennan MJ, Smith GS, Courtney TK

**Introduction:** To provide new insight into the etiology of work-related electrical injuries, we developed a multi-stage case-selection algorithm to identify electrical-related injuries from workers' compensation claims and a novel customized coding taxonomy to identify the preinjury circumstances.

**Methods:** Routinely collected workers' compensation claims over a one year period from a large U.S. insurance provider were used to identify electrical-related injuries using an algorithm that evaluated injury cause information (two fields), nature of injury, accident description, and injury description narratives. Concurrently, we developed a customized coding taxonomy for narratives to ascertain the activity, source, initiating process, mechanism, vector, and voltage.

**Results:** Among the 586,567 reported claims during 2002, electrical-related injuries accounted for 1,283 (0.22%) of nonfatal claims and 15 fatalities. Most (72.3%) were male, average age of 36, working in services (33.4%), manufacturing (24.7%), retail trade (17.3%), and construction (7.2%). Body parts injured included the hands, fingers or wrist (34.9%); multiple body parts/systems (25.0%); and the lower/upper arm, elbow, shoulder, and upper extremities (19.2%). The leading activities were conducting manual tasks (55.1%); working with machinery, appliances, or equipment; working with electrical wire; and operating powered or nonpowered hand tools. Primary injury sources were appliances and office equipment (24.5%); wires, cables/cords (18.0%); machines and other equipment (11.8%); fixtures, bulbs, and switches (10.5%); and lightning (4.2%). No reported vector was involved in 85% and the work process was not self-initiated in 9.6% of cases.

**Discussion:** Injury narratives provide valuable data to overcome the limitations of precoded data, supplement traditional epidemiological data, and provide important information for understanding the etiology of work-related electrical injuries and developing prevention opportunities.

Session: **E4.0**

**Title: Youth in Agriculture**

Moderator: Susan Gerberich

#### **E4.1**

**Title: Identifying Determinants of Being a Child Bystander on Midwestern Agricultural Operations**

Authors: **Williams Jr. Q**, Alexander B, Gerberich S, Ryan A

Background: Agricultural work is dangerous employment, placing at risk not only workers but also those who live on the operation, particularly children who are bystanders. We evaluated the incidence and determinants of bystander injuries to children in the Regional Rural Injury Study - II (RRIS-II).

Methods: The RRIS-II followed 32,601 people (~85% of eligible) from rural communities in the Midwest for two 6-month recall periods in 1999/2001. Injury events involving children and adults, demographic, and exposure data were collected using computer-assisted telephone interviews. A nested-case-control study of children evaluated the determinants of being a bystander in high-risk agricultural environments. Narrative data were used to identify work-relatedness of children's injuries by cataloging narrative scenarios into bystander categories.

Results: Of the child injures (aged <20 yrs), 102 (22%) were bystanders. Fourteen were identified as indirectly work-related (working bystanders), 27 nonworking accomplice (passengers/tag-alongs), and 60 nonworking attendant (playing on the operation). Multivariate analyses revealed important associations between a parent's belief in his/her child's readiness to do chores, based on specific characteristics, and bystanding in several locations on the operation: child size matters near water 1.9 (1.1, 3.3), gender matters near driveways 1.6 (1.1, 2.5) and workshops 1.5 (1.0, 2.2). A parent's view of a safe age to operate tractors showed moderately increased odds of bystanding near animals, fields, water, workshops, and stored machines 1.1 (1.0, 1.13) for any of the aforementioned areas.

Conclusions: To best direct prevention efforts to protect young children from bystander injuries, it is imperative to specifically identify the mechanism by which the injury occurred. Since children are vulnerable to many of the same hazards as adults, but are far less capable of understanding all of the potential hazards. It is necessary to examine parental factors that may be associated with children's

likelihood of bystanding in high-risk work environments.

#### **E4.2**

**Title: Farm Chores Worked by Youth and Adherence to the North American Guidelines for Children's Agricultural Tasks**

Authors: **Wilkins Jay**, Heaney Cathy, Ashida Sato

Introduction: In 1999, the North American Guidelines for Children's Agricultural Tasks (NAGCAT) were published to help adults in assigning and supervising chores for youth 7–18 years of age who work in agriculture. This abstract is based on work performed as part of our NIOSH-funded project "Adherence to the NAGCAT and Injury Risk Reduction."

Methods: During a recent 3-year period, 4-H youths (and their caregivers) were recruited into a study designed to evaluate the effectiveness of the NAGCAT to reduce agriculture-related injury risk. Relying on Participant Event Monitoring methodology, youth were expected to keep a daily diary of time spent doing farm chores, safety behaviors, adult supervision present, and relevant details of all injuries sustained during the 10-week followup period. In addition, parents/caregivers who were primarily responsible for chore supervision completed questionnaires that elicited information about health- and safety-related beliefs and attitudes, among other things.

Results: Of the 417 adult-child dyads agreeing to participate, 347 (83.2%) completed the necessary consent/assent forms, with 330 providing usable data. Based on the 31 chores relevant to central Ohio agriculture, participating youth (144 boys (mean age 13.8 years), 186 girls (mean age 13.6 years)) reported nearly 19,000 hours of work-related at-risk time. Wide variability was seen in both the frequency of working a chore (expressed as the mean number of work sessions per week) and in the duration of a work session (expressed as the mean number of minutes per work session). Adherence to NAGCAT work practice recommendations also varied widely. Some work practices, e.g., checking for people and obstacles in the work area, were almost always followed, while others, e.g., using a respirator, were rarely followed. Notable gender differences were seen with respect to all three measures, as will be described.

Conclusion(s): Our findings indicate exposure to injury hazards among youth who work in agriculture are quite variable. In addition, many central Ohio

youth work chores in a way that violate NAGCAT guidelines. The observed low adherence to many NAGCAT work practices suggests much needs to be done to increase risk-reducing safety behaviors among youth who work agriculture-related chores.

#### **E4.3**

##### ***Title: Enhancing Adherence to the North American Guidelines for Children's Agricultural Tasks***

Authors: **Heaney C**, Wilkins JR, Ashida S

Introduction: In 1999, the North American Guidelines for Children's Agricultural Tasks (NAGCAT) were published to help adult caregivers in assigning and supervising chores for youth 7–18 years of age who work in agriculture. This study developed and evaluated an intervention to disseminate the NAGCAT in ways that enhance adherence to the guidelines.

Methods: Youth/adult dyads were recruited into the study. 4-H youths and their parents completed questionnaires that asked about injury history, work history, and health- and safety-related beliefs and attitudes. In addition, during the 10-week study period, youth were expected to keep a daily diary of time spent doing specific farm chores, safety behaviors, and any injuries sustained.

The youth/adult dyads were recruited from nine counties in Ohio. Five of these counties were designated as intervention counties. The parents in these counties received home visits from a project staff person who conveyed motivating information about NAGCAT and how the guidelines could be used to inform parental decision-making and behavior. The content of the presentation was informed by Protection Motivation Theory (PMT). PMT proposes that protection motivation is dependent on perceived susceptibility and severity of the threat (for example, the risk of injury) and the perceived effectiveness of possible responses for dealing with that threat (for example, performing safe tractor operation behaviors).

Results: Intervention dyads (n = 217) and control dyads (n = 130) were similar at baseline. Preliminary results suggest that parents in the intervention households experienced a greater increase in protection motivation than parents in control households. A limited number of chores were worked frequently enough to permit a preliminary evaluation of pre-post intervention differences in levels of adult supervision and chore-specific safety practices. Among these five chores, post-intervention mean adult supervision scores were significantly higher for four of the five chores. Analogous comparisons among

control youth revealed no significant pre-post intervention differences.

Conclusion: A home visit intervention based on PMT principles can be effective in increasing parents' protection motivation and in enhancing adherence to some of the guidelines in NAGCAT.

#### **E4.4**

##### ***Title: Using Longitudinal Data Analysis Methods to Assess the Effectiveness of the North American Guidelines for Children's Agricultural Tasks in Reducing Childhood Agricultural Injury Risk***

Authors: **Wilkins J**, He X, Heaney C, Ashida S

Introduction: In 1999, the North American Guidelines for Children's Agricultural Tasks (NAGCAT) were published to help adults in assigning and supervising chores for youth 7–18 years of age who work in agriculture. This abstract is based on work performed as part of our NIOSH-funded project entitled "Adherence to the NAGCAT and Injury Risk Reduction."

Methods: During a recent 3-year period, central Ohio 4-H youth (and their caregivers) were recruited into the two-arm trial. Relying on Participant Event Monitoring methodology, youth were expected to keep a daily diary of time spent doing farm chores, safety behaviors, adult supervision present, and relevant details of all injuries sustained during the 10-week followup period.

After 3 weeks of diary maintenance, intervention households were visited by a trained "interventionist" who delivered a standardized Microsoft PowerPoint presentation to the primary caregiver to convey motivating information about NAGCAT and how the guidelines could be used to inform parental decision-making and behavior relevant to the youth's agricultural chores. An intervention booklet containing the guidelines on the 31 chores most relevant to the target population was given to each intervention family.

Longitudinal data analysis methods were used to analyze the change in the mean injury rate per exposure minute over followup (log-linear GEE models accounted for the within-subject correlation). Numerators of weekly rates were the total number of work-related injuries sustained over all chores worked. Denominators of weekly rates were all minutes worked over all chores.

Results: A total of 417 adult-child dyads agreed to participate, with 347 (83.2%) giving informed consent/assent. Intervention households numbered 217 over 5 counties. Control households numbered 130 over 4 different counties. Intervention and control youth were similar at baseline with respect to several potentially confounding variables.

Injury rates were based on >500 work-related events. GEE modeling results indicated that, overall, rates among intervention youth were lower than those among control youth ( $p < 0.05$ ). However, GEE models taking into account the timing of the intervention revealed no evidence of an intervention effect.

Conclusion(s): In-home delivery of the NAGCAT to adult caregivers who assign farm chores to youth may not be sufficient to reduce childhood agricultural injury risk.

Session: **E5.0**

**Title: Assessing Injury Risk Factors**

Moderator: Theodore Courtney

### **E5.1**

**Title: Gender Differences in Injury Patterns Among Workers in Heavy Manufacturing**

Authors: **Cantley L**, Taiwo O, Slade M, Pollack K, Vegso S, Fiellin M, Cullen M

Introduction: Women comprise 46% of the paid U.S. labor force. They have been increasingly entering traditionally male-dominated jobs in construction, mining, and heavy manufacturing, although their representation in these sectors remains significantly lower than that of men. The objective of this research is to determine if female workers in a heavy manufacturing environment have a comparable risk of occupational injury compared to their male counterparts when performing the same job and to evaluate if there are gender differences in type of injury and severity of injury.

Methods: Using company-maintained human resources data linked with incident surveillance data for hourly workers at six aluminum smelters, injuries occurring over a 10-year period were analyzed. Multivariate logistic regression, adjusted for job and age category, was used to calculate odds ratios (ORs) and 95% confidence intervals for female versus male injury risk for all injuries, recordable injuries, and lost work-time injuries. The analysis was repeated for

acute injuries and musculoskeletal disorder (MSD) injuries.

Results: Female workers in this industry have greater risk for sustaining injury after adjusting for age and job: OR 1.418 (1.340–1.499) for all injuries, OR 1.516 (1.296–1.546) for sustaining an injury requiring medical treatment, and OR 1.183 (0.852–1.643) for sustaining an injury resulting in lost work time. This excess risk for female workers persisted when injuries were stratified into acute and MSD-related categories for separate analyses.

Discussion: This study shows a clear difference in injury risk and injury severity between male and female workers. This supports the hypotheses that female workers are at higher risk for occupational injury and sustain more severe injuries than their male counterparts in a heavy manufacturing environment. Future research is needed to explore modifiable risk factors for targeted interventions.

### **E5.2**

**Title: Acute Injury and Heat Stress Level in an Aluminum Smelter**

Authors: **Bernard T**, Fogleman M

Introduction: Heat stress is a commonly recognized hazard in hot industries including aluminum smelters. The occupational exposure limits are based on physiological capacity to maintain thermal equilibrium. While there is evidence that heat disorders and acute injuries are associated with increasing levels of heat stress, the risk has not been related to the occupational exposure limits.

Methods: In this study, 153 recordable and first aid cases over a 3-year period were related to the heat stress level. The cases were reviewed and classified as acute injury (e.g., laceration, muscle strain) (125 cases), acute musculoskeletal injury (subclassification of acute injury) (89 cases), and heat-related disorder (28 cases). From an evaluation of the heat stress conditions related to the outside ambient conditions at the hour of the case report to medical, the heat stress level was categorized as low (below the ACGIH TLV), moderate (from TLV to TLV + 3 °C-WBGT) and high (greater than 3 °C-WBGT above the TLV).

Results: Based on the staffing levels, a Poisson regression was used to compute the odds ratio (OR) of a case. As expected, the ORs for heat disorders were significant and were 25 and 158. For acute injuries at moderate and high heat stress, the ORs (95% CI) were

1.4 (0.9–2.2) and 1.7 (1.0–2.9); and 1.8 (1.1–2.9) and 2.4 (1.4–4.3) for acute musculoskeletal disorders (MSDs).

Discussion: The current TLVs seem to be well set for heat-related disorders. The ORs for acute injuries and acute MSDs also point to heat stress as being a factor in their occurrence.

### **E5.3**

#### ***Title: \*A Case-Crossover Study of Occupational Laceration Injuries in Pork Processing: Methods and Preliminary Findings***

Authors: **Lander L**, Sorock G, Stentz TL, Eisen EA, Mittleman M, Hauser R, Perry MJ

Introduction: Despite prevention initiatives, the incidence of lacerations remains high in the meatpacking industry. This case-crossover study identified transient risk factors for lacerations in U.S. meatpacking plants. Transient exposures of interest included work equipment (sharpening, malfunction), work practices (unusual task, unusual method), and worker-related factors (rushing, distraction, tired, slipping).

Methods: Injured workers were recruited from two plants in Nebraska and Iowa. A telephone interview was conducted within 14 days of laceration to collect information on fixed and transient exposures that may have contributed to the injury. Case-crossover methodology was used to evaluate case and control data within the same subject, controlling for between-subject confounding. Mantel-Haenszel estimator for person-time data was used to estimate the relative risks of injury.

Results: A total of 362 workers experienced lacerations from April 2006 to October 2007, and 153 (42%) were interviewed (74% male, 41% Hispanic). Forty-eight percent of workers were injured by a knife or knifelike object such as scissors or bandsaw. Tool sharpening was associated with the highest relative risk of laceration (RR 91.6, 95% CI: 52.4–160.0), followed by slipping (RR 74.8, 95% CI: 30.5–183.3), equipment malfunction (RR 3.8, 95% CI: 2.8–5.3), and performing an unusual task (RR 3.7, 95% CI: 2.6–5.2). Being tired, distracted, or rushing were not significant risk factors for laceration. Gender, work experience, safety training, number of workers on the line, and hours of sleep were effect modifiers for several transient risk factors.

Discussion: Transient factors were associated with increased risk of laceration injuries in meatpacking. Given the variety of injury sources, intervention efforts should focus on engineering controls, improved personal protective equipment, administrative controls, and safety training to reduce the incidence of lacerations in meatpacking.

### **E5.4**

#### ***Title: \*A Descriptive Study of Workers' Compensation Claims in Washington State Orchards***

Authors: **Hofmann J**, Snyder K, Keifer M

The occupational fatality rate in agriculture, forestry, fishing, and hunting of 29.6 deaths per 100,000 employed in 2006 was higher than any other industrial sector, and non-fatal injuries are also common. Orchard work is particularly hazardous; accounting for almost 40% of all workers' compensation claims in Washington's agricultural industry.

Methods: We conducted a descriptive study of workers' compensation claims filed in the main tree fruit growing region of Washington State for injuries that occurred in orchards between January 1996 and December 2001. Claims were classified by cause of injury for "associated source" and "accident type." Particular emphasis was placed on claims in the ladder category to facilitate sub-analyses of the etiology of ladder-related injuries.

Claim incidence rates by cause of injury were calculated based on the number of full-time equivalent (FTE) "Orchards: Fruit Tree Crops" workers in Washington State. We also investigated the costs of claims in each cause of injury category. A claim is classified as compensable if the worker sustains an injury resulting in time loss, disability, or loss of earning power in addition to medical care.

Results: A total of 13,068 non-rejected, State Fund claims were reported among orchard workers between 1996 and 2001. Most claimants were male (84%), and the mean age among claimants was approximately 35 years. The average annual claim incidence rate was 97.8 per 1,000 FTEs. Nearly one-third of all claims (n=4,020) were ladder-related injuries. Trees, branches, and vegetation were the next most frequent cause of injury (n=1,674). Over half of the claims related to trees, branches, or vegetation were eye injuries (n=944).

The total cost of claims included in this analysis was an estimated \$50.5 million over the six-year study period. The median cost per claim was higher for

compensable claims than for non-compensable claims (\$2,544 vs. \$218). Although only 25% of claims were compensable (n=3,225), these claims account for 88% of the total estimated cost of all claims. Almost half of the compensable claims were related to ladders (n=1,549). Ladder-related claims were significantly more likely to be compensable than other claims in the dataset ( $P < 0.001$ , chi-square test). Ground-related injuries (e.g. trips and falls resulting in sprains or strains), motor vehicle injuries, and other musculoskeletal injuries also had a high proportion of compensable claims (38%, 33%, and 33% respectively). Ladder-related claims were far more expensive than any other category, with an average annual cost of \$3.6 million. Sprains and strains were the most common type of ladder-related injury (38%, n=1,511).

Conclusion: This analysis demonstrates a compelling need to develop interventions to prevent ladder-related injuries among orchard workers.

\* Winning submissions for the Liberty Mutual Student Paper Contest

Session: **F1.0**

**Title: Injury Prevention in Construction - II**

Moderator: David Fosbroke

**F1.1**

**Title: Applying NIOSH Prevention Through Design to Electrical Hazards in Construction Work Environments**

Authors: **Floyd HL**, Liggett D

Introduction: The construction industry represents 7% of the U.S. workforce, but accounts for 45% of occupational fatalities from electrical hazards. Prevention through Design is an initiative to address workplace hazard mitigation through design. NIOSH launched PtD on the premise that the U.S. is lagging in application of recognized hazard control measures. Engineering solutions that eliminate or reduce exposures are the most effective measures in safeguarding worker safety. ANSI Z10, Occupational Safety and Health Management Systems, provides a hierarchy of hazard control measures. Application of PtD in construction presents a great opportunity for reducing occupational electrical injuries.

Limitations of Existing Methods: NFPA70E, Standard for Electrical Safety in the Workplace, focuses on some control measures, but not those considered most

effective in reducing exposure. Use of the most effective control measures is largely voluntary.

Results: Control measures to protect construction workers during installation and demolition are not addressed in a similar manner as maintenance and operating exposures. Some of the barriers include:

- Electrical experts not being familiar with safety management
- Belief that “qualified workers” do not make mistakes
- Designers not being familiar with workplace hazards and safe work practices
- Design firms’ concern that addressing worker safety in the design process will increase liability
- Facility owners not understanding the cost of retrofitting safe work practices and other control measures after design is complete

Discussion: Avenues to better address electrical safety via PtD must be explored. Some opportunities include:

- Working to assure that electrical safety professional participate in the PtD initiative
- Influencing PtD in engineering education
- Developing further proposals to affect revision of existing recognized standards
- Demonstrating support for a new ANSI standard for guiding PtD application
- Working to aid in awareness and education on PtD benefits

**F1.2**

**Title: Construction Safety Training Issues for Hispanic Construction Employees**

Authors: **McGlothlin J**, Hubbard B, Aghazadeh F, Hubbard S, Mena I, Bertot J, Huerta J, Player L

Introduction: Numerous studies indicate that Hispanic construction workers comprise a disproportionately high number of construction workplace fatalities. This research documents the findings of a pilot study exploring issues related to safety training for Hispanic construction workers, which comprise a growing segment of the U.S. construction workforce. This study is a continuation of the research on construction safety training issues for employees new to the construction industry.

Methods: A group of Hispanic construction workers in Louisiana was surveyed to determine workers’ perceptions of construction safety, levels of safety training, familiarity with construction terms, and population characteristics.

Results: The survey found that 58% of the Hispanic workers had not taken any formal training in construction safety. Most Hispanic workers who did have training said that the training was given in Spanish or in both English and Spanish (90%). However, translating the course to Spanish does not address the limitations regarding comprehension of construction terminology. Many Hispanic workers are unfamiliar with the construction terminology used in Occupational Safety and Health Administration (OSHA) 10-hour training. Results indicated that no more than 20% of workers understood any of the terms used, and some terms were understood by only 3% of the workers surveyed. This lack of understanding of construction terminology could diminish the effectiveness of safety training and result in potentially unsafe working practices.

Conclusions: This pilot survey implies that safety training for Hispanic construction workers may be enhanced by providing pictorial storybook examples of construction terminologies combined with OSHA 10-hour safety training. Additional research is needed to understand and implement effective safety training strategies for Hispanic construction workers.

### **F1.3**

#### ***Title: A Community-based Participatory Approach to Prevent Falls Among Latino Construction Workers***

Authors: **Brunette M**, Azaroff L, Grullon M, Gagliardi M, Roelofs C, Shepherd S, Latowsky G, Matos C, Anziani D

Introduction: Latinos, the fastest growing ethnic group in the United States, are overrepresented in both fatal and nonfatal occupational injuries. The construction sector, with a large share of Latino workers (17%), is also one of the most dangerous industries, accounting for 20% of all occupational deaths. At the same time, falls are the leading cause of death at construction sites. Despite extensive research that has addressed fall prevention in construction, the number of fall-related fatalities continues to rise. In the United States, approximately one of five workers who die from falls on the job is Latino.

Methods: Fall prevention interventions shown to be effective in other settings may not be completely appropriate or accessible to the Latino workers. Interdisciplinary, participatory approaches are urgently needed to develop and evaluate measures for protecting the health of immigrant workers. The overall design of this project was based on the well-known framework for Community-based Participatory Research (CBPR) adapted here for occupational safety

and health intervention research. This is a cyclical and iterative process involving academic and community partners at each step. The major hypothesis of our project is that CBPR involving city agencies, a labor organization, academia, construction safety experts, workers, contractors, family members, and Lawrence, MA, residents can develop an effective approach to prevent exposure to fall-related hazards affecting Latino construction workers. This initiative also aims to build a community-wide support system to carry on the program in the future.

Results: Here we present preliminary qualitative results of the first stage (assessment) of this community-based and community-directed project.

Conclusions: By involving employers, health care providers, government agencies, insurance companies, and the broader community with workers and their union, this project is offering the potential for sustainable, systemic change at the multiple levels required for intervention effectiveness.

### **F1.4**

#### ***Title: Reducing Exposure to Pedestrians in Blind Zones***

Author: **Barclay S**

Introduction: Reducing runover, backover, and work zone accidents to pedestrians can be done economically and quickly. Being struck by equipment results in some of the most traumatic and expensive accidents at the workplace. The current use of electronic devices, high-visibility equipment, and observers has had little statistical impact on reducing these types of injuries and may even contribute to increased exposure.

Hardhat-mounted mirrors have a potential to reduce this exposure to danger from being struck from behind. In recent years, mirrors have evolved from a safety device for cyclists to ones specifically designed for hardhats and industrial environments.

Methods: Washington State has enacted a law requiring “visual awareness” behind pedestrian workers, specifically those working as flaggers. One method recommended is the use of a mirror mounted to a hardhat. This is also recommended in some NIOSH Fatality Assessment and Control Evaluations.

Hardhat mirrors increase the field of view significantly and allow the wearer to scan, almost instantly, a full 360° with very little effort. This type of safety device could have a quantifiable impact on

backover injuries, as the most common denominator to pedestrian injuries involving equipment is the blind zone of the pedestrian.

Results: Most users report that helmet-mounted mirrors require some acclimation but that they would not want to go without one after becoming accustomed to them. This is still a relatively unknown device in industrial safety, so meaningful statistics are still to be proven.

Conclusions: Mirrors are considered an invaluable tool to heavy equipment, mobile machinery, and other vehicles. Hardhat-mounted mirrors add an element of safety to pedestrians that has been proven for decades in other industries. They are economical, commercially available, and address issues in ways not available from any other type of safety device.

Session: **F2.0**

**Title: Workplace Violence in Healthcare Settings**

Moderator: Marilyn Ridenour

**F2.1**

**Title: Emergency Department Security Programs, Community Crime, and Employee Assaults**

Authors: **Blando J**, McGreevy K, O'Hagan E, Worthington K, Valiante D, Nocera M, Casteel C, Peek-Asa C

Introduction: Violence against healthcare workers is a serious occupational health hazard, especially for emergency department (ED) employees. A significant degree of variability in security programs among hospital EDs occurs in part because of the absence of federal legislation requiring baseline security features. Nationally, only voluntary guidelines from the Occupational Health and Safety Administration (OSHA) for the protection of health care workers exist.

The purpose of this study was to examine ED security programs and employee assault rates among EDs with different financial resources, size, and background community crime rates.

Methods: This cross-sectional survey was conducted among large and small hospitals located in communities with low or high rates of community crime. Hospital financial data were collected through the state health department, and employee assault data were abstracted from hospital OSHA logs. Comparisons were made using a chi-square or Wilcoxon test.

Results: Small hospitals located in towns with low community crime rates implemented the fewest security program features despite having the second highest rate of assault-related OSHA recordable injuries among ED employees (0.66 per 100,000 staff hours).

Discussion: Due to the highly stressful workplace characteristics of ED medical care, the risk of employee assault is universal among all hospital sizes in all types of communities.

**F2.2**

**Title: Hospital Employee Assault Rates Before and After Enactment of the California Hospital Safety and Security Act**

Authors: **Casteel C**, Peek-Asa C, Nocera M, Smith J, Blando J, Goldmacher S, O'Hagan E, Valiante D, Harrison R

Introduction: In 1993, California enacted the Hospital Safety and Security Act, which mandated that hospitals implement security plans to reduce assaults against hospital workers by July 1, 1995. Since enactment of the legislation, no studies have examined changes in violent event rates to hospital employees.

Methods: Pre- and post-enactment employee assault rates in California (n = 116) emergency and psychiatric departments were compared with those in New Jersey (n = 50), where statewide workplace violence initiatives did not exist. The assault rate was the number of OSHA-recorded violent events per 100,000 employee hours per year. Violent events were abstracted from hospital OSHA logs or Employers' Reports of Occupational Injury or Illness. The total employee hours were obtained from each state's health department. Poisson regression was used to compare assault rates between a 3-year pre-enactment period (1993–1995) and a 6-year post-enactment period (1996–2001) using New Jersey hospitals as a temporal control.

Results: Assault rates among emergency department (ED) employees decreased 48% in California post-enactment compared to ED employee assault rates in New Jersey (rate ratio (RR) = 0.52, 95% CI = 0.31–0.90). Employee assault rates in California psychiatric units decreased 37% compared to New Jersey psychiatric units (RR = 0.63, 95% CI = 0.26–1.52). ED employee assault rates decreased in smaller facilities and for-profit-controlled hospitals post-enactment. Among psychiatric units, for-profit-controlled hospitals and hospitals located in smaller

communities experienced decreased assault rates post-enactment.

Discussion: Assault rates among ED and psychiatric unit employees decreased in California following enactment of the law compared to employee assault rates in New Jersey, where specific statewide legislation did not exist. Policy may be an effective method to increase safety to health care workers.

### **F2.3**

#### ***Title: Evaluation of Workplace Violence at a Tertiary Hospital***

Authors: Sánchez-Arcilla I, Muedra M, Fernandez EM, Folgado DE

Introduction: Twenty-five percent of violent actions in the workplace takes place at health centers. A plan to prevent violence and assist workers involved in this kind of situation was introduced in our hospital, an inner-city tertiary care center in June 2005.

Methods: Using the data obtained from the report of violent actions collected by the Occupational Medicine Department from June 2005 to July 2006, a descriptive longitudinal study was conducted.

Results: During the study period, 45 cases were registered. The average reporting delay for the cases was 2.9 days. Aggressions were more likely during the morning (44.44%), 40% took place during the afternoon-evening shift, and 13.33% during the night. 73.33% of the violent actions were verbal, 20% were both verbal and physical aggressions, and 6.6% were physical. 97.77% of the cases did not require any health leave. Nurses were the most affected category of employees (33.33%), followed by nursing assistants (22.22%), medical staff (20%), attendants (20%), and administrative staff (2.2%). Forty-four percent of the reported aggressions took place at the emergency department, 17.78% at medical offices, 28.89% in hospital wards (of which 61.54% took place at nurse's stations and 38.36% in patient rooms), and 8.89% at other places. Visitors were the most common source of aggression (57.77%), and in 42.22% of cases the aggressor was the patient himself. In all reported cases, the aggression was classified as "light."

Discussion: The incidence rate of aggressions found is lower than reported in other studies where the same risk factors were expected. There were no severe physical injuries. The findings make reference to the psychological health of the workers as well as the

work environment. There were no cases that brought legal actions.

### **F2.4**

#### ***Title: Workplace Violence Prevention in Public Sector Addiction Treatment Centers***

Authors: McPhaul K, Lipscomb J, Geiger-Brown J, London M, Rosen J

Introduction: Workplace violence in healthcare and social services settings, especially public sector facilities, is on the rise. However, most employers are not addressing this problem in a systematic and effective way. Agreement exists on the primary elements of effective workplace violence prevention programs, and "best practices" are considered feasible. This paper examines the association between violence prevention strategies and the prevalence of three types of workplace violence (verbal aggression, client assault, staff assault) in State-run residential addiction treatment centers (ATCs), adjusting for characteristics of the direct care environment.

Methods: Thirteen ATCs in one northeastern state were the setting for a cross-sectional survey conducted as one risk assessment activity in a 5-year workplace violence intervention study. The intervention project consisted of focus groups that informed the survey and the intervention, an architectural survey, dissemination of findings to direct care staff and management, system level oversight, and organizational program audits at the completion of the intervention period.

Results: The survey, completed at work on work time, yielded a 77% response rate. Analysis of the cross-sectional survey for verbal threats indicated that before adjusting for the six background risk factors, 17% of the variance in verbal violence was explained by the block of eight violence prevention strategies. Adjusting for the six background risk factors in the direct-care environment increased the explained variance to 20%, indicating the importance of prevention strategies in reducing violence. In the final model, a staff's ability to use de-escalation procedures and clients' lack of procedures to make their concerns known to staff were significantly associated with verbal assaults.

Discussion: Workplace violence prevention activities, when perceived as effective by staff, are associated with fewer client acting-out behaviors, verbal violence, and physical assaults.

Session: **F3.0**

**Title:** *Review of Comprehensive Injury Efforts*

Moderator: Harlan Amandus

### **F3.1**

**Title:** *A Systematic Review of Occupational Health and Safety Interventions With Economic Analyses*

Authors: **Tompa E**, Dolinschi R, de Oliveira C, Irvin E

**Introduction:** We review the occupational health and safety intervention literature to synthesize the evidence on the financial merits of workplace-based health and safety interventions and to assess the quality of economic analyses undertaken in this literature.

**Methods:** We identify relevant studies through several sources: structured searches in journal databases, existing systematic reviews of occupational health and safety interventions, a summary table of studies on office ergonomics, and studies identified by content experts. The quality of economic analysis within these studies was assessed, and evidence on the financial merits of interventions was synthesized within industry-intervention-type clusters using a best-evidence synthesis approach.

**Results:** Our search identified 72 intervention evaluations with economic analyses. In total, we identified 7 industry-intervention-type clusters with sufficient quality and quantity of studies to comment on the financial merits of such interventions and 17 industry-intervention-type strata with insufficient evidence. For two clusters, we identified strong evidence. Specifically, we found strong evidence that ergonomics and other musculoskeletal injury prevention interventions in the manufacturing and warehousing sector are worth undertaking in terms of their financial merits. We also found strong evidence that disability management interventions executed across multiple sectors are worth undertaking.

**Discussion:** Although few workplace-based occupational health and safety interventions undertake economic evaluations, we did identify 72 that considered both costs and consequences, or at least consequences in monetary terms. We found a number of shortcomings in this literature in terms of its use of economic evaluation methods. Our review of evidence and methods provides insight into which sectors and which types of intervention need to include economic evaluation in future work in order to advance evidence on the financial merits of workplace-based occupational health and safety interventions.

### **F3.2**

**Title:** *Foreign Workers' Safety and Health in the United States*

Authors: **Akladios M**, Osornio M

The Occupational Safety and Health Administration (OSHA) is committed to improving safety and health in the workplace for workers regardless of nationality, race, gender, visa status, or age through regulations, standards, and programs. As a result, the number of workplace fatalities has dropped 20% in the last decade. However, the death rate of foreign workers has risen almost 35% in the same period. Various studies have found that factors such as language, education, and culture affect safety at work. Since, the Hispanic population is predicted to double by 2050, companies must act today to find methods to enhance the levels and conditions related to safety and health for these vulnerable workers. Various methods with a proven track record have been used to improve future trends for these workers. This paper discusses the different factors that affect foreign workers' safety perception in the United States and presents a variety of methods to improve these conditions based on proven case studies.

### **F3.3**

**Title:** *Safety and Health in the Wholesale and Retail Trade Sectors: Information Gaps and Research Needs*

Authors: **Anderson V**, Nguyen L, Linn H

Wholesale and retail trade (WRT) operations are perceived to provide relatively low-risk employment for workers compared to heavier industry sectors such as construction, agriculture, manufacturing, mining, and transportation. That perception is largely borne by the numbers and rates of illnesses, injuries, and deaths for these entire sectors. However, certain activities within subsectors of WRT are more hazardous than others. For example, cashiers in retail establishments, particularly in convenience stores, small grocery stores, liquor stores, gas stations, and other specialty retail shops, face increased risk of death due to robbery-related violence. Workers in large home centers and warehouse-style superstores seem to be at higher-than-average risk of nonfatal injuries, particularly falls and musculoskeletal disorders. WRT workers in automobile and parts sales (retail) and in certain wholesale subsectors who drive motor vehicles over the highway may face increased risk of injury or death from crashes. Additionally, younger workers, older workers, women, and minority workers who are employed in large and increasing numbers in WRT companies may face higher-than-average risks in

some work environments. This review is intended to summarize the occupational injury, illness, and fatality experience in this broad and diverse slice of U.S. economic activity and review what is known about risks and prevention, with a view toward outlining what yet needs to be discovered about risks, prevention options, vulnerable populations, and emerging issues to address these high-risk activities in WRT subsectors through future research and prevention efforts. The purposes are to inform, suggest, encourage, and facilitate collaborations and partnerships among researchers and the many other individuals and organizations with a stake in protecting workers and promoting economic health in these critical sectors of U.S. industry.

#### **F3.4**

***Title: A Systematic Review of the Effectiveness of Interventions to Prevent Agricultural Injury and Disease***

Authors: **Cryer C**, Lilley R

Introduction: Agricultural injury and disease are significant contributors to the burden of occupational morbidity and mortality in Australasia. This paper presents the findings of a systematic review of the efficacy of interventions to prevent agricultural-related ill health.

Methods: A review was undertaken using literature databases, citation searches, and journal hand searches. The review built upon previous interventional reviews in agricultural injury: one each in adult and childhood injury. Papers published since these reviews were included. Relevant study types included controlled trials and observational studies. All studies were evaluated for methodological quality.

Results: 32 papers were identified for inclusion: 15 involved education interventions; 9 engineering, ergonomic, or personal protective equipment interventions; 2 health screening; 2 financial/organizational interventions; and 4 mixed interventions. The educational interventions were evenly split between childhood and adult injury prevention. Seven randomized control trials were judged to have excellent methodological quality, and the remaining studies were of moderate quality.

Conclusion: The findings provided very limited evidence of interventions effective at reducing agricultural injuries. Moderate evidence was found for interventions that were effective at improving farm safety behaviors/knowledge but no supporting

evidence for subsequent injury reductions. Few studies, mostly of poor rigor, were found that evaluated strategies to reduce farm exposures known to lead to agricultural health problems. Despite a lack of strong evidence for the establishment of an evidence-based agricultural intervention, potentially promising interventions and future directions were identified.

Session: **F4.0**

***Title: Preventing Injuries Among Fire Fighters***

Moderator: Stephen Miles

#### **F4.1**

***Title: Preventing Deaths and Injuries of Fire Fighters Working Above Fire-Damaged Engineered Wood Floor Joists***

Authors: **Merinar T**, Tarley J

Introduction: Fire fighters are at risk of falling through fire-damaged floors. Fires burning underneath floors can significantly degrade engineered wood floor systems with little indication to the fire fighter working on the floor. Engineered wood I-joists represent an emerging technology in the building sector that offers several advantages over traditional sawn lumber. It is estimated that engineered wood I-joists are used in over half of all new wood-frame construction.

Methods: The NIOSH Fire Fighter Fatality Investigation and Prevention Program conducts investigations of fire fighter line of duty deaths to identify causal factors and formulate recommendations for preventing future deaths and injuries. The program does not seek to determine fault or place blame but to learn from these tragic events and prevent future similar occurrences.

Results: Structure fires are the third leading cause of fire fighter fatalities, behind only CVDs and motor vehicle incidents. In the past 2 years, NIOSH has investigated 3 incidents involving 3 fire fighter fatalities and 1 injury in which the fire fighters fell through fire-damaged engineered wood floors containing I-joists. The use of engineered wood I-joists and other engineered wood products will continue to increase.

Conclusions: Evidence collected during NIOSH investigations suggest that fire fighters may not be adequately trained in recognizing the hazards of working above fire-damaged engineered wood floor systems. Fire fighters need to be trained to identify

the presence of engineered wood I-joists and actions they can take when engineered wood floor systems are encountered. Fire Departments need to identify structures within their jurisdiction containing engineered wood products through pre-incident planning and inspections and develop appropriate response procedures. Builders, contractors, and owners should consider protecting engineered wood I-joists by covering the underside with fire-resistant materials.

#### **F4.2**

##### ***Title: Preventing Fire Fighter Deaths and Injuries Caused by Failure to Wear Vehicle Safety Restraints***

Authors: **Lutz V**, Romano N

Introduction: The National Fire Protection Association (NFPA) reports that motor vehicle incidents are consistently the second leading cause of on-duty fire fighter fatalities. A NFPA 30-year study (1977-2006) reveals that only 13% of the 406 fatal crash victims were wearing safety restraints, and 45 fire fighters died when they fell from a moving apparatus.

Methods: The NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) studies fatal fire fighter occupational incidents, with the goal of identifying effective prevention measures. Through on-site investigations, FFFIPP personnel collect agent, host, and environmental information from the pre-event, event, and post-event phases of the fatal incident.

Results: A review of FFFIPP investigations from 1998 - 2007 identified 63 motor vehicle related cases involving the death of 46 fire fighters where not being seated and restrained in a moving vehicle likely contributed to the fatality. Relevant findings from these investigations include: (1) fire departments often have established safety restraint standard operating procedures (SOPs) that are not enforced, and (2) there have been instances when fire fighters had to remove safety restraints to perform required tasks because of apparatus/equipment design and/or placement.

Conclusions: Evidence collected during FFFIPP investigations suggests that fire departments must not only develop, but need to enforce SOPs that require all occupants in moving apparatus to be seated and restrained at all times the vehicle is in motion. Manufacturers, fire departments, and those who refurbish emergency vehicles must take into consideration all movements needed to reach

equipment and ensure that safety restraints can be worn by all occupants when performing required tasks.

#### **F4.3**

##### ***Title: Physiological Effects of Boot Weight in Men and Women Fire Fighters***

Authors: **Turner N**, Chiou S, Zwiener J, Weaver D, Spahr J, Sinkule E, Haskell W

Introduction: Most fire fighters wear heavy rubber boots or lighter leather boots. Increases in oxygen consumption per kg of weight added to the foot may depend on gender, boot material, and whether or not subjects are wearing additional protective clothing or equipment.

Methods: Twenty-five men and 25 women fire fighters, while wearing full turnout clothing, a 10.5-kg backpack, gloves, helmet, and one of six randomly assigned pairs of fire fighter boots, walked for six minutes at three mph on a treadmill while carrying a 9.5-kg hose and then climbed a stair ergometer for six minutes at 45 steps per minute.

Results/Discussion: Minute ventilation (VE), oxygen consumption (VO<sub>2</sub> and VO<sub>2</sub>kg), CO<sub>2</sub> production (VCO<sub>2</sub>), and heart rate (HR) were measured, and an average of the breath-by-breath data from minute six was used for analysis. During treadmill exercise, boot weight had a significant effect ( $p \leq 0.05$ ) on VO<sub>2</sub>, VO<sub>2</sub>kg, and VCO<sub>2</sub> in men and women; boot weight had a significant effect ( $p \leq 0.05$ ) on VE and HR for men only. In men, a 1-kg increase in boot weight caused a 9% increase in VE and 6 - 8% increases in VO<sub>2</sub> and VO<sub>2</sub>/kg. The increase in VE observed in men could result in an approximate 8% decrease in service time for a 45-min SCBA cylinder. In women, 3% increases in VO<sub>2</sub> and VO<sub>2</sub>/kg were observed. Gender differences observed during treadmill walking may be due to a decrease in women's stride length while carrying a load. During stair climbing, a 1-kg increase in boot weight caused a 3.5% increase in VO<sub>2</sub> in men only ( $p \leq 0.05$ ). This 3.5% increase is less than the 5% increase observed in a previous study of leather and rubber boots where subjects wore only gym shorts and may reflect a diminished effect of boot weight with full turnout gear.

#### **F4.4**

##### ***Title: Survey Evaluation of the Fire Fighter Fatality Investigation and Prevention Program***

Authors: **Wassell J**, Peterson K, Amandus H

Introduction: In the Fire Fighter Fatality Investigation and Prevention Program (FFFIPP), NIOSH conducts investigations of fire fighter line-of-duty deaths to formulate recommendations for preventing future deaths and injuries. This evaluation was conducted to assess the effects of these recommendations on safety knowledge, attitudes, and behavior of fire fighters and to identify strategies for improvement.

Methods: During spring 2006, a Fire Department Survey was mailed to the Fire Chiefs of a stratified random sample of 3,000 fire departments across the country. The sample included the following specific groups: all 208 fire departments that had experienced a FFFIPP investigation as of December 31, 2003; a random sample of 215 fire departments where a fire fighter fatality had occurred but no FFFIPP investigation had been conducted; the 10 largest fire departments (by size of the protected population); and a stratified random sample of 2,575 fire departments where there had not been a fatality as of December 31, 2003. The survey consisted of 62 items related to standard operating procedures, standard performance requirements, fire fighter training, communication of safety practices and investment in safety equipment.

Results: The overall response rate for the survey was 54.9%. Most officers surveyed were familiar with NIOSH and have read a FFFIPP report; over half were not familiar with the FFFIPP investigation program itself. Fire department officers learn about FFFIPP recommendations primarily through NIOSH mailings, trade publications, and websites. NIOSH recommendations have been used by some 11,000 fire departments to update the content of their training programs.

Conclusions: The kinds of fire departments that most likely follow NIOSH's safety guidelines are career fire departments in large, urban jurisdictions in the Northeast. The most common recommendation from the survey is for improvements in the ways FFFIPP materials are disseminated and marketed.

Session: **F5.0**

##### ***Title: Safety Practice I***

Moderator: Mahmood Ronaghi

#### **F5.1**

##### ***Title: Operator Presence System: From Design to Implementation***

Authors: **Ammons D**, Powers J, Brand I

Introduction: Due in part to human factors concerns hydraulic stump cutters have historically not been equipped with an Operator Presence System. Manufacturers and dealerships provide extensive documentation on the proper operation and safe use of the machine. However, some operators who have not followed these procedures have been injured. An Operator Presence System could be useful in preventing accidents where the operator approaches the cutter wheel with the clutch still engaged. Such a system must permit productive operation without interfering excessively with operator interaction with controls and creating operator difficulties such as hand/arm fatigue. To solve this problem, NIOSH and Vermeer Manufacturing Company collaborated to investigate applying capacitive sensing technology to detect the operator at the controls of a stump cutter.

Methods: Vermeer and NIOSH agreed that NIOSH would investigate the feasibility of detecting an operator's location at the stump cutter controls. If this was determined to be feasible, Vermeer would refine and change the design as necessary and adapt it to hydraulic stump cutters. To this end, Vermeer provided NIOSH with various stump cutter components and general guidelines for mounting locations. NIOSH developed prototypes, conducted initial testing, and determined that sensing the operator's hand capacitively was probably feasible. Vermeer built from the successful work of NIOSH, made substantial improvements, and configured the design for use on hydraulic stump cutters. Field trials have now proven this design to be successful on the Vermeer SC252 and production has begun.

Results/Conclusions: The result of this successful collaboration between NIOSH and Vermeer will help reduce the likelihood of injuries to an operator who approaches the cutter wheel without first disengaging the cutter wheel drive. Details regarding the early developments of this safety system along with the mechanisms used to establish this partnership will be discussed.

## **F5.2**

### ***Title: Comparison of Anti-vibration Interventions for Use With Fastening Tools in Metal***

Authors: **Dale AM**, Burwell A, Hoeckelman L, Braunschweig L, Kilwin J, Standeven J, Rohn A, Patton A, Shannon W, Kick T, Evanoff B

Introduction: Occupational vibration exposure is associated with neurological and musculoskeletal injuries to the upper extremity. Some laboratory-based studies have validated the effectiveness of different types of commercial vibration-damping materials. This study evaluates the effectiveness of several anti-vibration gloves and an anti-vibration wrap under actual working conditions in a large manufacturing setting.

Methods: Three experienced sheet metal workers performed five metal fastener installations for bare hand, an anti-vibration tool handle wrap, and five different anti-vibration gloves for a total of 105 installations. Vibration energy was recorded with two tri-axial accelerometers placed on the tool handle and one on the back of the hand and analyzed according to standard practice. Subjects completed a user questionnaire following each intervention.

Results: All six interventions showed reduced vibration measured on the hand, when compared to the bare hand condition (mean hand vibration range for interventions = 0.31–0.57 Gs; mean hand vibration on bare hand = 1.32 Gs;  $p < 0.0001$ ). Vibration measured at the tool handle showed differences for only the anti-vibration wrap (1.20 Gs) when compared to the bare hand (1.68 Gs). The pilot for this study showed large variability of subjects' mean vibration values of the air bladder intervention (range = 0.84–3.33Gs) caused by improper inflation. Subjects reported variable subjective responses to each intervention, but preferred fingerless gloves and gloves with wrist support.

Conclusions: This study indicated that vibration damping gloves and wraps consistently reduced vibration values during the specific work conditions measured at the hand. While anti-vibration products are typically tested in laboratory settings, to assess the true protection levels testing should mimic working conditions. Because all interventions showed similar effectiveness, suggesting that choice of intervention should be guided by ease of use and worker preference.

## **F5.3**

### ***Title: Forklift-Related Injuries***

Author: **Windau J**

Introduction: Each year, about 120 fatal work injuries result from operating or working near forklifts. Recent data show that these fatalities are on the rise. A substantial number of nonfatal injuries, many with long absences from work, also result from working in or around forklifts. Moreover, OSHA's powered industrial truck standard is one of the most frequently cited standards in certain industries.

Methods: Data from the BLS occupational injury and illness programs were used to compile information on fatal and nonfatal injuries involving forklifts. A number of variables were reviewed, including occupation, industry, and demographic characteristics of the fatally injured worker and circumstances surrounding the incident (activity of the worker at the time, location of the incident, and other objects or equipment involved). Narrative fields on the data records were examined to obtain additional information about the incident.

Results: Industries with the highest totals of forklift-related injuries included manufacturing, construction, transportation and warehousing, and wholesale and retail trade. The types of incidents in which workers were injured included being struck by the forklift, being struck by another object, being caught under an overturning forklift, and falls. About 65 percent of the fatality victims were performing an activity other than operating the forklift at the time of the incident.

Discussion: In addition to targeting forklift operators, prevention efforts must be directed towards workers who repair lifts, those who load and unload lifts, those riding on or working from forklifts, and others working in the area of forklifts.

## **F5.4**

### ***Title: Toward Safer Stairways: Evaluation of the Nose-to-Nose Method for Measuring Uniformity of Steps in a Flight of Stairs***

Authors: **Jensen R**, Jensen L, Ross C

Many injuries result from falling on stairs. Experts on stairway safety agree that nonuniformity of steps on a flight is a major risk factor for falls. As a result, standards organizations have incorporated requirements for uniformity of step risers and tread depth. These assume the measurement system is capable of determining compliance. The state-of-the-art measurement system is a relatively new method

known as the nose-to-nose method. It involves measuring the distance between the noses of adjacent steps and the angle formed with the horizontal. From these measurements, the lengths of the riser and depth are calculated.

This study examined the concordance of compliance determinations for intra-observer repeatability and inter-observer reproducibility. The definition of compliance used the guidelines in the 2007 ANSI Standard for uniform risers and tread depths on flights of stairs. Six flights were randomly selected from stairs in three campus buildings. Two observers measured all six flights, twice each. Each step in the flights was marked in three places (left, center, and right), yielding 774 measurements. Cohen's Kappa statistic served as the indicator of concordance for the independently determined conclusions of compliance or noncompliance with the standard.

Results for repeatability of adjacent step risers indicated the first and second measurements by the observers agreed for 313 out of 336 compliance determinations (Kappa = 0.85). For repeatability of adjacent tread depth data, their first and second measurements agreed on 244 of the 300 compliance determinations (Kappa = 0.51). Results for maximum differences within a flight used the measurements taken in the center of each step. Of the 24 determinations of flights compliance, agreement was obtained on 23 for riser compliance; and on 22 for depth compliance. Procedures for improving reliability of stairway measurement will be discussed.

Session: **G1.0**

**Title:** *Injuries Among Electric Utility Workers*

Moderator: Richard Current

### **G1.1**

**Title:** *Work-Related Motor Vehicle Crashes Among Electric Utility Workers*

Authors: **Fordyce T**, Kelsh M, Mezei G

Introduction: Few studies have specifically focused on work-related motor vehicle crashes, despite the large impact these accidents can have on worker morbidity and mortality. Only one study to date has specifically focused on crashes among electric utility workers. The objective of this pilot study was to examine the feasibility of using vehicle crash reports to more accurately define and describe work-related motor vehicle crashes and crash trends among electric utility workers.

Methods: Crash reports and data from personnel files were collected from three utilities for the years 2000, 2004, and 2005. Data were standardized into a consistent, common format for comparison purposes. Crash rates were expressed in terms of the number of crashes per 100 employees during a year of follow-up.

Results: The overall crash rate for the three utilities combined was 2.49 crashes per 100 employee-years. The rate of crashes has increased over time, but the increase is not statistically significant. The highest crash rates by occupation varied by utility, though office-based staff had the lowest crash rates across utilities. Employees under the age of 20 had the highest crash rate, and male employees had a significantly higher crash rate than female employees. Employees with less than 1 year of experience had the highest rate of crashes followed by workers with more than 20 years of experience.

Conclusions: The findings from this pilot study indicate that a larger study of vehicle crashes is feasible; however, the quality and completeness of crash and exposure data need to be improved. The crash data currently provided by the utilities frequently lacks complete information on the circumstances surrounding crashes and the occupants involved. These data may exist on hardcopy forms and are not incorporated into an electronic database, or they may not be routinely reported.

### **G1.2**

**Title:** *Factors That Distinguish Serious Versus Less Severe Strain and Sprain Injuries: An Analysis of Electric Utility Workers*

Authors: Kelsh M, Fordyce T, Lau E, Mink P, **Morimoto L**, Lu E, Yager J

Introduction: Occupational sprain and strain injuries are one of the most common types of nonfatal occupational injuries and a significant source of lost workdays. This study examines factors associated with severe work-related sprain/strain injuries to the back, shoulder, and knees among electric utility workers using data from the Occupational Health Surveillance Database (OHSD).

Methods: A synthetic case control study was performed. Cases included all electric utility workers who had experienced a severe work-related sprain/strain injury to the back, knee, or shoulder. Primary controls were selected from all workers who had sustained a minor injury. Secondary controls were selected from employees with a minor sprain/strain injury to the back, knee, or shoulder. Multivariate

logistic regression models were used to estimate odds ratios and 95% confidence intervals.

Results: Middle and older age workers (< 40 years) were more likely to have experienced severe shoulder sprain/strain injuries (age 41–50: OR = 3.62, 95% CI: 1.71–7.65; age 51 and older: OR = 4.49, 95% CI: 1.89–10.67) and severe back sprain/strain injuries (age 41–50: OR = 1.70, 95% CI: 1.06–2.33; age 51 and older: OR = 1.5, 95% CI: 0.90–2.52). Line workers and maintenance workers had an increased risk of serious sprain/strain injuries. Gender and day of week were not significantly associated with sprain/strain injuries.

Conclusions: Increasing employee age was a strong predictor of both sustaining a back or shoulder injury, as well as requiring time away from work once the injury occurred, independent of years of experience on the job. Certain occupational groups, such as line workers, were not only at increased risk of acquiring sprain/strain injuries compared to office workers, but also of requiring time off from work after sustaining the injury. This study is limited by available data, but future studies may benefit from this preliminary examination of occupational and demographic characteristics associated with sprain/strain injuries among electric utility workers.

### **G1.3**

#### ***Title: Work-Related Injury Trends Among Electric Utility Workers***

Authors: **Fordyce T**, Kelsh M, Mezei G, Morimoto L

Introduction: Currently, only limited injury surveillance data for the electric utility workforce exist. To address this gap, an Occupational Health Surveillance Database (OHSD) for electric power utilities was established for epidemiologic monitoring and intervention program evaluation. The OHSD currently integrates 12 years (1995–2006) of personnel, injury, and claims data from sixteen electric utilities into a single database. The current data set includes more than 1,000,000 employee years of follow-up and more than 35,000 lost time and recordable injuries.

Methods: Injury rates were calculated by occupational and demographic factors and expressed in terms of injuries per 100 employees during a year of follow up. Confidence intervals assuming an underlying binomial statistical model were calculated where appropriate.

Results: Overall, injury rates have declined over the 12-year study period. Injury rates varied across utility occupations, from 0.38 per 100 employee-years for managers to 14.07 per 100 employee-years for meter readers. Meter readers, line workers, and welders had the highest observed injury rates. Compared with male workers, the risk of injury among female workers was lower overall, although their risk was higher in some nonoffice occupations than their male counterparts. Injury rates among younger workers were disproportionately high relative to their representation in the workforce. Sprains and strains were the most commonly reported injuries. The back and hand/fingers were the most commonly injured body regions, while injuries to the back, neck, and knees were the most severe.

Conclusions: Many of the trends observed among electric utility workers are similar to other service and manufacturing workers. Our results suggest that benchmarking and prevention efforts should be directed at specific occupational groups and specific injury types.

### **G1.4**

#### ***Title: Development of an Electric Field Sensor for Electrical-Proximity and Contact Detection***

Authors: **Zeng Shengke**, Powers John R, Newbraugh Bradley H

Introduction: The 998 electrocution deaths in 2003–2006 accounted for 5.8% of total U.S. occupational fatalities. Most victims (73.9%) had fatally contacted overhead power lines, wiring, or other electrical components. To protect workers from touching live wires, NIOSH developed a digital electrical proximity/contact sensor that workers wear for the purpose of alarming the worker and others as it detects the worker's proximity/contact to live wires.

Methods: The sensor senses 60-Hz electric fields emitted from live wires to a worker's wrist. The field level on the wrist increases as the worker goes closer to the wire. The sensor includes a pair of capacitive electrodes attached on one wrist that detects electric fields, a 60-Hz filter that rejects interference signals, and two amplifiers (with an adjustable gain) that amplify electric field signals. To determine whether the field variations on simulated human wrists are detectable by the above electrode/electronic setup, an experiment was conducted using the sensor to sense electric fields on 10 hog legs at low/high voltages.

Results: At 120 volts, the sensor with the gain of 64,931 sensed 1.3 microvolts on a hog leg as the leg was 100 centimeters away from an energized simulated power line, and 17.5 microvolts as the leg was moved to 1 centimeter to the wire. As the leg contacted the bare wire, the sensor measured 473.7 microvolts with the reduced gain of 3,135. At 9,000 volts, with the gain adjusted to 571, the sensor sensed 90.9 to 2,456.4 microvolts as the leg was moved the same distance as above.

Conclusions: The electrode/electronic setup has enough sensitivity and dynamic range to detect hog legs' electrical proximity and contact to an energized power line.

Session: **G2.0**

**Title: Workplace Violence Risk Factors**

Moderator: Hope Tiesman

### **G2.1**

**Title: Place Characteristics of Industries at High Risk for Worker Homicide**

Authors: **Ta M**, Marshall S, Kaufman J, Land K, Casteel C, Loomis D

Introduction: Social influences on violence have implications for workplace exposure to violence. This study aimed to identify area-based socioeconomic factors related to presence of workplaces belonging to industries at high risk for worker homicide.

Methods: North Carolina workplaces were assigned to 2000 United States Census block groups (BGs) based on spatial location. Census BGs (n = 3925) comprised the unit of analysis and were categorized as containing none (referent), high (> 15%), medium (11%–15%), or low (1%–10%) proportions of high risk workplaces (HRWP), defined as industries reported in the literature to be at high risk for homicide. Thirty Census-derived variables were selected a priori as potentially predictive of violence and summarized using factor analysis. Three factors were extracted: poverty/deprivation, human/economic capital, and transience/instability. Multinomial logistic regression was used to assess the association between quartiles of the BG-level factor scores (mutually adjusted for each other) and the proportion of HRWP in each BG.

Results: All three factors (poverty/deprivation, human/economic capital, and transience/instability) were independent predictors of the proportion of HRWP. Increasing level of poverty/deprivation and transience/instability were associated with a higher

proportion of HRWP (OR = 1.98, 95% CI: 1.47, 2.67 for 4th vs. 1st quartile of poverty/deprivation and OR = 1.77, 95% CI: 1.31, 2.37 for 4th vs. 1st quartile of transience/instability, comparing high to no HRWP). Increasing human/economic capital, on the other hand, was associated with a lower proportion of HRWP (OR = 0.65, 95% CI: 0.49, 0.87 for 4th vs. 1st quartile comparing high to no HRWP).

Conclusions: Areas with more poverty and transience, and less human capital, contain a higher proportion of HRWP. Social processes leading to diminished social control likely play a role in this relationship.

### **G2.2**

**Title: Burnout: The Risk of Physical Assault**

Authors: **Pinder ED**, Gerberich SG, Alexander BH, Church TR, Hansen J-IC, Ryan AD

Introduction: Burnout, which can emerge from chronic stressors, has been associated with absenteeism and lower organizational commitment, cardiovascular disease, and sleep disturbances. Burnout is defined as an affective reaction to ongoing stress caused by the gradual depletion over time of an individual's energetic resources. These reactions in teachers can include negative attitude and cynicism towards students. Teachers may repeatedly react to disruptive and aggressive students with criticism and punishment, rather than using positive attention to control a situation. This can potentially lead to anger and defiance among students and, consequently, cause them to attack teachers. While burnout has been assessed in teachers, it has not been examined previously as a possible risk factor for physical assault.

Methods: A nested case-control study of licensed Minnesota educators (n = 290 cases and n = 867 controls) examined burnout, using the Shirom-Melamed Burnout Measure Version 2, as a risk factor for physical assault. Cases reported at least one physical assault in the past 12 months and reported on exposures from the month prior to assault. Controls reported on exposures from a randomly selected period of time in which they worked. Potentially confounding variables were selected for multiple logistic regression analyses, using directed acyclic graphs; re-weighting adjusted for nonresponse and unknown eligibility biases.

Results: Compared to those reporting "Infrequently" experiencing feelings of burnout, the risk of physical assault was increased for those indicating "Always" (OR = 2.64, 0.94–7.4), "Frequently" (OR = 1.71,

1.03–2.82), and “Sometimes” (OR = 1.11, 0.77–1.61), and decreased for those indicating “Never” (OR = 0.27, (0.07–0.93). Risk of physical assault increased for those educators in the 80th percentile scoring level compared to others (OR = 1.71, 1.20–2.44).

Conclusions: Burnout was associated with increased risk of physical assault. This is a first step in examining violence as an outcome for burnout for this population, and serves as a basis for further in-depth research.

### **G2.3**

#### ***Title: Environmental Violence and Physical Assault Against Teachers***

Authors: **Gerberich S**, Nachreiner N, Ryan A, Mongin S, Church T, McGovern P, Geisser M, Feda D, Sage S, Pinder E, Watt G

Introduction: Teachers are known to be at high risk for work-related violence; however, data specific to risk factors are limited. Data from a case control study were analyzed to determine the effect of reported environmental violence on work-related physical assault among educators working in kindergarten through grade 12 schools.

Methods: From the Minnesota license database, 26,000 randomly selected educators were screened for eligibility by mailed questionnaire; 6,180 were eligible for data collection. Phase 1 (12-month recall) identified eligible cases (n = 290) and controls (n = 867) and characteristics of the violent events; Phase 2 (case control, recall from the calendar month before the violent events for cases or a randomly selected month for controls) enabled identification of environmental exposures. Confounders were selected for multiple logistic regression analyses using Directed Acyclic Graphs with reweighting for nonresponse biases.

Results: Response rates for each phase were 84%. Assaults were primarily perpetrated by students (95%). Respective risks (ORs; 95% CIs) for physical assault increased for educators working in environments where they witnessed students involved in physical assault 1–3 (2.94, 1.95–4.43), 4–10 (6.61, 3.73–11.72), 10+ (15.66, 7.84–31.27) versus zero times; threat 1–3 (1.49, 0.97–2.27), 4–10 (4.07, 2.40–6.90), 10+ (8.25, 4.57–14.91) versus zero times; sexual harassment 1–3 (1.94, 1.30–2.89), 4–10 (3.31, 1.73–6.36), 10+ (9.97, 4.47–22.23) versus zero times; verbal abuse, 10+ versus zero times (3.86, 2.26–6.57); bullying, 10+ versus zero times (3.21, 1.89–5.46). Witnessing persons, other than students, engaged in

violence was also important: physical assault 1–3, 4–10+ versus zero times (3.14, 1.67–5.88; 11.61, 1.78–75.64).

Discussion: Teachers were at increased risk for physical assault in environments where they witnessed students and others engaging in violent behaviors. Examination of such environments, in concert with other environmental characteristics, is essential for developing intervention efforts to protect educators and others in schools.

### **G2.4**

#### ***Title: EMS Providers' Exposure to Violence***

Author: **Heick RJ**

Introduction: Nearly half of patients involved in emergency department violence are transported by EMS personnel, making it likely that EMS providers would be at increased risk of exposure to violence and injury in the line of duty.

Methods: This cross-sectional study examined the relationship between assault injuries and patient restraint policies, looking at odds of physical assault and subsequent injury across multiple variables.

Results: Physical assault was reported by 147 (22%) of the 660 EMS providers who responded to the survey, with a total of 267 physical assaults reported. Physical assault was twice as frequent among paid providers versus volunteers. The patient was the most frequently identified perpetrator, with no significant difference found between paid and volunteer providers (p = 0.41). For both groups, the most common patient condition reported for patient-perpetrated assaults was use of alcohol or other drugs, followed by the “other or unknown” category. Nearly one third of assaults among paid and volunteer providers occurred while they were restraining or attempting to restrain a patient. Injury from physical assault was reported in 8% of paid and 7% of volunteer provider assaults (n = 26 injuries). No significant differences in training in handling of aggressive or combative patients were found between paid and volunteer providers. Training was not found to significantly decrease odds of physical assault. Written patient restraint policies were reported by 63% of paid and 42% of volunteer providers. Odds of physical assault decreased with law enforcement only policies (0.60, 95% CI 0.38–0.93) and increased when policies included chemical restraint (1.46, 95% CI 1.08–1.98).

Discussion: Exposure to violent or aggressive behavior is a significant problem for EMS providers.

Additional research is needed to examine assault circumstances, provider education related to violence, and law enforcement only policies.

Session: **G3.0**

**Title:** *Evaluating Mining Safety Initiatives*

Moderator: Robin Burgess-Limerick

### **G3.1**

**Title:** *Reduction of Fire Hazards on Large Mining Equipment*

Author: **DeRosa MI**

Analysis of mining equipment fires from 1990 to 1999 shows that there were 340 large mining equipment fires, resulting in 72 injuries and five fatalities. Many of the fires resulted in the loss of equipment and all posed potential or real risks to the operator. In 97 cases, the fires raged out of control due to engine shutoff failure, even upon activation of the machine fire suppression system (30-s discharge time), due to the spraying of pressurized hydraulic fluid and fuel onto the engine hot surfaces. In other cases, even after engine shutoff, the fires reignited, fueled by the continued flow of flammable fluids, remaining in the lines, onto the engine hot surfaces. In many of the fires, flammable vapors, evolved during the spraying of pressurized and combustible fluids, penetrated the cab, violently igniting, forcing the operator to exit under very hazardous conditions.

The use of emergency evacuation lines in the fuel and hydraulic fluid systems, the use of fire-resistant hydraulic fluids, and methods to prevent the spraying of pressurized fluids onto the engine hot surfaces would greatly improve the chances of successfully suppressing large mining equipment fires. In addition, the use of systems for preventing the ignition of flammable vapors inside the cab and suppressing fires originating in the cab would greatly enhance operator safety. The National Institute for Occupation Safety and Health (NIOSH) recently conducted experiments on methods to reduce the fire hazards associated with large mining equipment.

These experiments evaluated the use of cab inerting systems (presently commercially available) to prevent the ignition of flammable vapors inside the cab and suppress fires originating in the cab while maintaining a breathable atmosphere for the operator to bring the equipment to a stop and safely exit the cab. NIOSH also has developed and evaluated various fire barriers to prevent the spraying of hydraulic fluids and fuel onto simulated turbocharger hot surfaces. The

laboratory experiments are being accompanied by field studies. These methods may be viable additions to existing engine fire detection and suppression systems to greatly reduce large mining equipment fire hazards and enhance operator safety.

Industrial Hygienist, National Institute for Occupational Safety and Health, Pittsburgh Research laboratory; e-mail, mgd8@CDC.gov; tel. 412-386-4965

### **G3.2**

**Title:** *Making it Safer with Roof Screen: Evaluating the Invention Effectiveness of an Occupational Safety Communication Product in the Mining Industry*

Author: **McConnell G**

Introduction: While occupational health and safety research fits within the larger umbrella of public health work, it has lagged behind in conducting evaluations measuring the impact or utilization of ideas, processes, practices, and products, or, alternatively, intervention effectiveness studies. In an effort to better integrate evaluation research with occupational health and safety efforts, researchers at the National Institute of Occupational Safety and Health (NIOSH) Pittsburgh Research Laboratory (PRL) implemented a process evaluation of a safety communication product for the mining industry, focusing on its marketing, dissemination, and content. *Make It Safer with Roof Screen*, a video module, was written, produced, and distributed by the National Institute of Occupational Safety and Health (NIOSH) Pittsburgh Research Laboratory (PRL) and describes the use of roof screen to prevent roof-fall injuries in underground coal mines.

Methods: This presentation will describe the implementation of a process evaluation of this translational effort that utilized a mixed-methods evaluation design, incorporating both quantitative and qualitative data collection methods.

Results: Quantitative data provided evidence that the anticipated audience was reached, that there was secondary distribution of the video, that the video was being used for the intended purpose, and that some recipients used the information to modify current roof screening or to begin roof screening at their mine. Qualitative data identified strengths and weaknesses in the content and distribution and marketing of the video.

Conclusions: Based on evidence collected via the various methods, the evaluator provided a number of

recommendations to the production team of *Make It Safer with Roof Screen*. The results of this evaluation can assist other occupational safety and health researchers in both the development and evaluation of future information translational efforts.

### **G3.3**

#### ***Title: Evaluation of Peripheral Visual Performance When Using Incandescent and LED Miner Cap Lamps***

Authors: Sammarco J, Gallagher S, Bartels J, **Reyes MA**

Introduction: Illumination plays a critical role in an underground miner's safety because miners depend most heavily on visual cues to recognize hazards. Mobile mining machinery, located in the miner's peripheral field-of-view (10° to about 60° off-axis), pose potential pinning and striking hazards. The main objective of this research was to determine if there were peripheral visual performance improvements for the detection of moving objects when using cool-white light-emitting diode (LED) cap lamps as compared to incandescent light bulbs commonly used in miner cap lamps. The second objective was to determine if age is a factor for peripheral visual performance. Recent research has indicated that the spectral power distribution of LEDs can improve visual performance for mesopic lighting conditions similar to those encountered in underground mines.

Methods: Thirty subjects participated in the study, ten subjects in each age group: younger (18 to 25 years), middle (40 to 50 years), and older (50+ years). Visual performance was quantified by the subjects' speed and accuracy in detecting the rotation of high-contrast circular targets located 3.83 meters (m) away at -20°, 40°, and 50° off-axis. Subjects pressed a switch to activate a visual tracking task intended to focus eye orientation to a target located 3.83 m away at 0 degrees. Next, one of the targets at -20°, 40°, and 50° would rotate. The subject would then release a switch upon detecting the rotation. The speed and accuracy of detection was measured.

Results/Conclusions: The results of the visual performance comparison between LED and incandescent cap lamps suggest that cool-white LEDs do improve peripheral visual performance by 15% to 20%. Age does appear to be a significant factor. The middle and older age groups' target movement detection time declined 87% and 65%, respectively.

### **G3.4**

#### ***Title: Evaluation of Discomfort and Disability Glare From Incandescent and LED Miner Cap Lamps***

Authors: Sammarco J, Mayton A, **Lutz T**

Introduction: The National Institute for Occupational Safety and Health (NIOSH) is conducting mine illumination research to determine if light emitting diode (LED) cap lamps can improve safety by reducing glare. Glare can impede a miner's ability to see hazards and to safely perform their work. Another objective is to determine if age is a factor for glare (average miner: 43 years old).

Methods: Three cap lamps were used to evaluate glare: an incandescent cap lamp, a commercially available LED cap lamp, and a NIOSH prototype LED cap lamp. Thirty NIOSH personnel from the Pittsburgh Research Laboratory (PRL) served as test subjects (three age groups, ten subjects in each group). Testing was conducted in the Mine Illumination Laboratory (MIL) of NIOSH PRL. The MIL is a simulated underground coal mine environment equipped with various test apparatus and instrumentation.

Results: The results indicate no statistically significant difference in discomfort glare among the incandescent and LED cap lamps. However, an analysis of variance for disability glare indicates that the LED cap lamps were superior for the older subjects. Disability glare scores for the oldest subject group improved 53.8% when using the NIOSH prototype LED cap lamp compared to the incandescent cap lamp and 36.5% compared to the commercial LED cap lamp.

Discussion: It appears that, given the conditions of this study, LED cap lamps will not increase discomfort glare and can enable significant improvements for disability glare for older workers. It is also evident that not all LEDs are created equal. The disability glare improved the best for older workers when they used the NIOSH prototype LED cap lamp which has a different spectral power distribution (SPD) (more short wavelength energy) than the commercial LED cap lamp. Therefore, for disability glare, the results suggest that the SPD is an important factor to consider in cap lamp design.

Session: **G4.0**

**Title: *Effects of Work Organization of Safety***

Moderator: Max Lum

#### **G4.1**

**Title: *Risk Evaluation Index of Psychophysical Hazard Exposures in Electronics and Garments***

Author: **Lu JL**

**Introduction:** An investigation of the effects of organizational factors in industries that use information technology in garments and electronics industries in the Philippines. It consisted of a cross-sectional study of 23 establishments and 630 respondents in both electronics and garment industries in export zones in Cavite and Laguna.

**Methodology:** This investigation used questionnaires, walk-through survey of industries, and interviews.

**Results:** The results showed differences between electronics and garment industries, and among industry sizes ( $p = .05$ ). Work pressure was also 27% more likely to occur in electronics than in garments. The electronics industries were 62% more likely to have health and safety policies and 72% more likely to have better policies and benefits than the garment industries. On the other hand, the garment industry was 62% more likely to have hazardous work. Logistic regression showed that indeed organizational factors affect the health of women workers ( $p = .05$ ).

**Discussion:** The overall physical health of workers was affected by overtime and mental work. Moreover, workers who have autonomy in making use of their own strategy to accomplish their work were likely to have higher level of physical health. Poor quality of work and exposure to hazardous work also increased chances of having low physical health among workers. Organizational factors and hazard exposures were also seen to affect specific illnesses such as low back pain, skin allergies, abortion, visual problems, and anemia ( $p = .05$ ).

#### **G4.2**

**Title: *Is Current Workload Too Much for Nurses to Handle? Psychophysiologic Evidence From Hospital Settings***

Authors: **Chen J, Davis S, Wei P, Davis K, Daraiseh N**

**Introduction:** National surveys consistently report that excessive workload was cited by hospital nurses as one of the top reasons for their high turnover rate, medical errors and poor well-being. However, little evidence is available to support that current hospital

workloads exceed nurses' psychophysiological work capacity level. This study was to examine among female hospital registered nurses (RNs), whether their energy expenditure (EE), heart rate (HR) and work pace (WP) of a 12-hour day shift indicate psychophysiological strain.

**Methods:** A convenience sample of 145 female hospital RNs in Midwest completed a demographic survey, a work diary, and wore a physical activity monitor for a 12-hour day shift to continuously record their HR and WP (counted by extremities movement), which were later calculated to EE.

**Results:** The total EE of a 12-hour day shift was  $7.32 \pm 4$  Mets/hour. The average HR was 97 bpm; 36% of RNs experienced HR of over 100 bpm throughout the shift. WP intensity was significantly higher in 8 a.m.–3 p.m. than in 3 p.m.–7 p.m. ( $p = 0.008$ ), whereas EE intensity and HR constantly stayed at intense level without significant changes ( $p = 0.080$  and  $p = 0.419$ , respectively). In addition, repeated-measures MANCOVA revealed that interaction among shift period, years of nursing experience, body discomforts at work were associated with the shift periods' difference of WP intensity (Wilks' Lambda 0.613,  $p = 0.020$ ).

**Discussion:** RNs' WP intensity decreased over the shift hours while EE intensity and HR constantly stayed at strenuous level. Such finding indicates a pacing attempt by nurses to alleviate their psychophysiological strain. The results should raise industrywide concerns about hospital nurses' health and patient safety. Staffing policy design and individual work/rest scheduling should take into account of nurses' psychophysiological work capacity level.

#### **G4.3**

**Title: *Safety Issues in the Workplace Confronting Those in Extended Shift Work***

Authors: **Lu JL**

**Introduction:** The study looked into the occupational hazards and injuries among 500 workers in 10 semiconductor industries in Cavite Export Processing Zone in the Philippines.

**Methods:** The subjects included only those who were doing extended shift work beyond 8 hours, specifically 12 hours. Industries were classified as small-, medium-, or large-scale industries based on the number of workers in the company. This is a parametric study using stratified sampling where

instruments included workplace ambient monitoring, safety investigation, medical records review, survey questionnaires, and interviews.

Results: For the 500 workers given questionnaires, problems cited for work conditions included poor housekeeping, slippery floors, uneven floors, no machine guard, insufficient work area, and insufficient warehouse/storage area. These conditions may predispose a worker to accidents and injuries. The top five most frequent stressors for both male and female workers were overtime, fast-paced work, repetitive work, mental fatigue, and visual strain. The most prevalent injury was cuts and bruises at 65.5%. When hazards and injuries were associated for this group of extended shift workers, the results showed significant association between the following: noise with hearing loss ( $p = 0.19$ ), poor illumination with eye strain ( $p = 0.007$ ), muscle injury with vibration ( $p = 0.46$ ), excessive work with low back injury ( $p = 0.00$ ), slipping with poor housekeeping ( $p = 0.021$ ), slippery floor with falls ( $p = 0.32$ ), and with uneven floors ( $p = 0.003$ ).

Discussion: The injury data from the medical clinic for one year indicated 27 cases of laceration, 25 cases of punctures, 9 cases of chemical burns, 4 cases of fractures, and 3 cases each of amputation and eye injuries. All these injuries occurred in the workplace due to lack of machine guards, improper use of tools, nonergonomically designed tools, fast workplace, and unsafe conditions. Three amputations of the middle crease of the hand extending to all fingers were also noted. From the baseline data, safety risk assessment index was proposed.

#### **G4.4**

##### ***Title: Health Outcomes Associated With Perceived Work Stress in Police Officers***

Authors: **Gershon RM**, Barocas B, Canton AN, Li X, Vlahov D

Introduction: Law enforcement has long been recognized as a high stress/high strain profession. Work stress in policing, or “police stress,” has been associated with certain health problems, including cardiovascular disease and depression, as well as maladaptive and antisocial behavior, such as problem drinking, hyperaggressiveness and violence. The purpose of our study was to estimate the effects of perceived work stress in police officers and to determine the impact of coping and coping styles on both perceived work stress and health.

Methods: An anonymous self-administered questionnaire was distributed to 1072 officers from a large, urban police department. The five-page, 132-item survey instrument addressed police stressors, perceived work stress, coping strategies, and stress-related outcomes. Sample recruitment took place during roll call at each of the Department’s nine districts as well as at three other major divisions, including Headquarters. Of 1150 officers present at roll calls, 1072 (93.2%) questionnaires were completed and returned.

Results: Exposure to critical incidents, workplace discrimination, lack of cooperation among coworkers, and job dissatisfaction were significantly correlated with perceived work stress. Work stress, in turn, was significantly associated with adverse outcomes, including depression and intimate partner abuse. Officers who utilized negative or avoidant coping mechanisms reported both higher levels of perceived work stress and adverse health outcomes.

Discussion: Interventions that address modifiable stressors and promote effective coping and resiliency will probably be most beneficial in minimizing police stress and associated outcomes. Progressive police departments that actively implement innovative strategies (such as peer counselors, structural changes in administration, diversity programs, changes in hiring and training practices, adding critical incident management programs) may help minimize the risk of work stress among police officers.

#### **Session: G5.0**

##### ***Title: Systematic Review of Occupational Injury Literature***

Moderator: Bradley Evanoff

#### **G5.1**

##### ***Title: Workplace Injury/Illness Prevention and Loss Control Programs: A Series of Systematic Reviews***

Authors: **Brewer S**, King E, Amick B, Delclos G, Spear J, Irvin E, Mahood Q, Lee L, Lewis C, Gimeno D, Williams R

Introduction: This study sought to determine if injury/illness prevention and loss control programs (IPCs) are effective in reducing workplace injuries, illnesses or claims; and to describe the breadth of the literatures for the sustainability of safety culture/ climate and IPC measurement tools.

Methods: A systematic review of the IPC literature was completed to provide an evidence base for objective review. Scoping reviews were completed for objectives two and three. All objectives used the same search strategy. Full systematic reviews were not completed for objectives two and three because the literature was too immature to provide evidence based recommendations. Of the 12,393 articles identified and reviewed for relevance, 76 articles were considered relevant; these then underwent a quality assessment. Fifty-three articles were used in data extraction and 46 in evidence synthesis. A “best evidence” synthesis approach was used to synthesize the literature.

Results: Strong evidence for a positive effect of reducing or controlling injuries/illnesses was found for only one IPC, Return to Work/Disability Management Programs. A moderate level of evidence was found for five IPCs: supervisor practices, workstation adjustment and training, exercise, workstation adjustment, and ergonomics training. The categories of workstation adjustment and ergonomics training had no effect while supervisor practices, workstation adjustment and training, and exercise had a positive effect.

Discussion: Most high quality studies were in office environments. More high quality studies in a wider variety of business sectors need to be completed to determine effectiveness of IPCs in those settings. The safety culture/climate literature lacks intervention studies that establish an evidence base for their adoption by employers. IPC measurement tools are desired, but few scientifically validated tools are available for use in the workplace. Overall, there is a greater need to invest in research that examines the effectiveness of prevention programs.

## **G5.2**

### ***Title: Sharing Best Evidence: Results From Four Systematic Reviews of the Occupational Health and Safety Literature***

Authors: **Irvin E**, Van Eerd D, Brewer S, Tompa E, Tullar J

Introduction: A systematic review provides a concise and transparent synthesis of research evidence, making it a valuable aid to practitioners and researchers as an objective synopsis of the literature on a particular topic. This presentation will summarize the results from four systematic reviews of the occupational health and safety (OH&S) literature covering the areas of: (1) participatory ergonomic interventions, (2) occupational health and safety interventions with economic evaluations,

(3) workplace injury/illness prevention and loss control programs (IPCs), and (4) interventions in healthcare settings to protect musculoskeletal health. In addition we present an overview of the systematic review process developed and used by the Institute for Work & Health.

Methods: Each of the four reviews used essentially the same systematic review methodology, which will be described in this session. Briefly, comprehensive literature searches were completed and documents were screened for relevance. Next, quality was assessed and data was extracted from those that met relevance and quality criteria. A synthesis of the evidence from the literature was then compiled. In addition, the key role played by stakeholders in each of these reviews will be described.

Results: This presentation will focus specifically on those areas of convergence across the reviews and stakeholder uptake and engagement in the knowledge transfer process. For example, in one review we found strong evidence that disability management interventions executed across multiple sectors are worth undertaking for interventions with economic evaluations. We also found strong evidence for a positive effect of reducing or controlling injuries/illnesses for only one IPC, which was Return to Work/Disability Management (RTW/DM) Programs.

Discussion: This presentation will discuss key findings from four systematic reviews. In addition, we will indicate the challenges/benefits of conducting reviews of the OH&S literature. We also identify gaps in evidence across four research areas.

## **G5.3**

### ***Title: A Review of the Literature on Process and Implementation of Participatory Ergonomics***

Authors: **Van Eerd D**, Cole D, Village J, Theberge N, St Vincent M, Irvin E, Keown K, Clarke J, Mahood Q, Cullen K

Introduction: Participatory ergonomic (PE) interventions are considered useful to reduce occupational injuries. This review of the literature summarizes evidence regarding context, barriers, and facilitators to implementation of PE interventions in workplaces to improve worker health by attempting changes in (1) work processes, (2) work tools and equipment, and/or (3) work and workplace organization.

Methods: A comprehensive literature search involved searching 17 electronic bibliographic databases, contacting content experts, reviewing relevant reference lists and hand-searching conference proceedings. Keywords were used to generate search terms covering the following broad areas: participatory, ergonomic, intervention, and health outcome. Peer-reviewed and grey literature documents were reviewed for relevance using title and abstract or full article. Relevant documents were reviewed for content and quality. Documents meeting quality criteria or with rich information on process, facilitators, and barriers to PE proceeded to data extraction and synthesis. Data were extracted on context, team structure and process, training, intervention, and facilitators and barriers.

Results: We found 2151 unduplicated references in our comprehensive literature search. Of these, 1895 were excluded as they did not describe a PE intervention. The remaining 256 documents were evaluated for content and quality. Of these, 52 documents met our content and quality criteria and moved to data extraction and synthesis. In these 52 documents, the interventions most often involved equipment/tool changes. Workers, supervisors, technical staff, and external advisors were most often team members of the PE process. Decision making was accomplished primarily through group consultation. Facilitators and barriers most often mentioned included resources, support of PE, communication, and training.

Conclusions: Data from 52 peer-reviewed and grey literature documents on PE interventions from many jurisdictions and industries suggests some consistency in process. Many facilitators and barriers were described though most focused on support of PE, communication, training, and resources. Recommendations for PE interventions are described.

#### **G5.4**

##### ***Title: Interventions in Healthcare Settings to Protect Musculoskeletal Health: A Systematic Review***

Authors: **Tullar J**, Brewer S, Amick III B, Irvin E, Mahood Q, Pompeii L, Wang A, Van Eerd D, Gimeno D, Evanoff B

Introduction: The literature examining the effectiveness of occupational safety and health interventions on reducing musculoskeletal symptoms in healthcare settings is heterogeneous.

Methods: A systematic review of the literature used a best evidence synthesis approach to address the

general question, “Do occupational safety and health interventions in healthcare settings have an effect on musculoskeletal health status?” This was followed by an evaluation of specific interventions. The initial search identified 8,465 articles which were reduced to 16 studies based on content and quality. A “best evidence” synthesis approach was used to synthesize the literature.

Results: A moderate level of evidence was observed for the general question. Moderate evidence was observed for (1) exercise interventions and (2) multi-component patient handling interventions. Insufficient evidence of effect was observed for other identified intervention categories.

Discussion: Few high quality studies were found that examined the effects of interventions on musculoskeletal health in healthcare settings. Most interventions were in hospitals, and only one intervention was in a long-term care setting.

### **DAY THREE: THURSDAY, OCTOBER 23, 2008**

Session: **H1.0**

#### ***Title: Using Surveillance Systems to Identify Injury Characteristics in Construction***

Moderator: David Fosbroke

#### **H1.1**

#### ***Title: Fatal and Nonfatal Injuries in Construction Industry, 1992–2006***

Authors: **Dong S**, Men R, Fujimoto A

Introduction: The Center for Construction Research and Training (formerly known as the Center to Protect Workers’ Rights) has been monitoring construction safety and health to provide a basis for more effectively targeting injury and illness prevention efforts since 1990. This presentation summarizes the trends in fatal and nonfatal work-related injuries among construction workers from 1992 through 2006, the most recent years for which data were available.

Methods: Several large national datasets collected by the U.S. Census Bureau and the Bureau of Labor Statistics were used for this study, including the Census of Fatal Occupational Injuries, Survey of Occupational Injuries and Illnesses, Current Population Survey, and County Business Patterns. SAS version 9 was used for the data analysis.

Results: The construction industry continues to account for a disproportionate share of work-related deaths in the United States even though work-related deaths rates decreased from 1992 to 2006. Rates of nonfatal injuries and illnesses with days away from work declined for the goods-producing industries overall, but rates for construction remained the highest of the four major production industries. Falls are still the number one killer in construction. Being struck by an object, falls to a lower level, and overexertion in lifting continue to be the leading causes of nonfatal injuries. Among construction occupations, construction laborers ranked the highest in number of deaths from injuries. Ironworkers and electrical power line installers had the highest average death rates. During the study period, work-related deaths among Hispanic workers increased dramatically along with the growth of Hispanics in the construction workforce.

Conclusions: Overall, the construction sector continues to face serious challenges with regard to safety and health. Intervention strategies should focus on the leading causes of work-related fatal and nonfatal injuries, as well as vulnerable populations.

## H1.2

### *Title: Are Back Injuries in Carpenters Decreasing or Not?*

Authors: **Lipscomb H**, Dement J, Kucera K, Silverstein B, Cameron B

Introduction: In light of significant declines over 15 years in work-related back injuries from overexertion and more modest declines in acute traumatic injuries among a large cohort of union carpenters, we explored healthcare utilization for back problems through their private insurance coverage during the same time period.

Methods: Data from workers' compensation (WC) records were linked on an individual basis with records of health care utilization through the union healthcare trust for a dynamic cohort of 18,768 carpenters from 1989–2003. Yearly utilization rates for back disorders, based on months of insurance eligibility, were calculated over the 15 years and compared to patterns of workers' compensation back injuries. Rates of private healthcare utilization were also calculated before and after a work injury adjusting for age and gender.

Results: Sixty percent of the cohort did not seek medical care for back disorders through either WC or their healthcare trust; 10% sought care in both systems. WC claims for overexertion injuries were 62% lower in 2003 than in 1989 while healthcare utilization through the trust for back disorders increased 108%. Private healthcare utilization rates increased among carpenters with more WC injuries (1.3 for one work injury, 1.6 for two, 1.7 for three, 2.2 for four). Utilization patterns through the trust were slightly different for individuals following an acute traumatic work-related injury compared to those with overexertion injuries.

Discussion: The patterns observed raise concern that some work-related care for back disorders could have shifted to the carpenters' healthcare trust, particularly in later years. In any event, the analyses demonstrate interplay across the two healthcare delivery systems in this working population with insurance coverage. Even with the robust data available, these issues are difficult to clearly understand.

## H1.3

### *Title: Fractures in Construction: Activities, Events, Sources, and Disability Duration*

Authors: **Courtney T**, Brennan M, Matz S

Introduction: The construction industry continues to experience high rates of disabling injuries (second among major industry groups in 2005). Our earlier work suggested that fractures were among the most disabling injuries in the construction industry. We examined the construction claims experience of a large workers' compensation insurer with national coverage to better understand the activities, events, sources, and disability duration of these fractures.

Methods: We identified 899 fracture cases using ICD-9 and Current Procedural Terminology (CPT) codes, in addition to injury narratives. Disability duration was calculated from indemnity payments data using previously published methods. We analyzed injury event narratives to classify contributing antecedents for fractures. BLS OIICS was used to code antecedent factors. Activities were coded using a version of the BLS CFOI activities coding scheme modified to contain more construction-relevant activities.

Results: The average disability duration for a construction worker with a fracture was 97 days (median = 8 days). The fracture locations with the longest disability durations were the lower leg (median = 68 days), shoulder/upper arm (67 days), and knee (49 days). The most frequent events resulting

in fractures were being struck by falling objects (19.7%), struck by slipping handheld objects (11.8%), and falling from a ladder (6.6%). Falling objects were most frequently pipes and ducts, beams, and structural slabs. Hammers, powered drills and jackhammers were the most frequently noted slipping handheld objects. Work on ladders and lifting or loading/unloading materials operations were among the activities in which workers with the longest disability durations were engaged.

Discussion: These findings illustrate the importance of incorporating narrative text analysis and pursuing more granular level assessments of coding in large datasets to better refine our understanding of traumatic injury events such as fractures in construction.

#### **H1.4**

***Title: Relationships Between Medical Care and Paid Lost Time From Work After Work-Related Back Injury Among Washington State Union Carpenters***  
Authors: **Kucera KL**, Lipscomb HJ, Silverstein B

Introduction: Back injuries cause significant lost work time in construction. Beyond older age, differentiating those at risk of prolonged lost work time is difficult. We examined relationships between medical care provided for work-related back injuries due to overexertion and time off work among a cohort of carpenters.

Methods: Union records identified a dynamic cohort of 20,642 union carpenters who worked in Washington State from 1989–2003. These data were linked to Department of Labor and Industries workers' compensation files; data from this state-run program included records of medical care with diagnoses and provider type. Patterns of care received were examined by paid time loss status.

Results: Over 75,000 visits for medical care were identified over 15 years resulting from 2959 back injuries. Chiropractors (37%) and primary care providers (33%) were most frequent first providers followed by specialists (10%) and hospital/ER (9%); number of lost days differed significantly by first provider ( $p < 0.05$ ). Thirty-eight percent of those out 31–90 days and 24% out > 90 days never received physical therapy (PT). Individuals out of work for > 90 days were less likely to see a PT in the 30 days post injury (prevalence ratio = 1.7); mean days to first therapy increased with increasing time away from work (25, 50, and 114 days, respectively, for < 30 days, 30–90 days and > 90 days). Mean number of PT

visits in the 30 days after injury was greater among those out longer.

Discussion: Differences in cases based upon treatment in the first month after injury are worthy of further exploration. Although seeing a specialist as first provider was associated with delayed time away from work, being seen in an ER was not. Individuals with prior history of back problems may seek specialist care immediately after injury.

#### **Session: H2.0**

***Title: Injury Experience of Public Safety Workers***  
Moderator: Anita Schill

#### **H2.1**

***Title: Evaluating the Ambulance Patient Compartment as a Work Environment Using Digital Human Modeling Tools***  
Authors: **Ammons D**, Green J, Isaacs A, Moore P, Whisler R, White J

Introduction: Seat belts provided in most U.S. ambulances today do not allow emergency medical service (EMS) workers the mobility required to care for patients. As a result, EMS workers routinely work unrestrained in the patient compartment, daily risking their safety and health in the care of others. The use of mobile restraints, as previously tested by NIOSH, or the redesign of the workspace, as was done by the Winter Park (Florida) Fire and Rescue Department, offer opportunities to improve worker safety.

Methods: This research used digital human modeling tools to evaluate reach in both of these unique work environments. A matrix was developed to test three digital human body sizes, in two different work environments, each outfitted with two different restraint types: one fixed and one that allowed mobility. Each digital human then attempted to grab five different patient or equipment targets while remaining restrained. The underlying premise is that it is better to be restrained than unrestrained, and further, it is better to be restrained and seated than restrained but out of the seat.

Results: This study confirmed that severe limitations exist in today's ambulance environment as workers cannot reach the patient, or needed equipment, using the restraints provided. While mobile restraints offered a viable solution to this problem, the current configuration requires the worker to move substantial distances from the safety of the seat. The reconfigured workspace offered the worker a greater opportunity to

remain seated during patient care tasks though it alone did not solve all reach issues. With the addition of mobile restraint technology the models demonstrate the value of both changes.

Conclusions: Incremental improvement in worker safety can be achieved through innovative uses of mobile restraint systems in conjunction with the thoughtful placement and positioning of the worker, patient, and patient care equipment.

## **H2.2**

### ***Title: Occupational Injury Experiences of EMS Providers***

Author: **Heick RJ**

Introduction: Occupational injury is a significant problem among emergency medical service (EMS) providers, affecting their ability to perform their duties. A national survey was conducted to describe the problem of occupational injury among EMS providers.

Methods: This study examined the most common types of nonfatal injuries and the activities and environments where injury most frequently occurred. This study also examined the impact of multiple variables on odds of occupational injury.

Results: Occupational injury in the last 12 months was reported by more than 29% of 660 survey respondents, with multiple injuries reported by 64% of those reporting an injury. Paid providers had higher odds for overall injury (1.83, 95% CI 1.25–2.66) versus volunteers. A positive association was found between the number of calls responded to per week and increasing odds of overall injury. Paid providers also had higher odds for back injury (1.94, 95% CI 1.03–3.66) versus volunteers. Odds for overall injury and back injury were not affected by age, gender, length of service, or number of calls per week. Motor vehicle crashes were reported by 7% of paid and volunteer EMS providers, with all reported injuries occurring among paid providers. Odds of involvement in a motor vehicle crash did not vary significantly by paid versus volunteer status (1.08, 95% CI 0.55–2.10). One hundred forty-seven respondents reported physical assaults while working. No significant difference was found between paid and volunteer providers for occurrence of physical assault (1.21, 95% CI 0.74–1.97) or injury from assault.

Discussion: The results of this study indicate that occupational injury among EMS providers is indeed a serious problem. This study clearly identifies a variety

of injury issues, including the need to examine paid and volunteer providers as separate occupational groups when developing prevention programs.

## **H2.3**

### ***Title: Occupational Safety and Health for Public Safety Employees: Assessing the Evidence and Implications for Public Policy***

Authors: LaTourette T, Loughran D, **Seabury S**

Introduction: The provision of public safety is one of the most important responsibilities of government, and workers charged with protecting the public, such as police officers and fire fighters, are routinely asked to put their own lives at risk. As such, it is no surprise that public safety employees face much higher than average fatal and nonfatal occupational injury rates.

Methods: This work provides an in-depth study of the adverse health risks facing public safety employees. We combined in-depth literature reviews and new data analyses to characterize the types, causes, frequency, and severity of different injuries and illnesses suffered by public safety employees of different ages. This work was complemented with a series of roundtable discussions with numerous safety personnel to better understand the opportunities and challenges facing policies intended to reduce injuries and illnesses among police officers and fire fighters.

Results: An important goal of policymakers is to determine ways to help protect public safety employees from work-related injury and illnesses without compromising their ability to do their work. However, achieving this goal is hampered by a lack of solid information on the causes and consequences of adverse health events experienced by safety personnel.

Discussion: Using these findings, we discuss what is currently known about the different health risks facing safety employees and examine how well safety and health promotion policies align with these risks. Finally, we discuss the current gaps in our knowledge base and provide some guidance for future research. The research was cosponsored by the California Commission on Health and Safety and Workers' Compensation and the National Institute for Occupational Safety and Health.

## H2.4

### ***Title: Contrasting the Transportation Safety Data for Emergency Medical Services With Other Commercial Vehicles***

Author: **Levick N**

Introduction: To identify transportation safety data and data capture systems for EMS vehicles in contrast to commercial vehicles.

Methods: Search of published literature and online databases for EMS and commercial vehicle transportation safety data for years 1996–2005 via FMCSA and NHTSA, GES, and NASS. Analysis of data types of data captured nationally for these occupational environments.

Results: Estimates for ambulance fatality/mile traveled are 3–50 times large truck fatal crashes of 2.2/100 million miles traveled in 2005, with general estimates of 7.7 to 109 fatal crashes/100 million ambulance miles traveled. Estimates of 37 truck crashes injuries/100 million miles are well exceeded by ambulance estimates of crash injury of 308 to 4,360 injuries/100 million ambulance miles traveled. Ambulance in vehicle crash fatality percentage is double that for large trucks, with per vehicle fatality rates greater than three times higher for ambulance vehicles. The FMCSA data capture system provides extensive data on both numerator and denominator aspects of truck travel safety; however, EMS vehicles are exempt from the FMCSA data system. The NHTSA data fields captured for EMS were minimal with incomplete numerator data for both morbidity and mortality and virtually nonexistent denominator data.

Discussion: There appears to be wide disparity in the capture of transportation safety data between EMS and other commercial transport vehicles. The FMCSA database provides extensive detail on many aspects of truck safety—similar national data are not practically identifiable for EMS ground transport.

Conclusion: Ambulance transport is one of the most hazardous transport environments per vehicle and per mile traveled. Despite the high hazards of the EMS transport environment, comprehensive transportation safety data is not being captured nationally on the EMS transport system. Without this comprehensive data it is not possible to effectively define key safety determinants or measure the impact of safety interventions.

Session: **H3.0**

### ***Title: Safety Practices II***

Moderator: Guang Chen

## H3.1

### ***Title: Quantifying Workers' Hazard Identification Ability Using Fuzzy Signal Detection Theory***

Author: **Abdelhamid T**

Safeguarding construction workers from occupational hazards, whether arising from traumatic, ergonomic, and/or exposure accidents, is part and parcel of the lean construction ideal of waste elimination. This research applies Fuzzy SDT, proposed by Parasuraman et al. (2000), to increase the applicability of conventional SDT analysis to construction settings where the definition of a signal event and its associated response do not follow a binary or dichotomous structure. Application of the methodology is demonstrated using a pilot study involving structural steel workers. Results from the sample of 10 ironworkers indicated the average sensitivity in identifying hazards was above average and that workers generally adopted a conservative strategy. Data analysis using conventional SDT model showed a marginally increased sensitivity, but with a very high variation. This result illustrated that fuzzy SDT model was more reflective of the ability of construction workers to identify construction hazards.

## H3.2

### ***Title: The Reducing and Avoiding Injury Initiative: The Alberta Experience***

Authors: **Mughal W**, Wood N

Introduction: The Calgary Health Region is an integrated healthcare system with 29,000 employees and 2,300 physicians providing services to over 1.2 million people in the southern Alberta urban and rural regions. In 2007, the government ministry for Alberta healthcare provided the Region with almost \$8.5 million to reduce and avoid injuries to healthcare workers. This project outlines the substantial undertaking in organizing, prioritizing and preparing for the development, delivery and evaluation of a comprehensive safe client handling program for the Calgary Health Region.

Methods: Administrative data was acquired and organized by pay period, cost centre, location and program to provide worked hours, sick time, overtime, injury incidence and injury burden. Normalized data were calculated and examined to identify areas most likely to benefit from the intervention. A project steering committee was struck along with project task

groups to manage specific issues such as education/training and equipment selection. A comprehensive marketing strategy is being developed, and collaborations are being identified with the patient safety group for developing a comprehensive and industry-relevant evaluation framework for the initiative

Results: A comprehensive framework for developing, managing and evaluating this initiative is required for an undertaking of this size. The methodology employed not only identify what is needed to select the appropriate equipment, but also to develop strategies to support the safe and effective use of the purchased equipment. The projected time frame for the initiative is four years.

Discussion: A comprehensive approach for preventing musculoskeletal injuries has been supported in the literature, and this project represents a comprehensive strategy not only in its intended effect, but also in its construct. This project has its foundations in evidenced-informed decision-making, and seeks to maximize the benefit from having multiple stakeholder groups involved in the initiative from the outset.

### **H3.3**

#### ***Title: Building a Culture of Safety and Health Through Integrated Safety and Health Management System***

Authors: **Evangelista-Alvarez B**, Recaña R, Laqui MG

Introduction: The Integrated Safety and Health Management System is not just mere an Occupational Safety and Health (OSH) compliance program nor an advocacy but also as an important tool to build a culture of safety and health. This program's primary goal is to establish the link between safety and health programs including environment with productivity as one of the indices. It also aims to identify and determine the various factors and variables contributing to the success of the company's safety and health program and their effects to its overall productivity and more so to the employee culture towards OSH.

Method: The integrated OSH management system is implemented through programs committed to the protection of the environment and the health & safety of workers and meeting all applicable environment, health and safety laws, regulations and other requirements the company subscribes to. The programs also recognize that by integrating sound

environment, health and safety management practices into all aspects of the company processes and activities, technologically competitive products can be offered while conserving and enhancing resources for future generations.

Results: Continual improvement in our environment, health and safety management systems supported elimination of accidents, occupational injuries and workplace thereby creating a culture of safety and health. The subject of the research is a two-time winner of the Gawad Kaligtasan at Kalusugan Award, a national award for safety health given by country's Department of Labor and Employment.

Discussion: OSH programs presented would showcase linked safety and health programs including environment and productivity using integrated OSH and environment management system (ISO 14001, OHSAS 18001) and Zero Accident Program fully supported by combined effort of safety and health practitioners and workers with strong management support.

### **H3.4**

#### ***Title: Development of an Integrated Dataset for the Health Workplace Initiative***

Authors: Thomas-Olson L, Keen D, Brown MP

Introduction: QWL indicators have been identified in the literature as tools to help re-design work and make evidence-based organizational decisions. The use of "leading" and "trailing" indicators has been mentioned in the literature as a means of organizational health surveillance to determine the health of a workplace. Healthcare organizations maintain a number of internal databases with performance indicators from a variety of contexts. Published papers have noted that in order to gain insight into the "health" of a workplace, these internal databases should not be analyzed as independent, unrelated entities but rather regarded as components of a larger integrated model. The purpose of this project was to examine the feasibility of developing a comprehensive healthy workplace profile using patient and worker safety for the healthcare setting.

Methods: Data were extracted from administrative databases within a large healthcare organization for one calendar year to include patient safety adverse events, worker injury and organizational data. Datasets were integrated using department and sites as key fields. 1769 individual departments were identified within the final dataset.

Results: A total of 13 indicators were acquired, integrated and summarized. Data from four indicators were transformed into “full time equivalent” positions in order to contextualize costs associated with these variables. In addition to individual interpretations of each indicator, comprehensive tables with normalized and raw data were provided. Response to the initiative was very positive resulting in strategic goals reflecting these data integrated into the organization’s performance tracking system.

Discussion: Despite the challenges with integration of multiple, independent datasets, data integration is possible, and valuable, for large healthcare organizations. This project was a substantial undertaking to help a large organization understand the range of risk and loss occurring within its various systems, and to move it closer to the goal of “healthy people, healthy workplaces.”

Session: **H4.0**

**Title: Evaluations of Safety and Health Management Practices**

Moderator: Elyce Biddle

#### **H4.1**

**Title: Does a Safety and Health Management System Contribute to a Safer Work Environment?**

Authors: **Biddle EA**, Newell S, Hendricks S

Introduction: Managing occupational safety and health through management systems at the company level has become increasingly popular. However, little research has been conducted concerning the relationship between adopting a safety and health management system and the occupational injury and illness (OII) experience of an individual firm. This study examined the degree to which implementation of five key management system components contributed to a safer work environment.

Methods: Participating Fortune 200 companies were solicited to complete a two-module web survey. Module one requested annual OII rates. Module two requested self-rating on a scale of 1 (worst) to 4 (best) of the relative degree of implementation or the "percentage of process in place and completed toward established targets" for the following management system components:

Leadership Commitment and Support  
Employee Involvement  
Risk Identification and Elimination and Safe Practices

Accountability at All Levels  
Continuous Improvements

Results: Of the 91 companies that provided annual OII data, 73 provided management system information. OII total case rates ranged from .29 to 9.2 (mean = 1.88) in 2005 and .15 to 10.05 (mean = 2.28) in 2004. Days away from work (DAFW) case rates ranged from .02 to 2.07 (mean = .57) in 2005 and .08 to 2.96 (mean = .54) in 2004. The average score measuring the degree of management system implementation was 2.55, from 2.08 for Accountability to 2.82 in Continuous Improvements. System components were positively correlated with coefficients of .46 to .84. OLS regression indicated that implementing a management system reduced OII rates. Component pair analysis identified Leadership and Accountability as the best predictors for controlling OII, and Risk Identification as the best predictor for controlling DAFW cases.

Conclusions: This study demonstrated that implementing a management system with these five components contributed to lower OII rates. Because the respondents are among the most safety-conscious global enterprises, the results may not be generalizable.

#### **H4.2**

**Title: Development of a Comprehensive Working Alone Program for Community Care**

Authors: Odin J, Keen D, Thomas-Olson L,

Introduction: Past approaches to managing risk of personal injury to staff working alone have employed various controls, including check-ins, use of technology, or policies. No other Canadian healthcare organization has developed a comprehensive program to reduce risk of injury to community healthcare workers who work alone in the community in both urban and rural settings. This project aimed to develop and trial a comprehensive safety program for healthcare workers working alone in community settings.

Methods: A request was made from the joint OH&S committee to address the risks of staff members working alone in community settings. Areas represented included home support, mental health, environmental health, licensing, home health, and public health. A steering committee was struck to include representation from union OH&S committee members, management, and Workplace Health and Protection Services. Areas examined included needs assessment, intake processes for clients, and relevant

policies and procedures. Staff participating in the Working Alone Program (WAP) trial completed pre- and post- intervention surveys to determine the effectiveness of the program.

Results: Core components of the program included risk identification checklists, active check-in/check-out procedures, use of technology, additional security services, and education and training regarding risk identification and controls. The WAP pilot sites reported overall success in implementing most required elements. Statistical analysis showed that perception of risk, access to safety resources and awareness of the hazard reporting process all demonstrated statistically significant improvement from pre- to post-intervention. The safety climate score also increased from pre- to post-intervention.

Conclusion: Short-term outcomes include improved documentation and control of risk, and greater level of communication regarding risk among the various occupations in the community setting. Long-term goals of this program are to reduce incidence of worker safety events and sustainable improvement in safety culture.

#### **H4.3**

##### ***Title: Proactive Management: A Multilevel Communication Intervention in the Construction Industry***

Authors: **Moore JT**, Smith A, Cigularov K, Chen P

Introduction: Successful injury-prevention interventions should target all levels of the organization. Interventions focusing on psychosocial variables such as communication can add value to traditional safety programs. The present study describes an intervention targeted at increasing the frequency of safety communication skills across three levels (worker, supervisor, top management) at a general contractor in order to prevent injuries on the job.

Methods: The intervention took place at a general contractor in the Midwest. The first component involved training 24 foremen from five experimental jobsites on leadership communication skills using discussion, role plays, and goal setting. The second component involved meeting with the site-level supervision to explain how to support foreman transfer of training onto the job. The third component was aimed at the tradesman and laborer level of the organization, and involved a communication campaign

with posters, safety talks, and paycheck stuffers supporting the importance of safety feedback and sharing near misses in injury and accident prevention.

Results: A pre-intervention assessment of communication climate and employee injuries was collected in October, indicating that the company most needed to improve on sharing near misses and daily verbal exchanges with supervisors. The post-intervention assessment is currently being collected. Pre- and post-training surveys of the foreman workshop indicated that the training changed participants' self-efficacy for giving positive recognition to their crews, and that affective reactions to the training were moderately high. Surveys of the communication campaign indicated that most employees felt the campaign was "very useful" or "somewhat useful" and that the safety talk materials were the workers' favorite component.

Discussion: We hope to see a reduction in injuries reported from the October assessment and an increase in reported frequency of supervisor safety communication skills by workers. Future research should examine the most effective ways to teach safety communication in contractor settings.

